Viva and OSCE Exams in Ophthalmology

A Revision Study Guide

Timothy H. M. Fung
Winfried M. K. Amoaku
Editors

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Preface

There are numerous books and online resources that you may find useful in preparation for the oral component of ophthalmology examinations. This particular book attempts to amalgamate all these resources together in one text. We hope prospective candidates will find it useful in the preparation for their examination, and subsequently as a reference text.

The book is aimed predominantly for those preparing for the FRCOphth Part 2 Fellowship Oral Component. Each chapter of the book is therefore based on a station of the FRCOphth Part 2 Fellowship Oral Component. We have tried to cover all the essential topics required for the examination in an accessible and concise way. We hope this book will also be useful for candidates preparing for other ophthalmology membership or fellowship exams and any allied health professionals who want to broaden their general ophthalmology knowledge base. For the latter candidates, the individual chapters may not be an exact fit of their examination. However, the knowledge and basic information of technique and preparations remain the same.

To all prospective candidates, we wish you every success in the examination and your future career and hope this book will contribute in some way to your success.

Nottingham, UK — Timothy H. M. Fung
Nottingham, UK — Winfried M. K. Amoaku

Contents

Abbreviations

AAC	Acute angle closure
ABK	Aphakic bullous keratopathy
AC	Anterior chamber
ACE	Angiotensin converting enzyme
ACG	Angle closure glaucoma
ACIOL	Anterior chamber intraocular lens
AD	Autosomal dominant
AF	Atrial fibrillation
AION	Anterior ischaemic optic neuropathy
AKC	Atopic keratoconjunctivitis
AL	Axial length
AMD	Age-related macular degeneration
ANA	Anti-nuclear antibodies
ANCA	Anti-neutrophil cytoplasmic antibodies
APMPPE	Acute posterior multifocal placoid pigment epitheliopathy
AR	Autosomal recessive
ARN	Acute retinal necrosis
AZT	Azathioprine
BCC	Basal cell carcinoma
BCL	Bandage contact lens
BCVA	Best corrected visual acuity
BD	Twice a day
BK	Band keratopathy
BMD	Best's macular dystrophy
BMO-MRW	Bruch's membrane opening-minimum rim width
BP	Blood pressure
BPES	Blepharophimosis epicanthus syndrome
BRAO	Branch retinal artery occlusion
BRVO	Branch retinal vein occlusion
BSV	Binocular single vision
CAR	Cancer-associated retinopathy
CAS	Clinical activity score
CCT	Central corneal thickness
CDR	Cup-to-disc ratio
CHED	Congenital hereditary endothelial dystrophy
CJD	Creutzfeldt–Jakob disease
CKD	Chronic kidney disease

CL	Contact lens
CLRAO	Cilioretinal artery occlusion
CME	Continuing medical education
CMO	Cystoid macular oedema
CMV	Cytomegalovirus
CN	Cranial nerve
CNLDO	Congenital nasolacrimal duct obstruction
CNS	Central nervous system
CNV	Choroidal neovascular
COAG	Chronic open angle glaucoma
CPD	Continuing professional development
CPEO	Chronic progressive external ophthalmoplegia
CPSD	Corrected pattern standard deviation
CRA	Central retinal artery
CRAO	Central retinal artery occlusion
CRP	C-reactive protein
CRVO	Central retinal vein occlusion
CSF	Cerebrospinal fluid
CSMO	Clinically significant macular oedema
CSNB	Congenital stationary night blindness
CSR	Central serous chorioretinopathy
CT	Computed tomography
CTA	Computed tomography angiography
CTR	Capsular tension ring
CVA	Cerebrovascular accident
CWS	Cotton wool spot
CXR	Chest X-ray
DALK	Deep anterior lamellar keratoplasty
DCG	Dacryocystography
DCR	Dacryocystorhinostomy
DESP	Diabetic eye screening programme
DIC	Disseminated intravascular coagulation
DM	Diabetes mellitus
DME	Diabetic macular oedema
DMEK	Descemet's membrane endothelial keratoplasty
DMO	Diabetic macular oedema
DR	Diabetic retinopathy
DSAEK	Descemet's stripping automated endothelial keratoplasty
DSEK	Descemet's stripping endothelial keratoplasty
DSG	Dacryoscintigraphy
EBMD	Epithelial basement membrane dystrophy
EBV	Epstein–Barr virus
ECG	Electrocardiogram
ECLO	Eye clinic liaison officer
ED	Epithelial defect
EDT	Electrodiagnostic tests
EMG	Electromyography
EMGT	Early manifest glaucoma trial

EOG	Electrooculogram
EOM	Extraocular muscle
EPP	Exposure prone procedures
ERG	Electroretinogram
ERM	Epiretinal membrane
ESR	Erythrocyte sedimentation rate
ET	Esotropia
ETDA	Ethylenediaminetetraacetic acid
FAF	Fundus autofluorescence
FB	Foreign body
FBC	Full blood count
FED	Fuchs endothelial dystrophy
FFA	Fundus fluorescein angiogram
FHx	Family history
GA	Geographic atrophy/general anaesthetic
GCA	Giant cell arteritis
GDI	Glaucoma drainage implant
GHT	Glaucoma hemifield test
GI	Gastrointestinal
GMC	General medical council
GP	General practitioner
GPA	Granulomatosis with polyangiitis
GPC	Giant papillary conjunctivitis
GRT	Giant retinal tear
HES	Hospital eye service
HM	Hand motions
HRT	Heidelberg retinal tomograph
HSV	Herpes simplex virus
HTLV-1	Human T-lymphotropic virus-1
HTN	Hypertension
HVF	Humphrey visual field
Hx	History
HZV	Herpes zoster virus
ICA	Internal carotid artery
ICE	Iridocorneal endothelial
ICK	Infectious crystalline keratopathy
ICP	Intracranial pressure
IFIS	Intraoperative floppy iris syndrome
IIH	Idiopathic intracranial hypertension
IK	Interstitial keratitis
ILM	Inner limiting membrane
IM	Intramuscular
INO	Internuclear ophthalmoplegia
IOFB	Intraocular foreign body
IOL	Intraocular lens
IOP	Intraocular pressure
IR	Inferior rectus
IRF	Intraretinal fluid

IRMA	Intraretinal microvascular abnormalities
ITC	Iridotrabecular contact
IV	Intravenous
IVCM	In vivo confocal microscopy
JIA	Juvenile idiopathic arthritis
KC	Keratoconus
KP	Keratic precipitates
LASIK	Laser-assisted in situ keratomileusis
LCA	Leber congenital amaurosis
LCAT	Lecithin-cholesterol acyltransferase
LESC	Limbal epithelial stem cell
LF	Levator function
LFT	Liver function test
LHON	Leber hereditary optic neuropathy
LP	Lumbar puncture
LR	Lateral rectus
LRI	Limbal relaxing incision
LTS	Lateral tarsal strip
MA	Microaneurysm
MacTel	Macular telangiectasia
MALT	Mucosa-associated lymphoid tissue
MAR	Melanoma-associated retinopathy
MD	Mean defect
MFC	Multifocal choroiditis and panuveitis
mfERG	Multifocal electroretinogram
MG	Myasthenia gravis
MGD	Meibomian gland dysfunction
MH	Macular hole
MI	Myocardial infarction
MIGS	Minimally invasive glaucoma surgery
MR	Medial rectus
MRA	Magnetic resonance angiography
MRD1	Marginal reflex distance 1
MRI	Magnetic resonance imaging
MS	Multiple sclerosis
MTX	Methotrexate
NAI	Non-accidental injury
NF	Neurofibromatosis
NFL	Nerve fibre layer
NLD	Nasolacrimal duct
NLDO	Nasolacrimal duct obstruction
NPDR	Non-proliferative diabetic retinopathy
NSAIDS	Non-steroidal anti-inflammatory drugs
NTG	Normal tension glaucoma
NVA	Neovascularisation of the angle
NVD	Neovascularisation of the disc
NVE	Neovascularisation elsewhere
NVG	Neovascular glaucoma
NVI	Neovascularisation of the iris

OCP	Oral contraceptive pill/ocular cicatricial pemphigoid
OCT	Optical coherence tomography
OD	Once a day
OIS	Ocular ischaemic syndrome
ORT	Outer retinal tubulations
OSA	Obstructive sleep apnoea
OVD	Ophthalmic viscosurgical devices
PA	Palpebral aperture
PAC	Primary angle closure
PACG	Primary angle closure glaucoma
PACS	Primary angle closure suspect
PAN	Polyarteritis nodosa
PAS	Peripheral anterior synechiae
PBK	Pseudophakic bullous keratopathy
PC	Posterior capsule
PCG	Primary congenital glaucoma
PCIOL	Posterior chamber intraocular lens
PCR	Polymerase chain reaction
PCV	Polypoidal choroidal vasculopathy
PDP	Personal development plan
PDR	Proliferative diabetic retinopathy
PDS	Pigment dispersion syndrome
PDT	Photodynamic therapy
PED	Pigment epithelial detachment
PERG	Pattern electroretinogram
PESS	Post enucleation socket syndrome
PGAs	Prostaglandin analogues
PI	Peripheral iridotomy
PK	Penetrating keratoplasty
PL	Perception of light
PMD	Pellucid marginal degeneration
POHS	Presumed ocular histoplasmosis syndrome
PPA	Peripapillary atrophy
PPCD	Posterior polymorphous corneal dystrophy
PPV	Pars plana vitrectomy
PRP	Panretinal photocoagulation
PSD	Pattern standard deviation
Pt	Patient
PTK	Phototherapeutic keratectomy
PVD	Posterior vitreous detachment
PVR	Proliferative vitreoretinopathy
PXF	Pseudoexfoliation
RA	Rheumatoid arthritis
RAP	Retinal angiomatous proliferation
RAPD	Relative afferent pupillary defect
RCOphth	Royal College of Ophthalmologists
RCT	Randomised controlled trial
RD	Retinal detachment
RK	Radial keratotomy

RNFL	Retinal nerve fibre layer
RNIB	Royal national institute of blind people
ROP	Retinopathy of prematurity
RP	Retinitis pigmentosa
RPE	Retinal pigment epithelium
RRD	Rhegmatogenous retinal detachment
RVO	Retinal vein occlusion
SAC	Seasonal allergic conjunctivitis
SCD	Schnyder's crystalline dystrophy
SCR	Sickle cell retinopathy
SD-OCT	Spectral domain optical coherence tomography
SF	Short-term fluctuations
SJS	Stevens–Johnson syndrome
SLE	Systemic lupus erythematosus
SLO	Scanning laser ophthalmoscopy
SLT	Selective laser trabeculoplasty
SO	Sympathetic ophthalmia
SPA	Subperiosteal abscess
SR	Superior rectus
SRF	Subretinal fluid
STI	Sexually transmitted infection
TA	Triamcinolone
TAB	Temporal artery biopsy
TASS	Toxic anterior segment syndrome
TB	Tuberculosis
TBUT	Tear film break up time
TED	Thyroid eye disease
TEN	Toxic epidermal necrolysis
TIA	Transient ischaemic attack
TM	Trabecular meshwork
TPD	Training programme director
TTP	Thrombotic thrombocytopenic purpura
UES	Uveal effusion syndrome
URTI	Upper respiratory tract infection
US	Ultrasound
VA	Visual acuity
VDRL	Venereal disease research laboratory
VEGF	Vascular endothelial growth factor
VEP	Visual evoked potential
VF	Visual field
VFI	Visual field index
VHL	Von Hippel–Lindau
VKC	Vernal keratoconjunctivitis
VKH	Vogt–Koyanagi–Harada
VMT	Vitreomacular traction
VR	Vitreoretinal
XR	X-linked recessive
XT	Exotropia

Part I

Structured VIVA

VIVA Technique: Do's and Don'ts

1

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1.1 Formalities

- It is expected that you have prepared yourself for the examination (and not there for a rehearsal)
- Ensure that you have adequate amounts of sleep and rest in the lead up to the exam
- Dress professionally on the day of the exam
- Arrive at the exam venue in good time

1.2 Answering Examiners Questions

- Listen to the questions
- Answer the question that you have been asked
- Take a moment or two to gather your thoughts before answering the questions
- Maintain eye contact with the examiner when talking (and not at the floor, or elsewhere!)
- Speak clearly and succinctly. Do not speak too quietly or too quickly
- Try to give a well-structured answer to the questions
- Be confident in your answer if you think you are right, but do not argue with the examiner!
- The examiner may ask "*are you sure?*" in response to your answer. Have a think about your answer and do not feel afraid to stick to your answer (if you believe it to be correct), or afraid to retract statements (if you feel you were wrong)
- If you do not know the answer to a question, be honest and say so
- Really important that you avoid saying anything that would pose a danger to patients

1.3 Communications Skills (for the Communication Skills Station)

- Practice with your colleagues and fellow candidates before your real VIVA examination. Watch good communicators at work to see how they would handle different scenarios
- Try to imagine yourself with a real-life patient in your communication skills scenario

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- Always maintain good eye-contact, show good body language and show empathy
- Do not forget to introduce yourself and to check the patient's identity before proceeding
- Remember to keep the delivery of information to the patient (actor) simple with the avoidance of medical jargon
- Remember to identify and address any patient concerns

1.4 When You Think Things Are Going Badly

- Remember that difficult stations are likely to be difficult to all candidates
- Each VIVA station is marked separately. Try to stay positive (easier said than done) if you feel you have performed badly in a particular station. A poor performance in a station does not necessarily mean that you will fail the exam overall.

2 Patient Investigations and Interpretation

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2.1 Optical Coherence Tomography (OCT)

2.1.1 Principles

- OCT is based on the principle of low-coherence interferometry, in which the signal carrying light returning from the eye is allowed to interfere with light that has travelled a known path length. This is achieved in a Michelson interferometer.
- Infrared (830 nm) incident beam created by a superluminescent diode source is divided into two beams by a beam splitter. One beam axially project to the patient's retina whist the second beam (internal reference beam) is projected to a reference mirror at a known distance.
- When the two light beams (internal reference beam and the back-scattered and back-reflected light from the retina) attempt to recombine at a detector, the reference beam must be altered in order to combine with the diagnostic beam.
- The amount the reference beam is altered compared to its baseline to match the probe signal (optical path length difference) results in a signal generation (Fig. 2.1).

2.1.2 Indications

- Anterior segment pathology
- Macular pathology (see Sect. 2.1.3)
- Optic nerve pathology (see Sect. 2.1.4)

2.1.3 OCT Images of Common Macular Pathologies

2.1.3.1 Macular Oedema (Fig. 2.2)

Causes of Macular Oedema

- Inflammatory disorders: post-operative (cataract, VR, corneal), post-laser (PI, PRP), post-cryotherapy, uveitis (anterior/intermediate/posterior)
- Retinal vascular diseases: DR, RVO, OIS, hypertensive retinopathy, radiation retinopathy, MacTel
- Choroidal vascular disease: CNV
- Drugs: latanoprost, topical adrenaline, glitazones, niacin, chemotherapy agents (e.g. paclitaxel)

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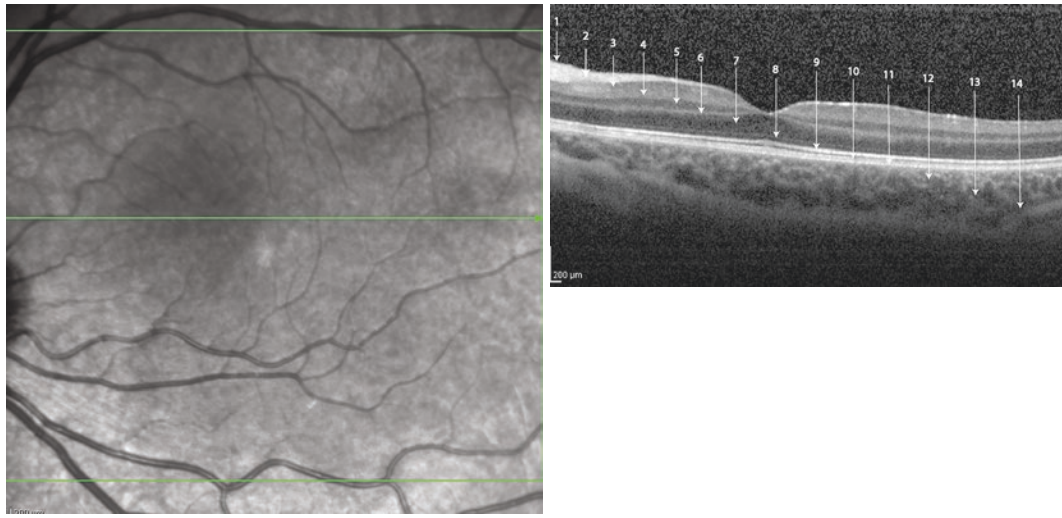

Fig. 2.1 OCT image of a patient with a normal macula. 1: Inner Limiting Membrane; 2: Nerve Fiber Layer; 3: Ganglion Cell Layer; 4: Inner Plexiform Layer; 5: Inner Nuclear Layer; 6: Outer Plexiform Layer; 7: Outer Nuclear Layer; 8: External Limiting Membrane; 9: Ellipsoid Zone; 10: Interdigitation Zone; 11: RPE/Bruch's Complex; 12: Choriocapillaris; 13: Sattler's Layer; 14: Haller's Layer

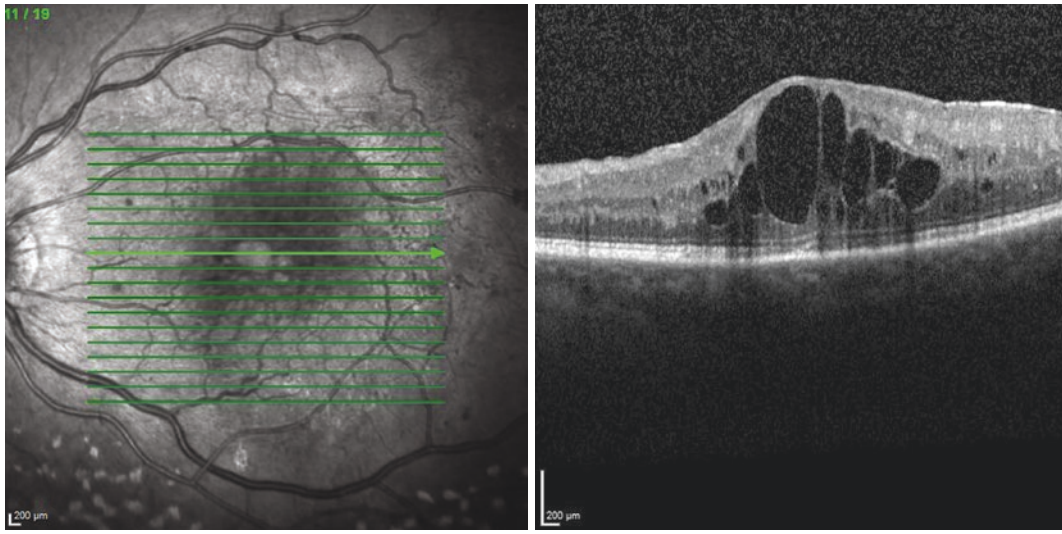

Fig. 2.2 OCT image of a patient with macular oedema. There are large intraretinal hyporeflective spaces (cysts) with an intact RPE/Bruch's membrane complex and ILM

- Inherited retinal dystrophies: RP, autosomal dominantly inherited CMO
- Disorders of vitreoretinal interface: VMT, ERM
- Optic nerve head abnormalities: optic disc pit, optic disc coloboma
- Tumours of the choroid/retina

Mechanisms of Macular Oedema

- Increased vascular permeability: PGAs, VEGF, loss of vascular structure or vascular wall dysfunction — DR, RVO, uveitis, posterior scleritis
- Increased blood flow — post-op

- Dysfunction of RPE barrier/pump: retinal dystrophies
- Tractional stress — VMT, ERM (may not be true oedema, but tractional disruption of macula architecture)
- Drug reactions
- Fluid migration from optic nerve head abnormalities — optic disc pit

History

- Past medical history: diabetes, hypertension, hypercholesterolaemia, coagulopathies (e.g. myeloma) or autoimmune conditions, any previous radiation exposure of orbit, globe, sinuses or nasopharynx
- Past ocular history: any previous operations or laser procedures
- Social history: smoker
- Drug history: prostaglandin analogues, glitazones, topical epinephrine, nicotinic acid, OCP
- Family history: retinal dystrophies, autosomal dominantly inherited CMO

Examination

- Visual acuity
- Blood pressure: hypertension in RVO and hypertensive retinopathy
- RAPD: Ischaemic CRVO
- Prominent collateral vessels on forehead (connect external carotid artery on one side of head to the other): OIS
- IOP: may be low in OIS from ciliary body hypoperfusion, may be high in patients with NVA
- AC for flare/cells: OIS — flare out of proportion to cells, post-op, post-laser, post-cryotherapy, uveitis
- Gonioscopy for NVA: DR, OIS, RVO, radiation retinopathy
- Examine undilated iris for rubeosis: DR, OIS, RVO, radiation retinopathy
- Anterior vitreous for cells: uveitis
- Fundus examination: snowballs/snowbanking (intermediate uveitis), chorioretinal lesions (posterior uveitis), optic disc pits and colobomas, optic disc swelling (CRVO, hypertensive retinopathy), retinal haemorrhages (DR — bilateral, RVO — unilateral, OIS — unilateral, hypertensive retinopathy — bilateral, radiation retinopathy — bilateral), tortuosity and dilatation of retinal veins (RVO, OIS only has dilated veins with no tortuosity, DR — dilated and beaded), venous beading and IRMA (DR), attenuation of retinal arteries (OIS, RP), NVD/NVE (DR, OIS, RVO), bone spicules and waxy pale optic disc (RP), hard exudates at posterior pole (DR), retinal/choroidal masses

Investigations

- Fasting glucose and lipids: DR, OIS
- FBC, BP, Glucose, ESR: RVO (The Royal College of Ophthalmologists 2015 Retinal Vein Occlusion Guidelines)
- B-scan (choroidal mass)
- OCT: ERM, VMT, RVO (CMO respects horizontal raphe)
- FFA:
  - Delayed arm-to-choroid and arm-to-retina (normally 8–12 s) circulation times (depend whether dye injected in ACF or hand): OIS
  - Patchy and/or delayed choroidal filling [choroidal filling normally complete within 5 s after the first appearance of dye]: OIS, *not* present in CRVO or DR
  - Prolongation of the retinal AV transit time (major retinal veins in the temporal vascular arcade are completely filled normally within 10–11 s after the first appearance of dye within the corresponding retinal arteries): OIS, RVO, CRAO
  - Petaloid pattern of leakage: CMO
  - Capillary non-perfusion: RVO, OIS, DR
  - Staining of retinal vessel walls: OIS — arteries stain more than veins, RVO — only veins stain
  - Hyperfluorescence of optic disc: OIS, RVO, absent in DR
  - Early hyperfluorescence and late leakage suggestive of NVD or NVE: OIS, RVO, DR
- Carotid artery imaging (e.g. carotid artery duplex scan to look for 90% or more internal or common carotid artery stenosis: OIS

Management

- Co-manage with GP/physicians for systemic vascular risk factors (DR, RVO, OIS).
- Stop predisposing drugs if possible
- Carotid endarterectomy (OIS)
- PRP if NVI, NVD or NVE present (DR, RVO, OIS, Radiation retinopathy)
- Macular oedema — laser (RVO, DMO, optic disc pit), intravitreal anti-VEGF (DMO, RVO), topical steroids/NSAIDS (post-op, post-cryo, post-laser), peri-ocular steroid (post-op, post-cryo, post-laser, non-infectious uveitis), intravitreal TA (post-op), Ozurdex (DMO, non-infectious uveitis), Iluvien (DMO), topical/oral CAIs (RP), oral prednisolone (post-op, non-infectious uveitis)
- CNV — intravitreal anti-VEGFs (Eylea, Lucentis, Avastin)
- PPV (VMT) / PPV + ERM peel (ERM)

2.1.3.2 Subretinal Fluid (SRF) at the Fovea (Fig. 2.3)

Causes

- CSR
- AMD
- PCV
- Infections and inflammatory disorders — POHS, VKH/SO, posterior scleritis, UES
- Optic disc pit with serous macular detachment
- Tumours — choroidal melanoma, choroidal haemangioma, choroidal metastases, choroidal osteoma, leukaemic infiltrates
- Vascular disorders — SLE, PAN, scleroderma, dermatomyositis, relapsing polychondritis, DIC/TTP, toxaemia of pregnancy, malignant HTN
- Dome shaped maculopathy (High myopia without CNV) — cap of hyporeflective subretinal space ('SRF') in absence of CNV, associated with inward bowing of the sclera-choroid complex in the central area.

History

- Ask about risk factors for CSR — steroid use (all forms), pregnancy, Hx of cushings disease
- Ask about risk factors for AMD — smoking, diet, spectacle prescription (hypermetropia), HTN, hypercholesterolaemia
- Ask about risk factors for PCV — HTN
- Ask about history of known primary tumour — choroidal metastases
- Ask about symptoms of vascular disorders — SLE (rashes, photosensitivity, chest pain, arthritis, oral ulcers, seizures), scleroderma (raynaud's phenomenon), dermatomyositis (pains and weakness in the shoulders or hips, rash affecting eyelids — heliotrope, cheeks, nose, chest, and extensor surfaces), relapsing polychondritis (ear and nose pain)

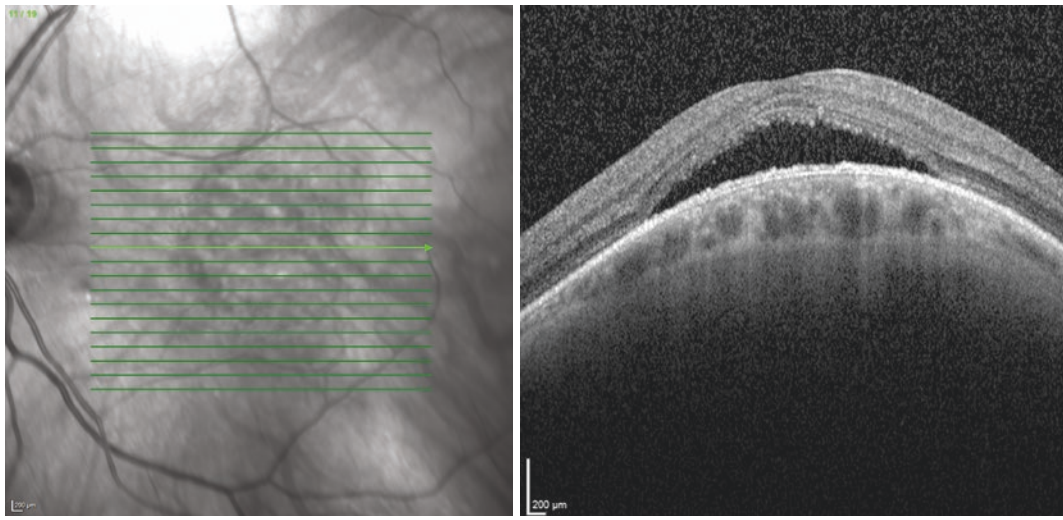

Fig. 2.3 OCT scan showing subretinal fluid at the fovea

Examination

- Look for signs of Cushings disease (moon shaped face, buffalo neck hump, purple abdominal striae), well-demarcated oval shaped area of neurosensory RD in posterior pole — CSR
- Look for drusen, RPE focal hyperpigmentation, GA — AMD
- Look for protruding orange red elevated subretinal lesions, subretinal haemorrhage, subretinal lipid exudation — PCV
- Look for presence of peripheral "punched out" chorioretinal lesions, PPA, and arcuate striae in the mid-periphery — POHS
- Look for presence of vitritis, optic disc hyperaemia, dalen fuch nodules (peripheral yellow white choroidal granulomas), sugiura sign (perilimbal vitiligo), associated systemic manifestations (vitiligo, poliosis, alopecia) — VKH/SO
- Look for ciliochoroidal detachments (brown-orange, solid-appearing elevations with smooth, convex surfaces. Choroidal detachments do not undulate appreciably with ocular movements, and this helps to distinguish them from RRD), visible ora serrata without scleral indentation, leopard spots in the fundus (diffuse depigmentation and multifocal hyperplasia of RPE) — UES
- Look for optic disc pit
- Look for creamy yellow mass in posterior pole — choroidal metastases, choroidal osteoma
- Look for circumscribed orange-red elevated mass posterior to equator — choroidal haemangioma
- Look for signs of vascular disorders — SLE (malar rash, discoid rash, oral ulcers, arthritis, pericarditis, pleuritis), scleroderma (thickening and tightening of skin especially in hands and fingers), dermatomyositis (rash affecting eyelids — heliotrope, cheeks, nose, chest, and extensor surfaces, plaques over knuckles of fingers — Gottron's papules), relapsing polychondritis (auricular nasal chondritis)
- Check BP and look for signs of malignant HTN (optic disc swelling, retinal haemorrhages, CWS, focal arteriolar narrowing, choroidal infarcts that are focal (elschnig's spots — grey-yellow spots) or linear along choroidal arteries (siegrist's streaks — linear hyperpigmented streaks)

Investigations

- Liaise with GP/medics to rule out suspected Cushings disease if signs are present — request a 24 h urine collection for cortisol
- Liaise with GP/medics to rule out suspected SLE (urine dip for proteinuria, thrombocytopenia, lymphopenia, ANA, anti-dsDNA), PAN, scleroderma (CXR — pulmonary fibrosis), dermatomyositis (raised ESR, muscle biopsy, elevated skeletal muscle enzymes, abnormal EMG), or relapsing polychondritis if suspected.
- B scan — T sign (scleral thickening with a echolucent area at the posterior pole behind the echo of the sclera) for posterior scleritis, smooth thick dome-shaped membrane with little after movement in UES, low internal reflectivity (choroidal melanoma), high internal reflectivity (choroidal metastases, choroidal osteoma, choroidal haemangioma)
- FFA — ink blot/expansile dot pattern (CSR), smoke stake (dye rises within the neurosensory detachment and expands laterally in a mushroom-like or umbrella-like fashion at the upper limit of the detachment — only present in 10% of cases of CSR)
- ICG (choroidal lesions less obscured than FFA as ICG absorbs and emits near-infrared light, which readily penetrates the RPE and binding affinity of ICG to plasma proteins means that it does not leak from the choriocapillaris in the same was as fluorescein) — look for branching network of inner choroidal vessels (PCV), nodular polypoidal aneurysms or dilatation at the edge of these abnormal vessel networks (PCV), look for mutifocal hyperpermeable choroidal patches that are best seen as areas of hyperfluorescence in the mid-phase (CSR)

Management

- AMD
  - Intravitreal anti-VEGF (aflibercept [Eylea], ranibizumab [Lucentis], bevacizumab [Avastin]; know regulatory status)
- PCV
  - Verteporfin PDT + ranibizumab (EVEREST II study): after 12 months, combination therapy of ranibizumab plus verteportin PDT was not only non-inferior but also superior to ranibizumab monotherapy in best-corrected visual acuity and superior in complete polyp regression while requiring fewer injections (Koh et al. 2017)
- CSR
  - Conservative: CSR has high rate of spontaneous remission (80% spontaneously recover to 6/12 VA or better within 1–6 months). Pregnancy related CSR usually resolves 1–2 months post-delivery. Lifestyle modification and avoidance of glucocorticoid medication
  - Indications for intervention in CSR: persistence for at least 4 months, multiple recurrences, occupational needs, contralateral persistent visual impairment from CSR
  - Laser photocoagulation: extrafoveal CSR; (caution with potential visual loss)
  - Half-fluence PDT: subfoveal CSR
  - Eplerenone: not superior to placebo for improving BCVA in people with treatment naive chronic CSR (4 months or more) after 12 months of treatment (Lotery et al. 2020)

2.1.3.3 Pigment Epithelial Detachment (PED) (Fig. 2.4)

Causes of a PED

- AMD (see Sect. 10.7)
- PCV
- Idiopathic CSR
- Ocular inflammation — VKH/SO
- Multifocal idiopathic PEDs

Classification of PED

- Drusenoid PED: represents large areas of confluent soft drusen)
- Serous PED
- Fibrovascular PED: growth of a CNV membrane in the sub-RPE space — type 1 CNV membrane
- Haemorrhagic PED: blood from CNV lesion is noted beneath or exterior to the RPE

Natural History of PED

- The spontaneous rate of RPE tear in the natural history of serous/fibrovascular PED associated with AMD has been reported to be 10% (Casswell et al. 1985).
- At 5 years, 19% and 23% of patients with drusenoid PED associated with AMD progress to geographic atrophy and neovascular AMD, respectively (Cukras et al. 2010).
- Most recognised risk factor for RPE tear is a large PED height (more than 400 μm). Additional risk factors include larger PED diameters and small ratio of CNV size to PED size.

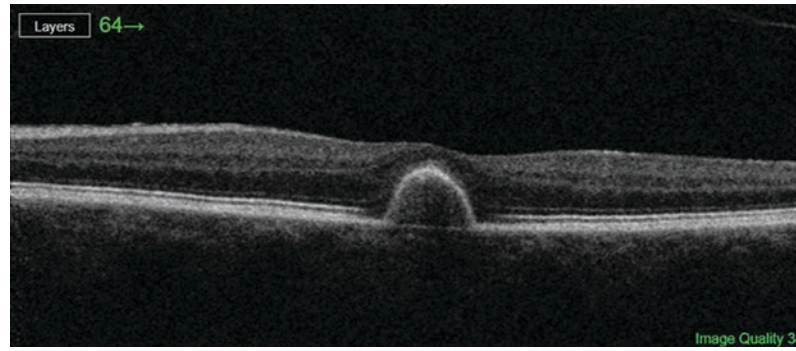

Fig. 2.4 OCT image of a patient with a PED

Examination

- Drusenoid PED: appear as well-circumscribed yellow or yellow-white elevations of the RPE that are usually found within the macula. They may have scalloped borders and a slightly irregular surface.
- Serous PED: appear as a distinct circular or oval-like detachment of the RPE. Clear or yellowish-orange in colour, this dome shaped elevation of the RPE has a sharply demarcated border
- Fibrovascular PED: seen as an irregularly elevated lesion on clinical examination; flattened or notched border of the PED is a frequent and important sign of hidden associated CNV. Yellow subretinal or intraretinal exudates that occur typically at the PED margins, subretinal haemorrhages at PED margins, sub-RPE blood which appears darker than subretinal blood with a fluid level sign, irregular elevation of the PED, radial chorioretinal folds surrounding the PED are caused by the contraction of Bruch membrane and the CNV.

Investigations

- OCT:
  - Elevation of highly reflective external band, which usually conforms to a concave smooth elevation with an optically quiet zone within the dome-shaped elevation. The highly reflective band should be continuous on both sides of the PED; a discontinuity may raise suspicion for an RPE tear or could be the result of blocking of the incident OCT beam by overlying exudate, blood, or fibrosis.
  - Drusenoid PED — smooth contour of detached hyperreflective RPE band that may demonstrate an undulating appearance with moderate or high hyperreflectivity
  - Serous PED (see Fig. 2.5) — appear as dome shaped elevation of the RPE seen overlying a homogenously hyporeflective space, with Bruch's membrane often visible as a thin hyper-reflective line at the outer aspect of the PED
  - Fibrovascular PED (see Fig. 2.6) — appear as broad elevations of the RPE band rela-

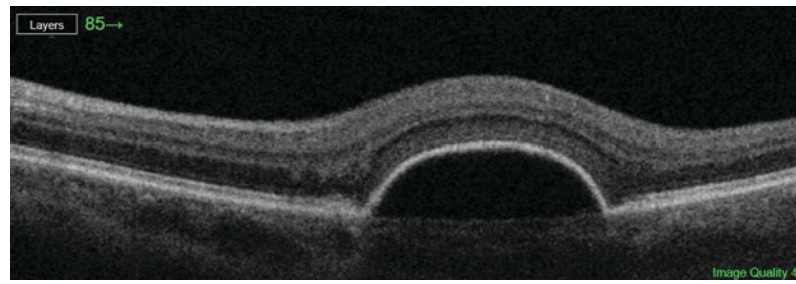

Fig. 2.5 OCT image of a patient with a serous PED

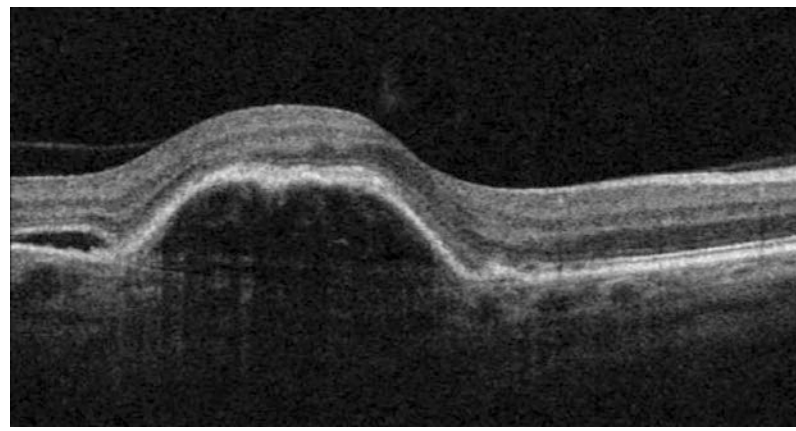

Fig. 2.6 OCT image showing a fibrovascular PED with adjacent SRF

tive to Bruch's membrane that are filled with solid layers of medium reflectivity separated by hyporeflective clefts

- FFA:
  - Serous PED — uniform bright intense hyperfluorescence in the early phase, with a smooth contour to the RPE by the middle phase, and little, if any, leakage at the borders of the PED by the late phase. Brisk progressive pooling within the serous PED in a homogenous and well-demarcated manner. Late staining of serous PED is typical.
  - Fibrovascular PED (see Sect. 2.2) — stippled hyperfluorescence along the surface of the RPE by the middle phase and may show pooling of dye in the overlying subsensory retinal space in the late phase.
  - Drusenoid PED — hyperfluorescence faintly during the transit and do not progress to bright hyperfluorescence in the late phase. No late leakage will be present.
  - Look for ink blot/smoke stake pattern: CSR
- ICG:
  - Look for branching vascular network (BVN) — PCV
  - Look for hyperfluorescent hot spot — RAP

2.1.3.4 Retinal Pigment Epithelium (RPE) tears

Causes of RPE Tears

- Long standing substantial sub-RPE fluid collection due to active CNV (spontaneous RPE tear).
- Following verteporfin PDT or laser photocoagulation of lesions overlying a serous PED.
- Following intravitreal injections of anti-VEGF agents.

Mechanisms of RPE Tears

- RPE is put on stretch as a result of increasing or considerable SRF accumulation, and contraction of fibrovascular element of CNV; this stress leads to a tear in the RPE. Tear occurs at junction of detached and attached RPE.
- Sheet of RPE cells then contracts and scrolls up upon itself in a radial fashion, leaving an area of retina without underlying RPE.
- Traction from CNV contraction and adhesion form the RPE that is still attached.

Examination

- Subretinal haemorrhages frequently accompanies an RPE tear, which appears ophthalmoscopically as an area of well-demarcated hyperpigmentation immediately adjacent to an area of relative hypopigmentation (see Fig. 2.7). Size is variable depending on extent of fibrovascular tissue and size of tear

Investigations

- OCT (directly through RPE tear) — irregular highly reflective outer band that appears thicker than the normal band due to scrolling of the RPE. This is immediately adjacent to an area where there is increased reflectivity from the choroid (posterior thickening of the external band) from the absence of the RPE (absence of RPE in region of tear allows for deeper penetration of the OCT signal, creating the characteristic reverse shadowing or hyper-

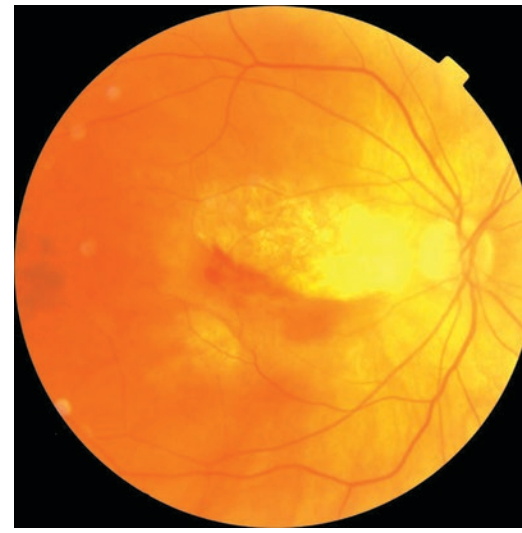

Fig. 2.7 Colour fundus image of a patient with an RPE tear following an intravitreal injection of an anti-VEGF agent

transmission sign). A sharply demarcated vertical discontinuity can also be seen in some instances (Fig. 2.8)
- FFA — absolute window defect, with well-circumscribed hyperfluorescence that does not increase in intensity or leak as the angiogram progresses, with an area of adjacent relative hypofluorescence corresponding to the scrolled RPE. Lack of fluorescein leakage distinguishes an RPE tear from a totally (100%) classic CNV membrane

2.1.3.5 Age-Related Macular Degeneration (AMD)

OCT Features of Non-neovascular AMD
- Small and intermediate typical drusen appear as discrete areas of RPE elevation with variable reflectivity
- Large typical drusen appear as dome-shaped areas of RPE elevation with underlying hypo- or medium-reflective material separating the RPE from the underlying inner collagenous zone of Bruch's membrane (see Fig. 2.9)
- Intraretinal pigment migration and clumping appears as discrete foci of hyperreflectivity with underlying shadowing (see Fig. 2.10)
- Reticular pseudodrusen (risk factor for advanced AMD — GA involving the fovea or any features of neovascular AMD) appear as hyperreflective material between the IS/OS junction and the RPE, i.e. subretinal space (see Fig. 2.11)
- Vitelliform lesions appear as hyperreflective material in the subretinal space (see Fig. 2.12)
- GA appears as areas of sharply demarcated choroidal hyper-reflectivity from loss of the overlying RPE (see Fig. 2.13)

OCT Features of Neovascular AMD
- Intraretinal fluid (IRF), subretinal fluid (SRF), outer retinal tubulations (ORTs): IRF and SRF appear as hyporeflective spaces, ORTs (see Fig. 2.14) are branching tubular structures that appear as round or ovoid hyporeflective spaces with hyperreflective borders in the ONL overlying areas of subretinal fibrosis or PED. ORTs represent a rearrangement of photoreceptors in response to injury and RPE loss.
- Subretinal hyper-reflective material/Disciform scar: CNV membranes in the subretinal space (type 2 CNV membrane — see Fig. 2.15) appear as an amorphous lesion of medium- to high-reflectivity above the RPE, disciform scar formation (see Fig. 2.14) appears as a well demarcated highly hyperreflective lesion

- Serous PED (see Fig. 2.5)
- Fibrovascular PED (see Fig. 2.6)
- Haemorrhagic PED (frank haemorrhage from proliferating blood vessels in the sub-RPE space)
- Polypoidal choroidal vasculopathy (PCV) — black and asian populations, reddish-orange polypoidal lesions and is often associated with serosanguineous PEDs, branching vascular

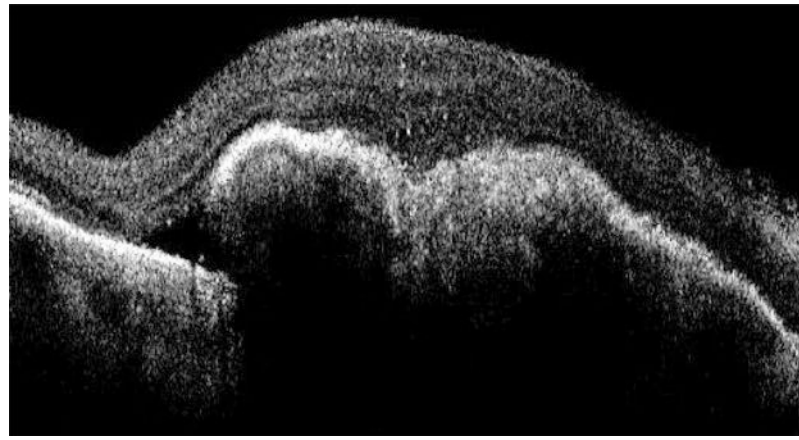

Fig. 2.8 OCT image of the same eye of the patient in Fig. 2.7 confirming an RPE tear

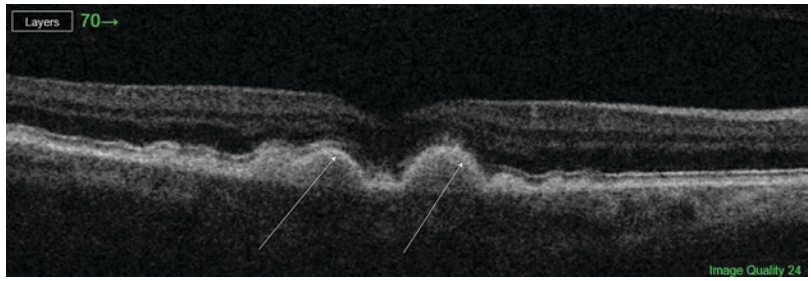

Fig. 2.9 OCT image showing large drusen. Discrete mounds (see white arrows), exhibiting medium reflectivity below the RPE, and above the choroid are obvious. The ellipsoid zone is present over some of the elevations, and less obvious over others

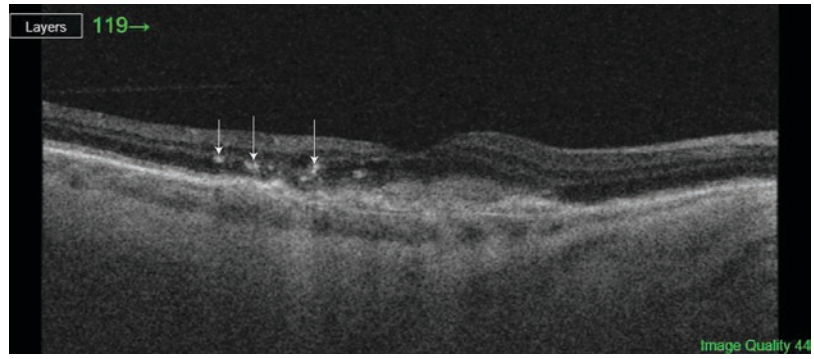

Fig. 2.10 OCT image showing multiple hyperreflective foci (white arrows) representing RPE clumping and migration into the neuroretina, and an adjacent subretinal CNV membrane

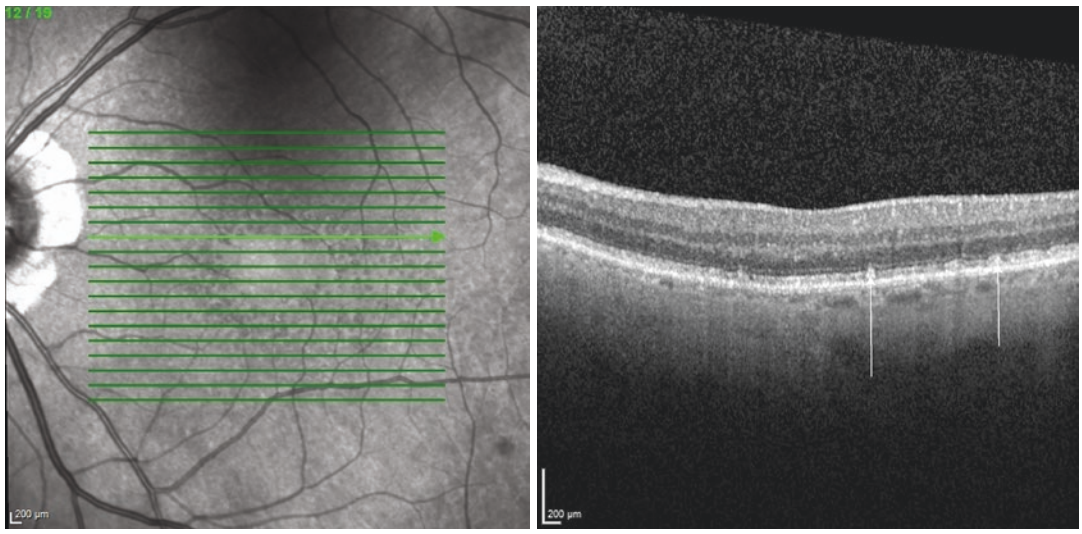

Fig. 2.11 OCT image of reticular pseudodrusen (RPD) showing accumulation of material (represented by focal subretinal hyper-reflective foci) in the subretinal space (see white arrows)

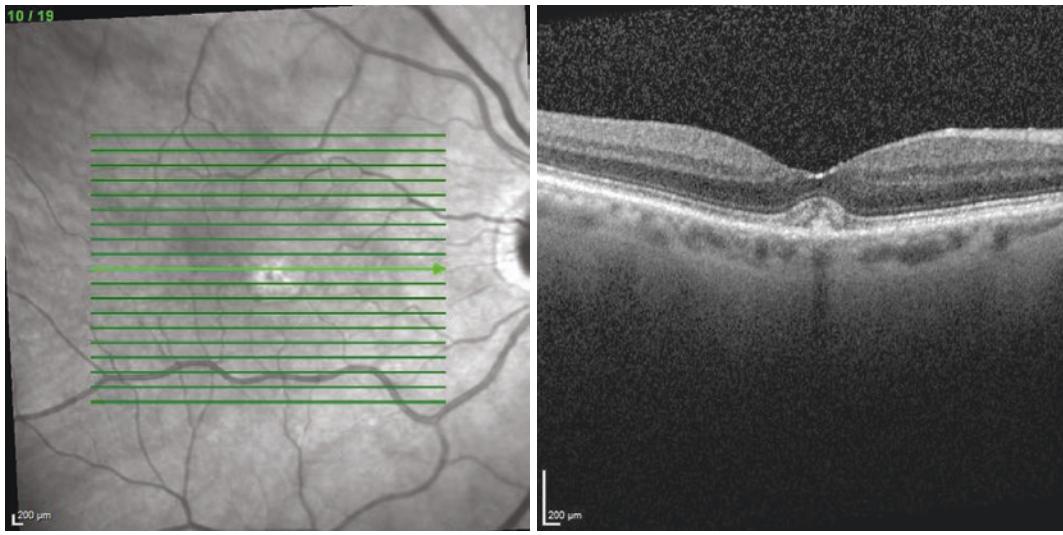

Fig. 2.12 OCT image of a patient with a vitelliform lesion showing a well defined hyperreflective material in the subretinal space and splitting the RPE, without disruption of the overlying tissue

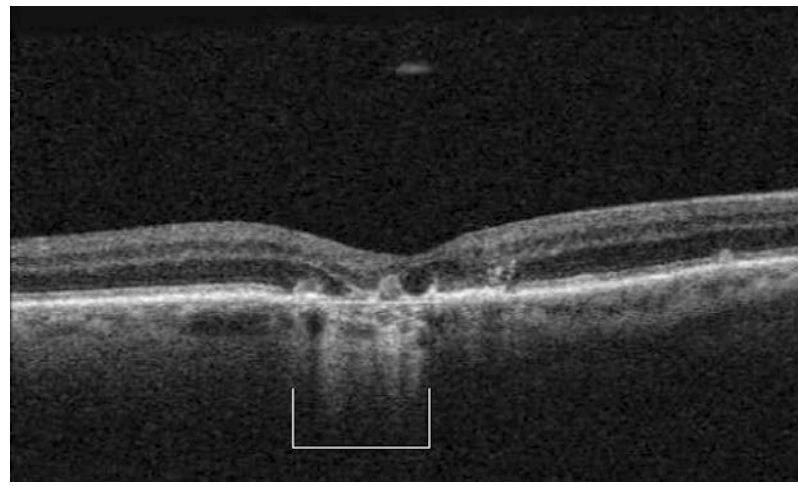

Fig. 2.13 OCT image showing areas of increased choroidal hyper-reflectivity from overlying RPE atrophy. There are associated localised hypo-reflective spaces overlying the RPE atrophy

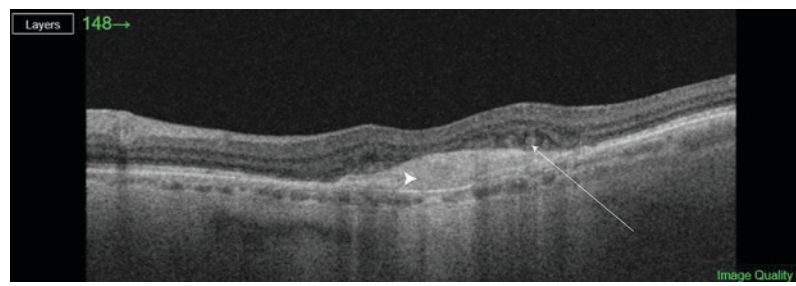

Fig. 2.14 OCT image showing a disciform scar (highly hyperreflective subretinal material — white arrowhead) and the presence of overlying ORTs (at the right edge of scar — white arrow)

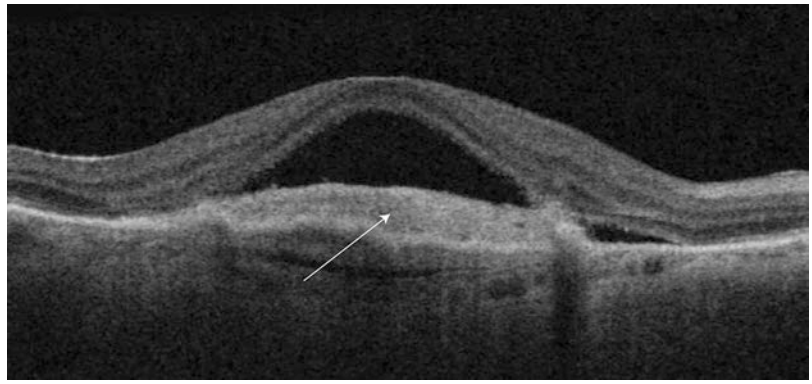

Fig. 2.15 OCT image showing an active CNV membrane (hyperreflective 'sausage-shaped' material overlying RPE/Bruch's membrane complex — white arrow) in the subretinal space with adjacent SRF

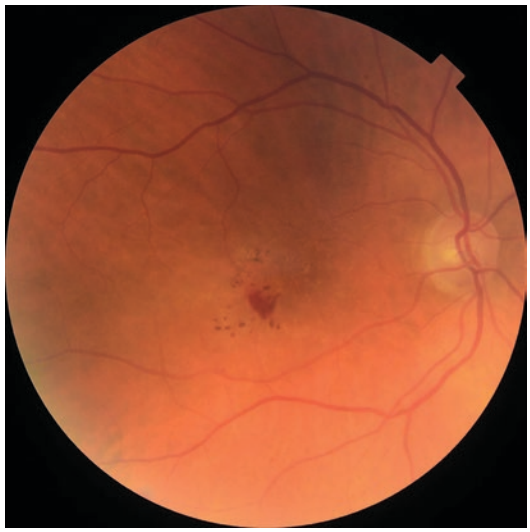

Fig. 2.16 Colour fundus image of a patient with RAP showing focal areas of intraretinal haemorrhage and right-angled venules

network (BVN) appear as a shallow elevation of the RPE, while the polypoidal lesions appear as sharper protuberances

- RAP (intraretinal neovascularisation with retino-choroidal anastomosis — seen clinically as focal areas of intraretinal haemorrhage, right-angled venules and circinate collection of hard exudates — see Fig. 2.16): active RAP lesions have a characteristic OCT appearance typified by frank CMO overlying a fibrovascular PED and accompanied by SRF (see Fig. 2.17), "kissing sign" — a focal funnel shaped defect in the RPE associated with an intraretinal hyper-reflective lesion

2.1.3.6 Epiretinal Membrane (ERM) (Fig. 2.18)

Causes of ERM

- Idiopathic
- Postsurgical — RD surgery, cryotherapy, photocoagulation
- Trauma — penetrating or blunt accompanied by persistent vitreous haemorrhage
- Ocular inflammatory diseases — posterior uveitis, sarcoidosis, pars planitis
- Retinal vascular diseases — RVO, telangiectasias, arteriolar macroaneurysms, DR, SCR
- Intraocular tumours — retinal angiomas or hamartomas
- Inherited retinal dystrophies — RP

Mechanisms of ERM

- Glial cells (fibrous astrocytes and muller cells) of retinal origin proliferate through defects in the ILM. Defects in ILM usually associated with vitreous separation.
- In cases of membrane formation before vitreous detachment, glial cells may grow into the vitreous cavity. As the membrane extends over the surrounding retina, a layer of vitreous is trapped against the ILM.

Examination

- Look for complications of ERM including retinal striae (contraction of ILM), tortuosity of retinal vessels, pseudohole (negative watzke-allen test), fovea ectopia (diplopia), intra-/pre-retinal haemorrhages and tractional macular detachment

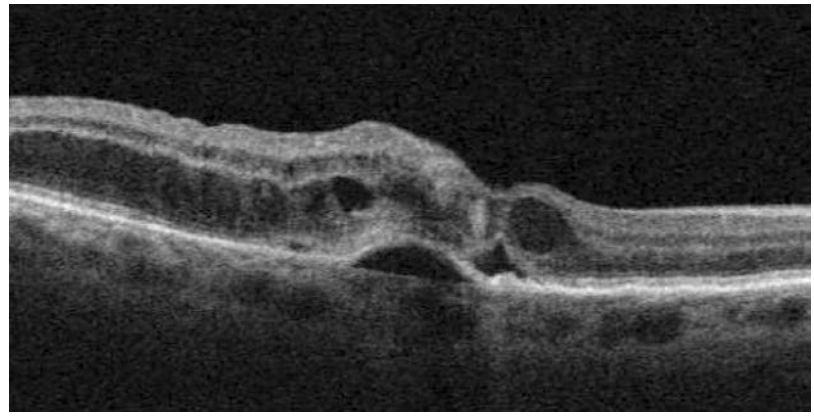

Fig. 2.17 OCT image of the same eye of the patient in Fig. 2.16 showing frank CMO (IRF) overlying a fibrovascular PED and accompanied by SRF

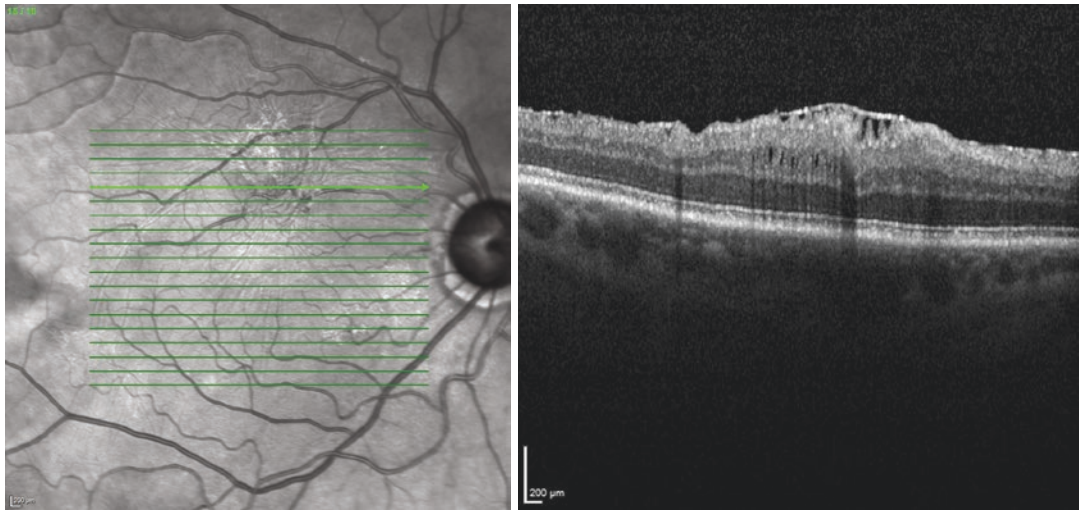

Fig. 2.18 OCT image of a patient with an idiopathic ERM. The inner retinal is distorted and irregular, with a hyper-reflective membrane with inner retinal hyporeflective spaces. Note RPE and outer retinal layers are intact in this scan. Occasionally, the outer retinal disruption may be shown as outer retinal hyporeflective spaces

- Look for signs of DR including retinal haemorrhages, venous beading, IRMA, previous PRP scars, NVD/NVE, macular exudates and CSMO
- Look for signs of RVO including retinal haemorrhages, optic disc collaterals, telangiectatic vessels, venous dilatation and tortuosity

Investigations

- OCT: ERM ± CMO
- FFA: macular ischaemia (RVO, DR), delayed arteriovenous transit time (RVO), capillary non-perfusion (DR, RVO, SCR), optic disc hyperfluorescence (RVO), staining of retinal vessel walls (RVO)

Management

- Ensure that macular function is not limited by an additional underlying pathology (e.g. ischaemia due to RVO)
- PPV + ERM peel indicated for severely symptomatic membranes
- Consenting for PPV + ERM peel: up to 80% develop nuclear sclerotic cataract within 2 years (Cherfan et al. 1991), retinal tears/detachment may occur in 2.5% (Michels et al.

1979), retinal toxicity from dyes, up to 15% worsened acuity, 5% symptomatic recurrence

Prognosis

- 75% show no deterioration in vision after diagnosis
- With surgery, 60–85% patients show 2 or more snellen lines of visual improvement (Haritoglou et al. 2003)
- Poor prognostic features are longer duration of symptoms before surgery, underlying macular pathology, lower preoperative visual acuity, thinner membranes and no retinal elevation (de Bustros et al. 1988)

2.1.4 OCT Images of Common Optic Nerve Pathologies

2.1.4.1 Glaucoma (Fig. 2.19)

2.2 OCT-Angiography (OCT-A)

2.2.1 Principles

- Non-invasive technique for imaging the microvasculature of the retina and the choroid. OCT-A visualises the flow that circulates inside blood vessels (vessel walls are not visualised)
- OCT-A is based on the en-face OCT technique that reconstructs scans performed multiple times in a vertical plane into a single image shown on a horizontal plane. OCT-A uses laser light reflectance of the surface of moving red blood cells to accurately depict vessels through different segmented areas of the eye
- Schematically, its principles is to highlight only the changes that occur between a time (t1) and a time (t2). For example, it would only highlight the circulatory movements in the image while removing all fixed components

2.2.2 Indications

- Look for choroidal neovascularisation — visualising a neovascular network on OCT-A does not systematically mean neovascular activity. New vessels may be present on OCT-A but inactive either spontaneously or after suitable treatment
- Look for macular ischaemia

2.2.3 Limitations

- Depending on the software used to generate the analysis temporal window, a flow that is too rapid or too slow may not be detected by the apparatus
- No apparatus available at present that can perform an automatic assembly of the posterior pole and its adjacent mid-periphery
- Presence of artefacts on images related to eye movements or related to the superimposition of images from different planes.

2.3 Fundus Fluorescein Angiography (FFA)

2.3.1 Principles

- Based on the principle of fluorescence whereby excitation at one wavelength occurs and is emitted immediately through a longer wavelength.
- 5 ml of 10% Sodium fluorescein is injected intravenously into the patient's blood stream. 20% of sodium fluorescein remains unbound to protein and is available for fluorescence.
- Unbound sodium fluorescein molecules within the bloodstream or the sodium fluorescein molecules that have leaked out of blood vessels are excited with a blue flash (wavelength of 465–490 nm) of a camera. On cessation of the blue flash the excited fluorescein

RNFL Single Exam Report OU
SPECTRALIS® Tracking Laser Tomography

HEIDELBERG ENGINEERING

Patient:	**DOB:**	**Sex:**
Patient ID:	**Exam:**	
Diagnosis:	**Comment:**	

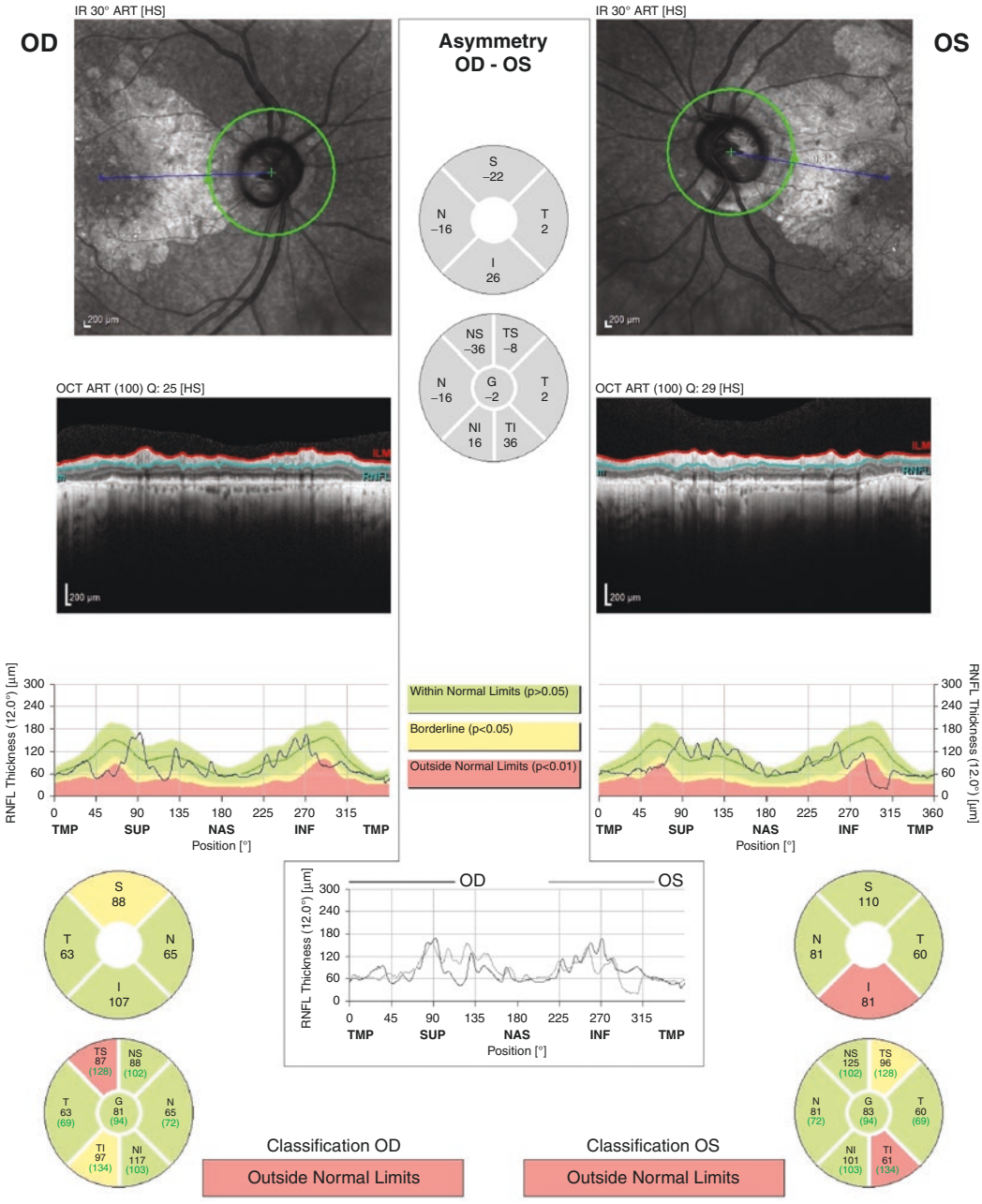

Fig. 2.19 OCT analysis of the retinal nerve fiber layer (RNFL) showing thinning of the neuroretinal rim in both eyes of a patient with primary open angle glaucoma

molecules will immediately emit a green-yellow light at a higher wavelength of 520–530 nm. The higher wavelength (green-yellow) light is then absorbed by the camera film to generate angiographic images.

2.3.2 Indications

- Look for vascular filling defects (e.g. areas of capillary non-perfusion) or blocked fluorescence
- Look for retinal and choroidal vascular abnormalities including leakage, staining etc. as in neovascularisation (e.g. CNV membrane), vasculitis, other causes of retinal vascular barrier breakdown, or RPE window defects

2.3.3 Contraindications

- Women who are pregnant, especially those in the first trimester
- Severe reactions to sodium fluorescein

2.3.4 Possible Side-Effects

- Extravasation of fluorescein under the skin ± subsequent local-tissue necrosis
- Nausea and vomiting
- Transient skin and urine discolouration
- Vasovagal reaction (bradycardia, hypotension, sweating, patients sense of feeling cold)
- Allergic reaction (hives, itching)/anaphylaxis
- Death

2.3.5 Treatment of Anaphylaxis

- Crash call
- Oxygen
- Hydrocortisone 200 mg IV
- Adrenaline IM (1:1000 in 0.5 ml) or IV (1:10,000 in 0.5 ml)
- Chlorpheniramine 10 mg IV

2.3.6 Interpretation

2.3.6.1 Identify Phases of FFA

- These timings are only valid if the patient has been cannulated in the antecubital fossa and the patient's arm is fully stretched (i.e. the elbow joint is not flexed) when dye is injected intravenously.
- Choroidal phase:
  - Fluorescence begins to appear in the choroid approximately 10–12 s after dye injection in young patients and 12–15 s after injection in older patients. Appears as faint, patchy, and irregularly scattered throughout the posterior fundus
  - A cilioretinal artery, if present, will usually begin to fluoresce as the choroid fluoresces
- Arterial phase (see Fig. 2.20):
  - Starts 1–2 s after choroidal fluorescence is visible or approximately 10–15 s after dye injection
  - Extends from first appearance of dye in the arteries until whole arterial circulation is filled
- Arteriovenous phase (see Fig. 2.21):
  - Starts 1–2 s after the arterial phase
  - Retinal veins begin to fill with a white line of fluorescence visible only along the margins of the retinal veins (laminar flow)

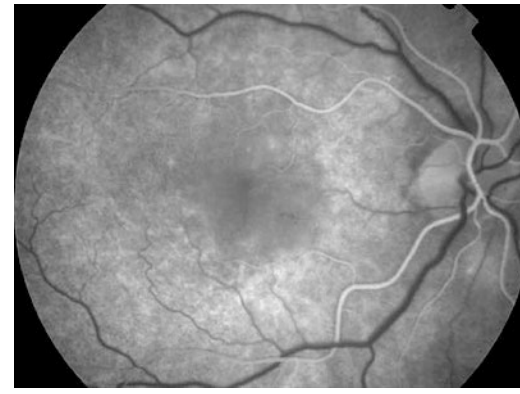

Fig. 2.20 Arterial phase of a fluorescein angiogram showing complete filling of arterial circulation with no filling of retinal veins

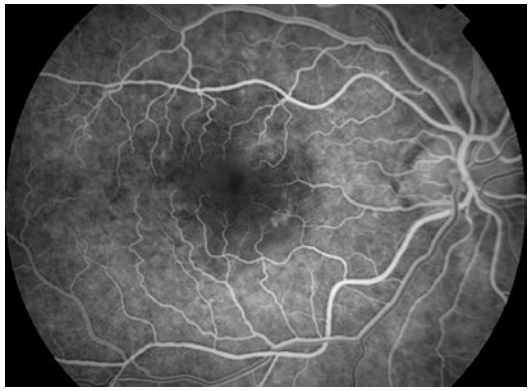

Fig. 2.21 Arteriovenous phase of a fluorescein angiogram showing laminar flow in the retinal veins

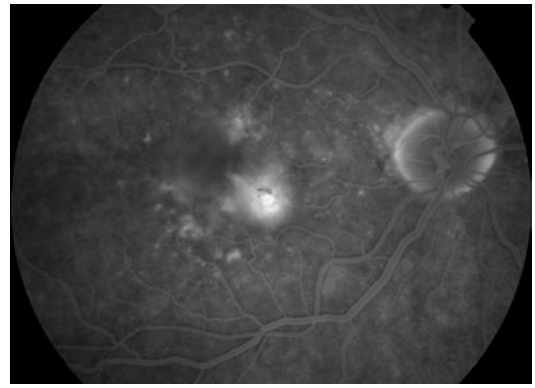

Fig. 2.23 Re-circulation phase of a fluorescein angiogram showing a grey appearance to the retinal vessels as fluorescein dye is eliminated from the retinal circulation

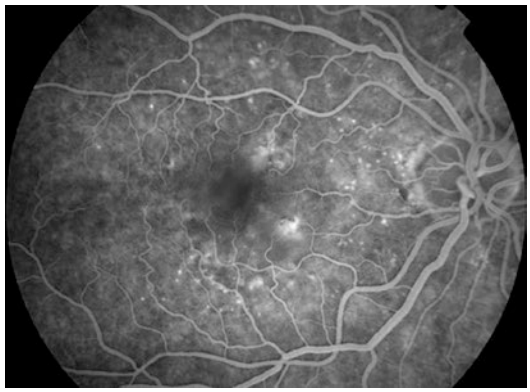

Fig. 2.22 Venous phase of a fluorescein angiogram showing complete filling of the retinal veins

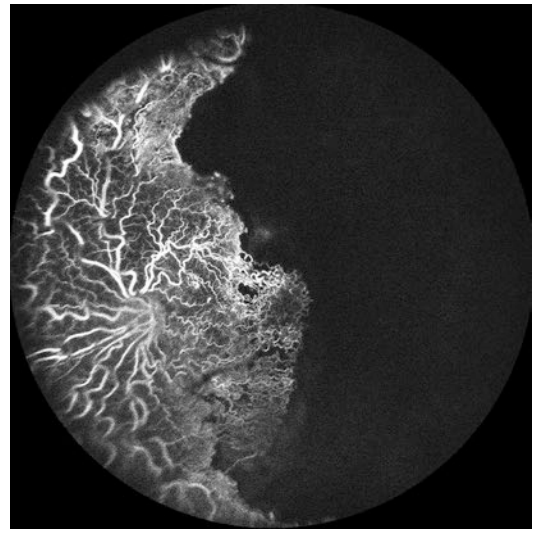

Fig. 2.24 Abnormal hypofluorescence in a fluorescein angiogram from a vascular filling defect due to an absence of retinal vasculature (extensive retinal capillary non-perfusion)

- Venous (see Fig. 2.22):
  - Occurs at approximately 30 s after dye injection
  - Complete fluorescence of retinal veins
- Re-circulation phase (see Fig. 2.23):
  - Starts approximately 2–4 min after dye injection
  - Gradual elimination of dye from the choroidal and retinal vessels with a subsequent grey appearance to the vessels

2.3.6.2 Identify the Presence of Abnormal Hypofluorescence on FFA

- Hypofluorescence is a reduction or absence of normal fluorescence (abnormally dark area)
- Causes
  - Vascular filling defect:
    Absence of vascular tissue (see Fig. 2.24) or complete/partial obstruction of retinal vessels (see Fig. 2.25)
  - Blocked fluorescence (see Fig. 2.26):
    Visualisation of fluorescence from the retinal or choroidal circulation prevented by material located anterior to the retinal or choroidal circulation
- To differentiate blocked fluorescence from a vascular filling defect, correlate the hypofluo-

rescence on the FFA with the ophthalmoscopic view or with a colour fundus image. If there is visible material ophthalmoscopically or on the colour fundus image that corresponds to the area of the hypofluorescence then blocked fluorescence is present. If no correspondence exists, the hypofluorescence is a vascular filling defect.

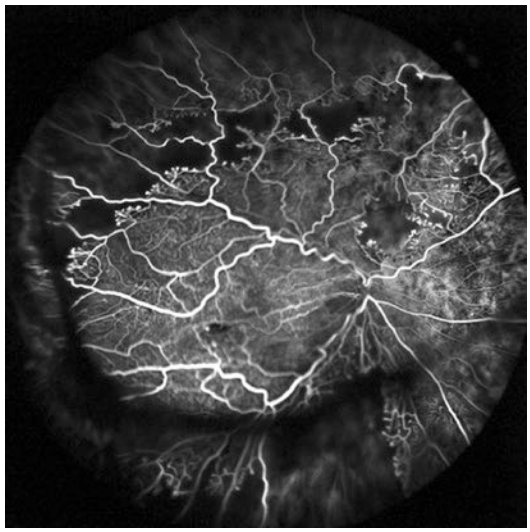

Fig. 2.25 Abnormal hypofluorescence in a fluorescein angiogram from a vascular filling defect due to scattered areas of retinal capillary non-perfusion

2.3.6.3 Identify the Presence of Abnormal Hyperfluorescence on FFA

- Hyperfluorescence is abnormally excessive hyperfluorescence (abnormally bright area)
- Causes
  - Window defects (see Fig. 2.27):
    Increased choroidal fluorescence due to the absence of RPE which normally forms a barrier to choroidal fluorescence
    Four characteristics:
    - Appears in the choroidal phase of the FFA
    - Fluorescence increases in intensity as dye concentration in the choroid increases as the FFA progresses
    - Fluorescence does not increase in size or shape during the FFA later phases
    - Fluorescence fades or disappears as dye is eliminated from the choroid at the end of FFA
  - Leakage (see Sect. 2.3.7.1):
    Hyperfluorescence caused by leakage of fluorescein molecules from the inner (retinal vascular endothelium) and outer blood retinal barriers (RPE)

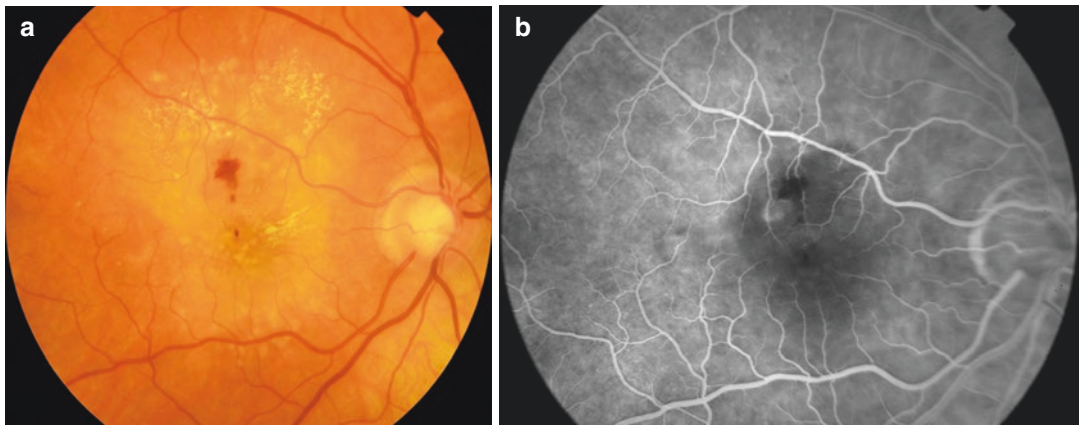

Fig. 2.26 (**a**) Colour fundus image showing an area of subretinal haemorrhage at the macula and (**b**) venous phase of a fluorescein angiogram showing the subretinal haemorrhage seen in image (**a**) as an area of hypofluorescence from blockage

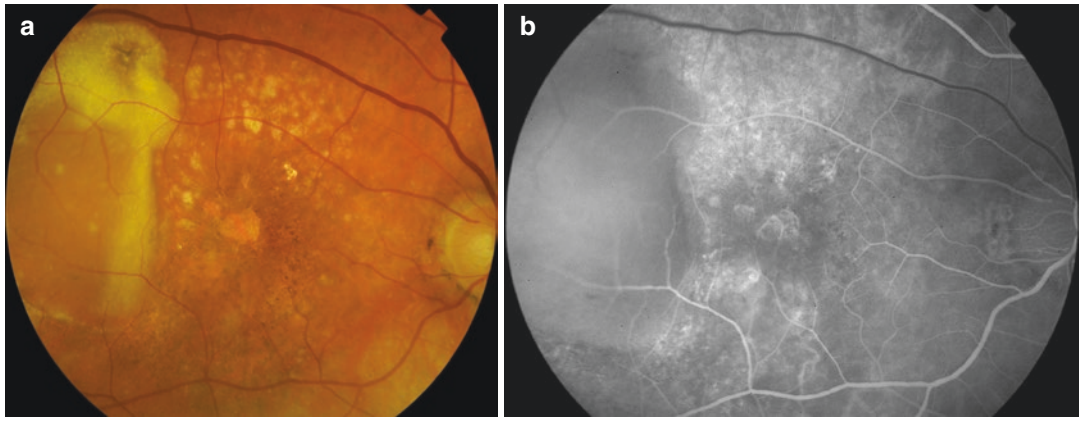

Fig. 2.27 (**a**) Colour fundus image showing areas of temporal subretinal scarring and chorioretinal atrophy at the macula. (**b**) Arterial phase of a fluorescein angiogram showing the areas of macular chorioretinal atrophy seen in the colour fundus image in (**a**) as hyperfluorescence areas from window defects

Fluorescence increases in intensity as FFA increases but its original borders become increasingly blurred as the FFA progresses

– Pooling (see Sect. 2.3.7.2):
  Hyperfluorescence caused by fluorescein accumulating and filling a distinct anatomic space (e.g. subretinal space or sub-RPE space)
  Fluorescence increases in intensity as FFA progresses with distinct borders in the late phase of FFA
– Staining (see Fig. 2.28):
  Hyperfluorescence caused by the diffusion of fluorescein into a tissue or material (e.g. drusen or scar tissue)
  Fluorescence increases in intensity as FFA progresses and persists in late phases, but its borders remain the same throughout the FFA

2.3.7 Fluorescein Angioscopic Appearance of Common Macular Disorders

2.3.7.1 Choroidal Neovascular Membrane (CNV) Membrane

Classic CNV Membrane (Fig. 2.29)

- Consists of a discrete, well demarcated focal area of hyperfluorescence that can be seen in the early phases of the angiogram
- Hyperfluorescence increases in intensity and extends beyond the boundaries of the hyperfluorescent area identified in earlier frames of the angiogram through the mid- and late-phase frames

Occult CNV Membrane

- Refers to two hyperfluorescent patterns on FFA
  – Fibrovascular PED: appears as an irregular elevation of the RPE with stippled hyperfluorescent dots (see Fig. 2.30)
  – Late leakage of an undetermined source: no clearly identifiable classic CNV or fibrovascular PED in the early- or mid-phases of the angiogram to account for an area of leakage in the late phase

2.3.7.2 CSR

'Ink Blot' Leakage Pattern

- Leakage starts as a hyperfluorescent pin point in the early phase and concentrically diffuses out in the late phase and appears like an 'ink blot' (see Fig. 2.31).

Smoke Stack Leakage Pattern

- Leakage starts as a hyperfluorescent pinpoint in the early phase, but it gradually tracks upward and then expands to form a mushroom cloud or umbrella-like appearance.

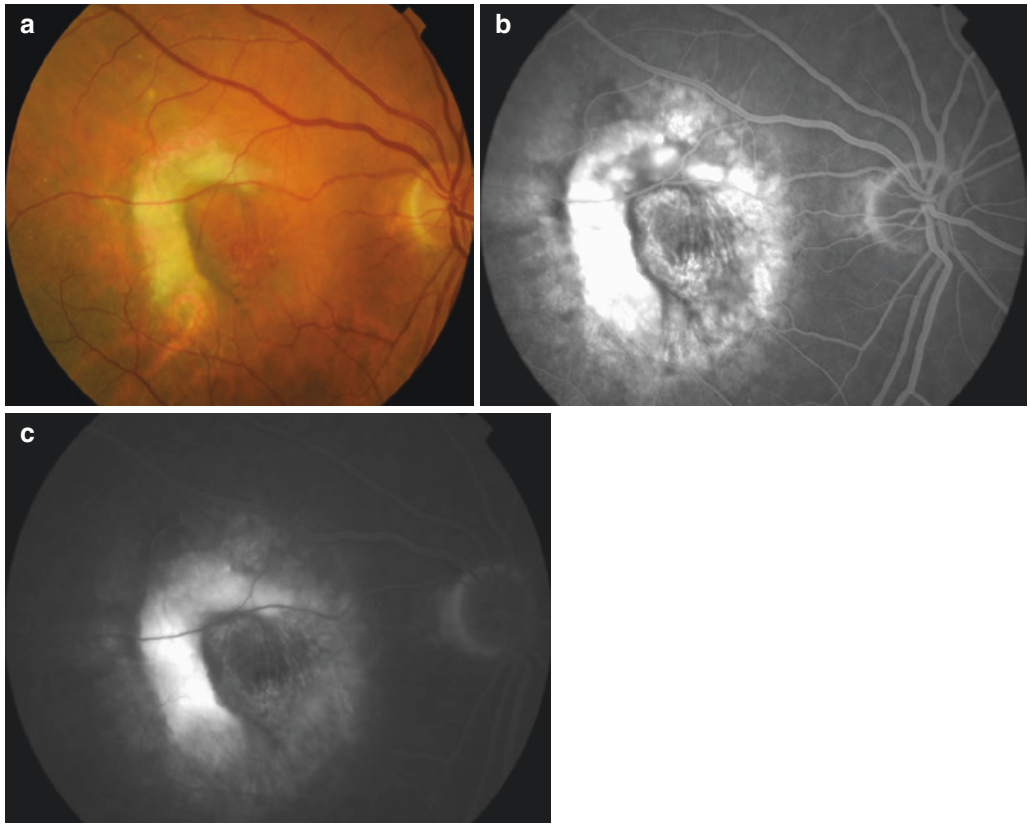

Fig. 2.28 (**a**) Colour fundus image showing a disciform scar associated with a temporal macular RPE tear depicted by the pigmented edge adjacent to the pale crescent temporal to the fovea. (**b**) Venous phase of a fluorescein angiogram showing hyperfluorescence from staining and a hypofluorescent margin corresponding to the folded margin of the RPE tear. (**c**) Re-circulation phase of a fluorescein angiogram showing that the borders of the hyperfluorescence from staining of the disciform scar and temporal 'bare sclera' shown in image (**a**) remained the same throughout the angiogram

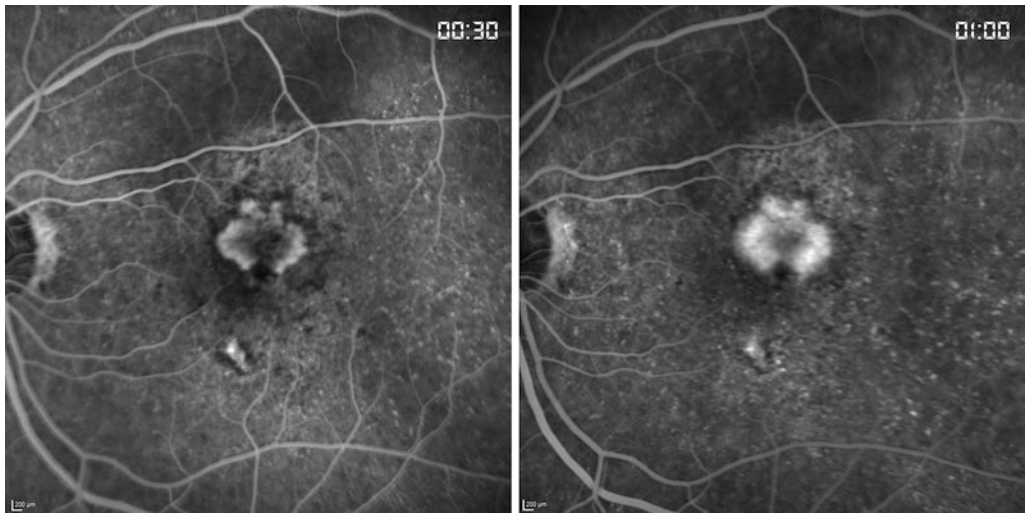

Fig. 2.29 Fluorescein angiogram showing a classic CNV membrane: initial irregular, lacy pattern of leakage which subsequently obliterated by dye leakage

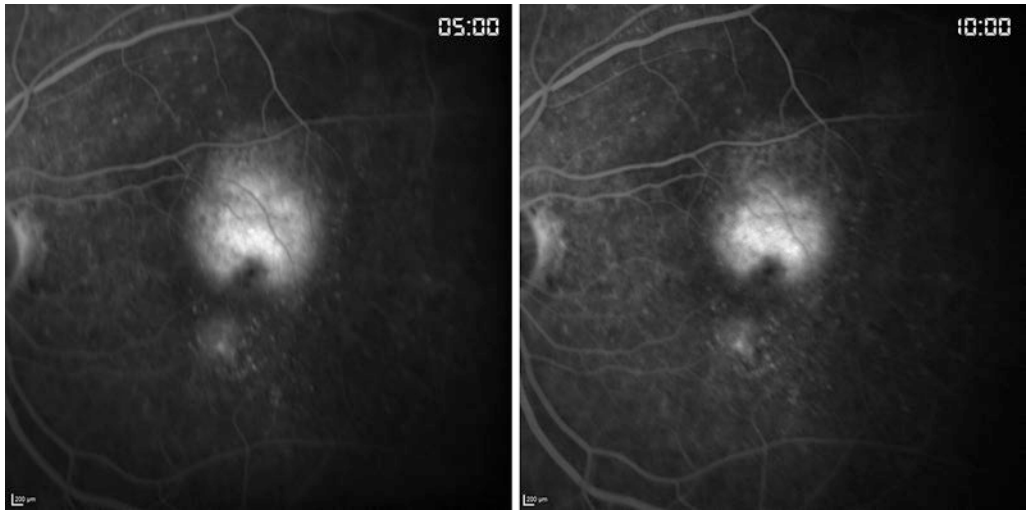

Fig. 2.29 (continued)

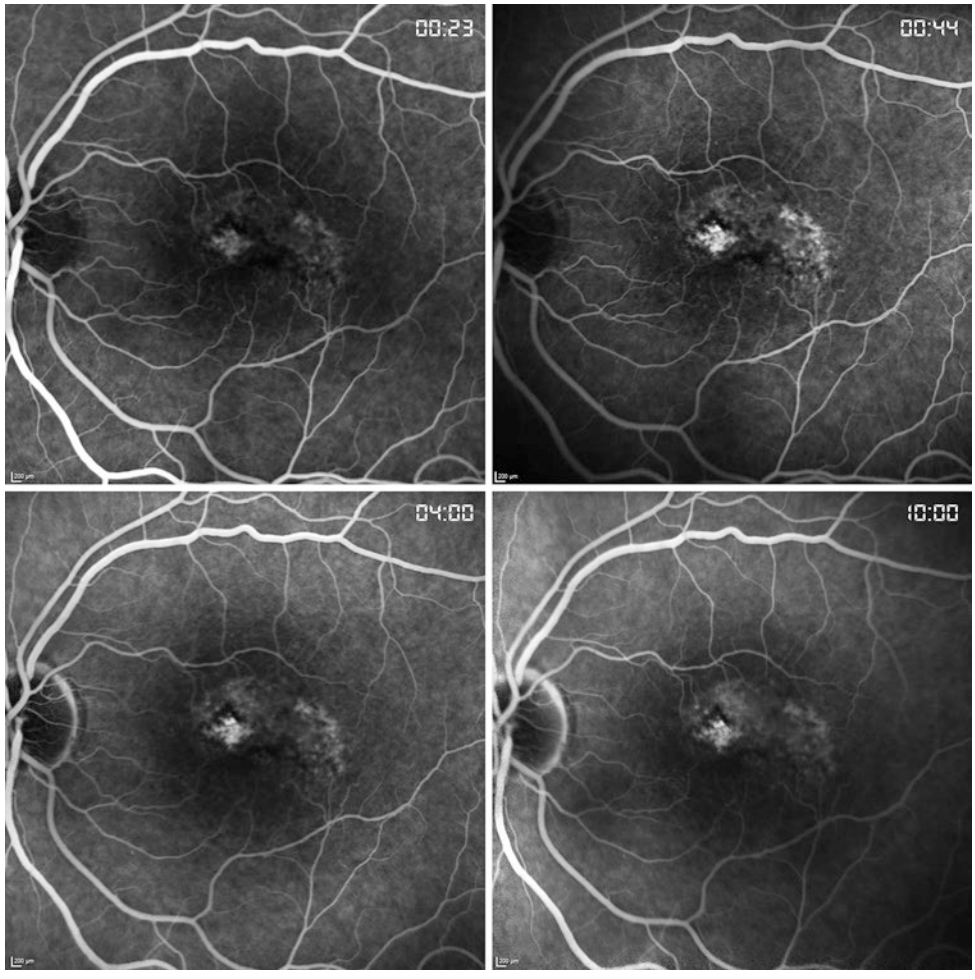

Fig. 2.30 Fluorescein angiogram showing an occult CNV membrane

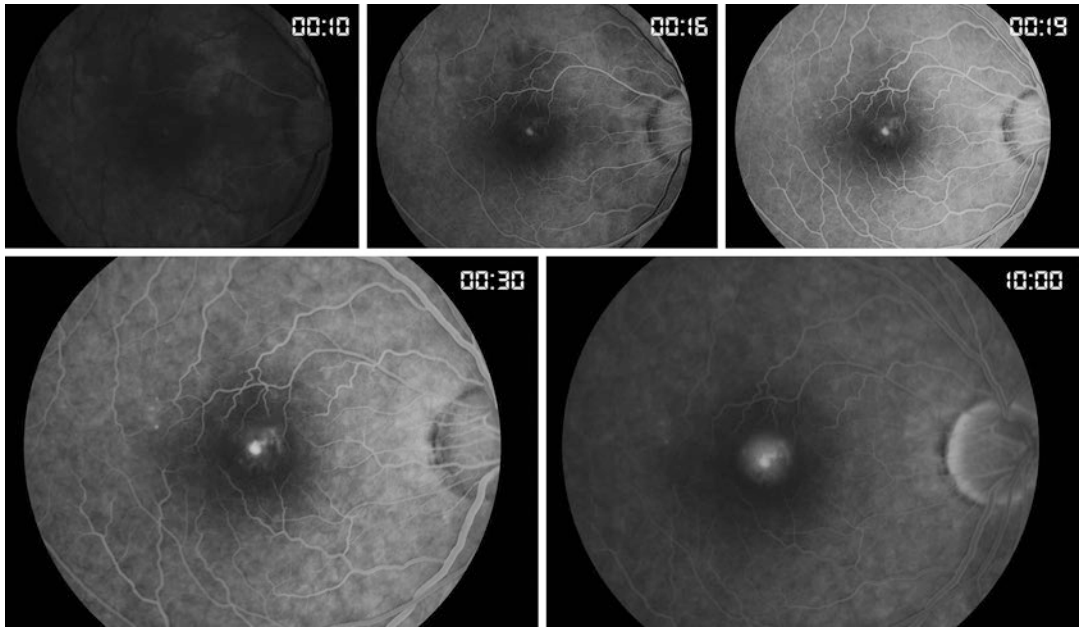

Fig. 2.31 Fluorescein angiogram showing leakage with an inkblot appearance

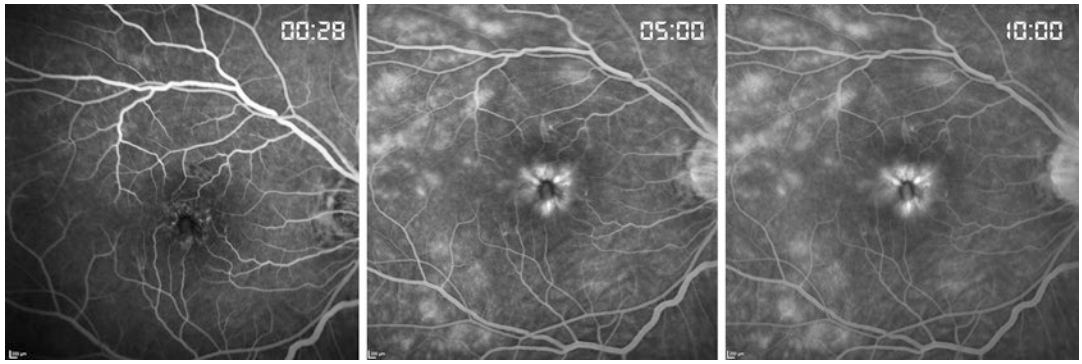

Fig. 2.32 Fluorescein angiogram showing CMO with a petaloid leakage pattern of hyperfluorescence surrounding the fovea. There are scattered hyper-fluorescent (leaking) areas, probably subretinal, in the macula

2.3.7.3 Cystoid Macular Oedema (CMO)

- Cystoid oedema in the macular takes on a stellate form due to the oblique nature of the outer plexiform layer (Fig. 2.32)

- Sherrington's and Hering's law of innervation
- Dissociation of the eyes by means of complementary colour (Hess chart) or a mirror (Lees screen)

2.4 Hess Chart

2.4.1 Principles

- Foveal projection in the presence of normal retinal correspondence

2.4.2 Indications

- Help diagnosis for incomitant cases of strabismus
- Monitoring (for improvement or progression)
- Surgical planning and post-operative effects of surgery

2.4.3 Interpretation

- Size
  - Smallest field denotes the affected eye
  - Underactions are depicted by noting the inward displacement of the dot. Maximum displacement occurs in the direction of the main action of the affected muscle
  - Overactions are noted by the outward displacement of the dots. Maximum displacement occurs in the direction of the main action of the overacting contralateral synergist
  - Other displacements may also be noted, indicating the development of muscle sequelae
- Position
  - The position of the field reflects the position of the eye, e.g. the higher the field the higher the eye
  - The position of the central dot indicates the deviation in primary position, fixing with the opposite eye
  - Each small square represents 5°; therefore an approximate measurement may be made
  - Torsion cannot be assessed unless an adaptation is used (T-bar)
- Shape
  - Mechanical restrictions will have a much flatter displacement, usually showing reversal of deviation
  - Sloping fields denote the presence of alphabet patterns such as A or V patterns. They do not indicate the presence of torsion
  - Longstanding deviations show the development of muscle sequelae, i.e. concomitant fields

2.4.4 Distinguishing Neurogenic Palsies and Mechanical Disorders of Ocular Motility on a Hess Chart

- Neurogenic palsies
  - Field of affected eye will be smaller
  - Proportional spacing between the outer and inner fields, with both fields displaced according to the deviation
  - Muscle sequelae: overaction of contralateral synergist (yoke muscle) in the unaffected eye, overaction of ipsilateral antagonist in the affected eye, secondary inhibition of contralateral antagonist in the unaffected eye
- Mechanical disorders
  - Outer field of chart will be very close to the inner field in the direction of maximum limitation of movement
  - Field of the affected eye will be very narrow either horizontally or vertically
  - Muscle sequelae: limited, often confined to overaction of the contralateral synergist in the unaffected eye

2.4.5 Hess Charts of Common Ocular Motility Disorders

2.4.5.1 Cranial Nerve III Palsy (Fig. 2.33)

2.4.5.2 Cranial Nerve IV Palsy (Figs. 2.34 and 2.35)

2.4.5.3 Cranial Nerve VI Palsy (Figs. 2.36 and 2.37)

2.4.5.4 Brown Syndrome (Fig. 2.38)

2.4.5.5 Duane's Syndrome (Figs. 2.39, 2.40 and 2.41)

2.4.5.6 Internuclear Ophthalmoplegia (INO) (Figs. 2.42 and 2.43)

2.4.5.7 Thyroid Eye Disease (TED) (Fig. 2.44)

2.4.5.8 Orbital Floor Fracture (Fig. 2.45)

2.5 Computerised Tomography (CT)

2.5.1 Principles

- CT scanner is shaped like a large cylinder (ring). Thin beams of X-rays are scanned through the patient (located in the centre of the

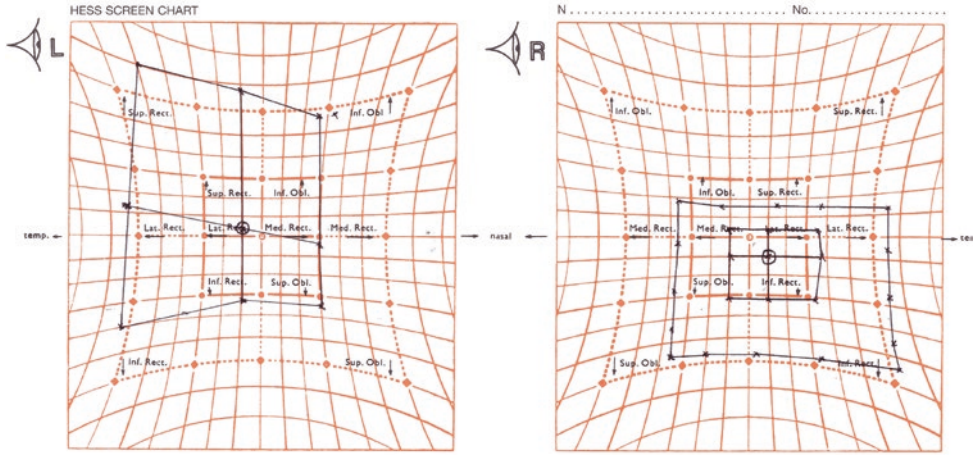

Fig. 2.33 Hess chart of a patient with a right CN III palsy

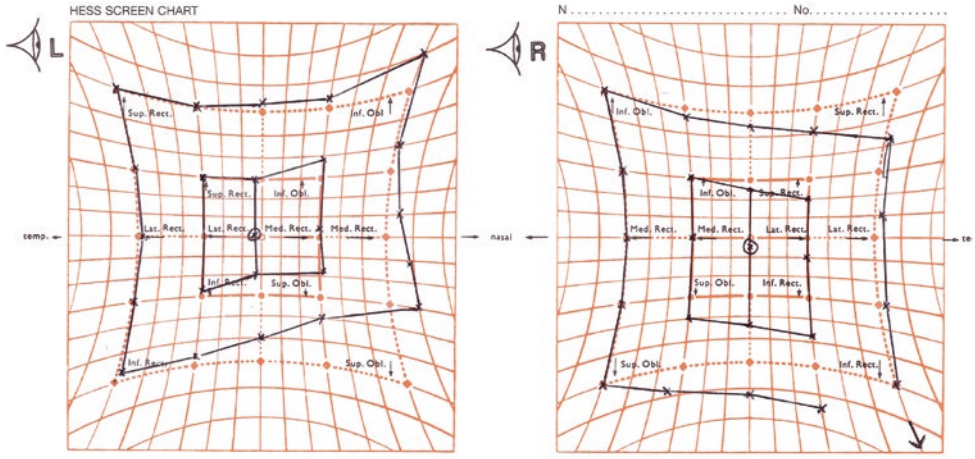

Fig. 2.34 Hess chart of a patient with a left CN IV palsy with muscle sequelae (left IO overaction, right IR underaction, right SR underaction)

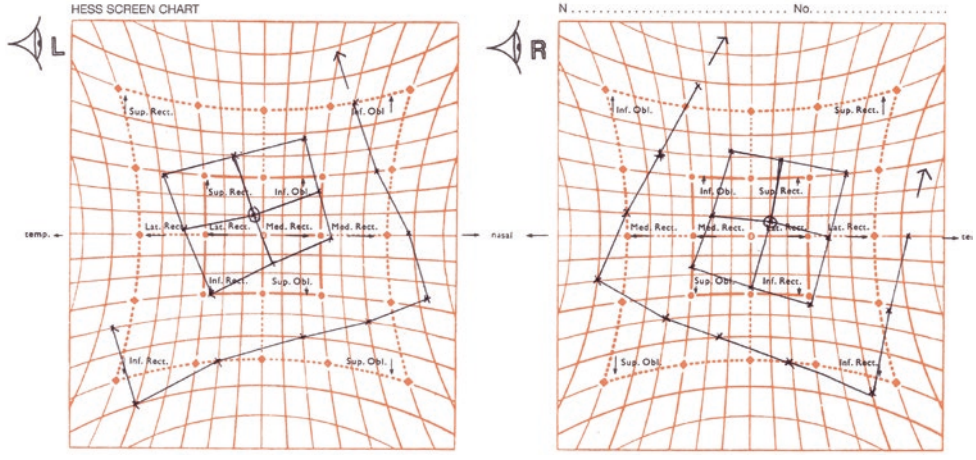

Fig. 2.35 Hess chart of a patient with a bilateral CN IV palsy with a V-pattern

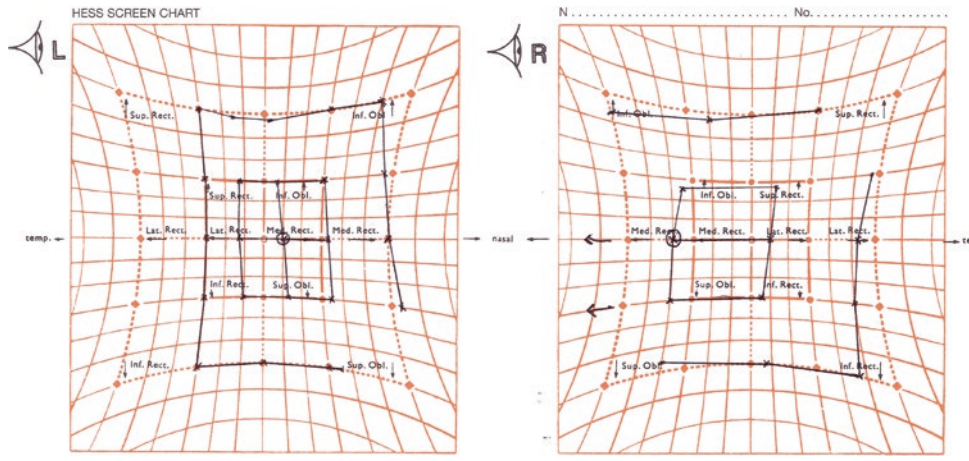

Fig. 2.36 Hess chart of a patient with a left CN VI palsy

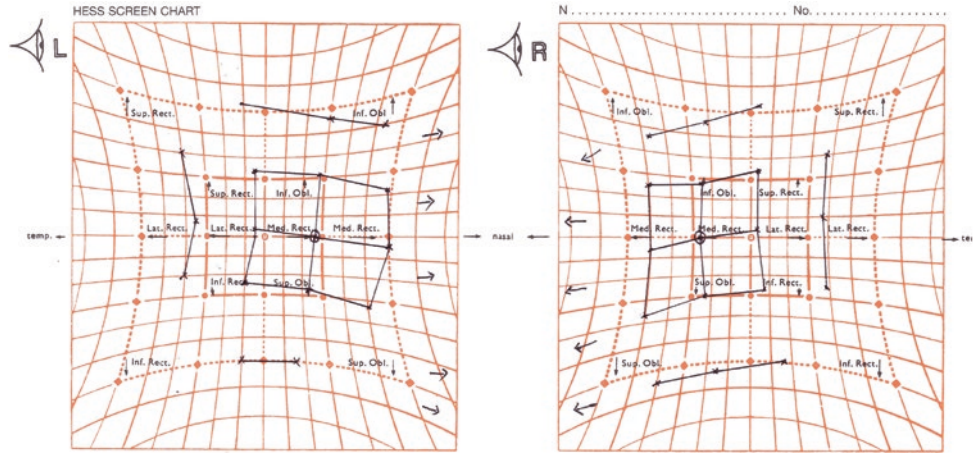

Fig. 2.37 Hess chart of a patient with a bilateral CN VI palsy

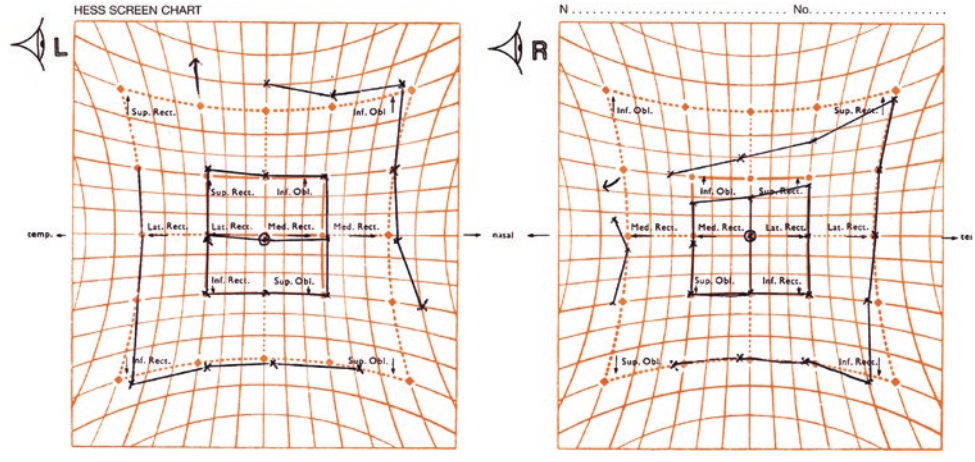

Fig. 2.38 Hess chart of a patient with a right Brown syndrome with limited muscle sequelae of overaction of the right SR muscle

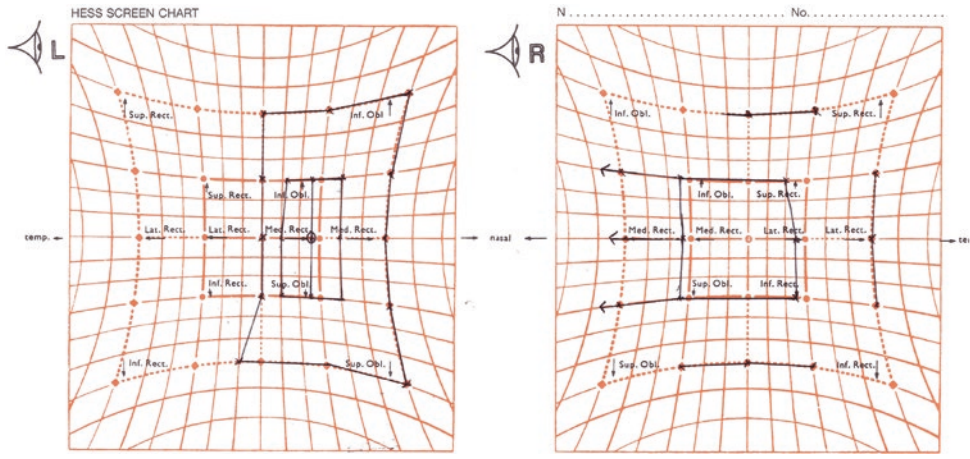

Fig. 2.39 Hess chart of a patient with type I Duane's syndrome

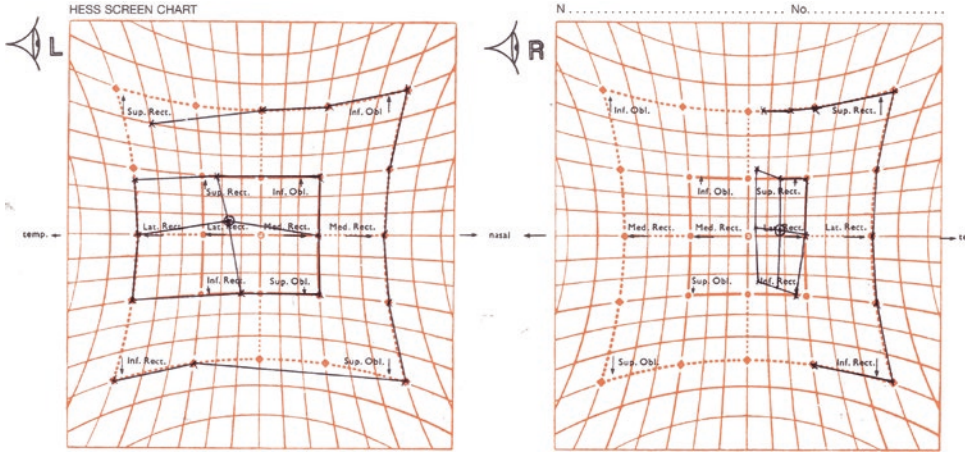

Fig. 2.40 Hess chart of a patient with type II Duane's syndrome

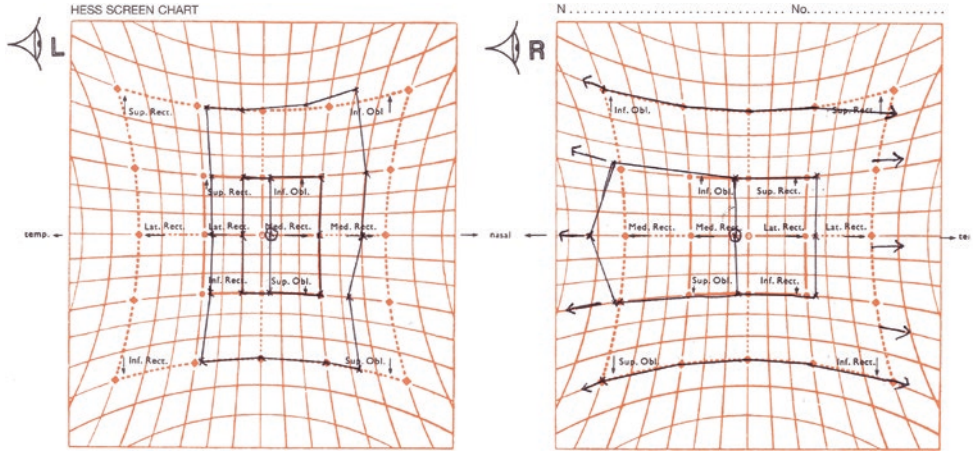

Fig. 2.41 Hess chart of a patient with type III Duane's syndrome

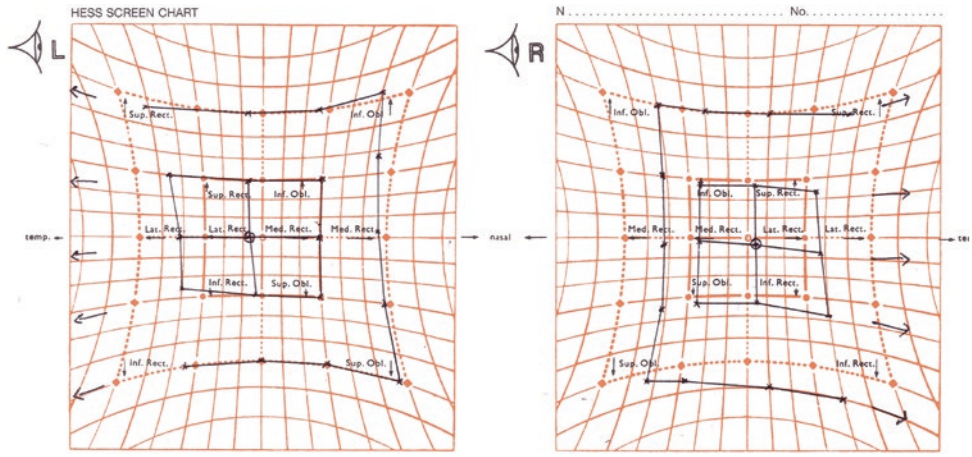

Fig. 2.42 Hess chart of a patient with a right INO

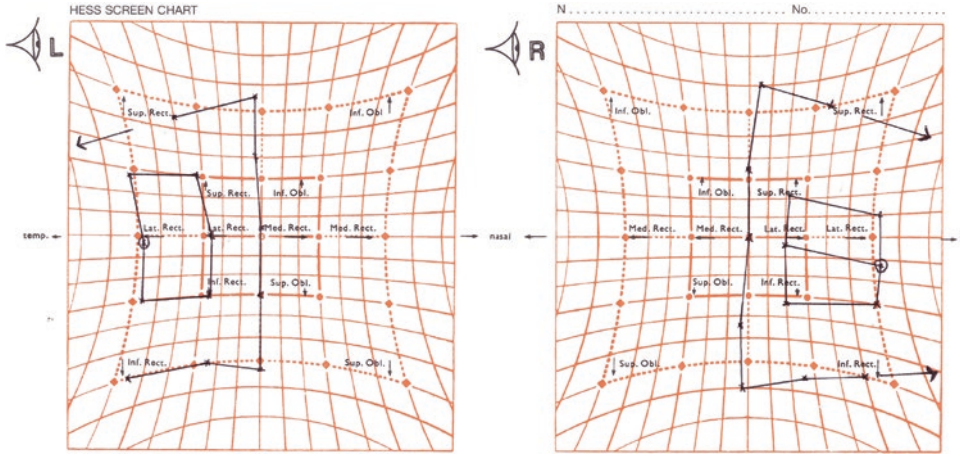

Fig. 2.43 Hess chart of a patient with a wall eyed bilateral INO (WEBINO)

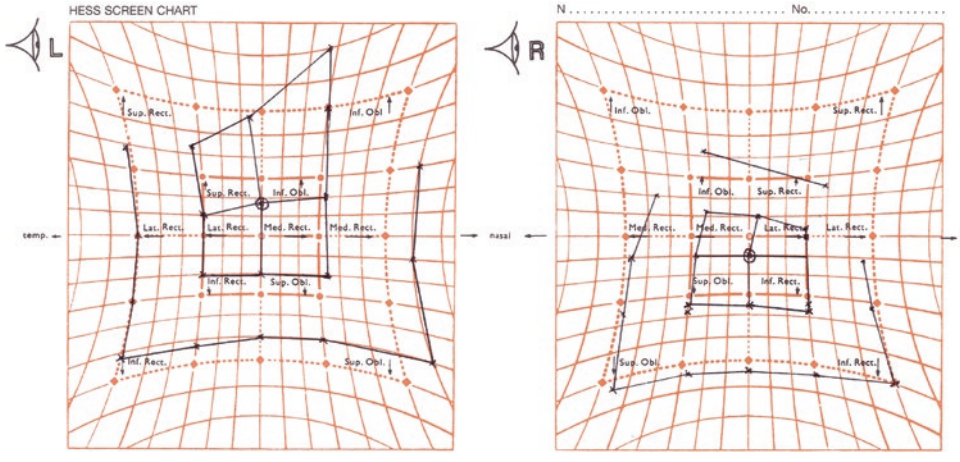

Fig. 2.44 Hess chart of a patient with TED with restriction of elevation of the right eye

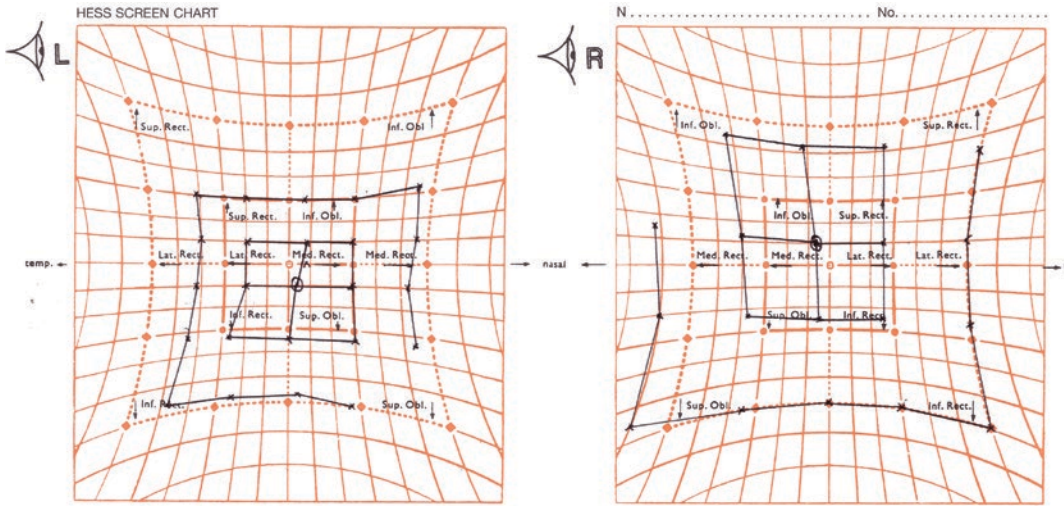

Fig. 2.45 Hess chart of a patient with a left orbital floor fracture

ring), from many different points around the ring, and picked up by detectors on the opposite side (of the ring). As the X-rays pass through the patient in a CT scanner, they are partially absorbed by the tissues encountered. The amount absorbed depends on the density of the tissues traversed. CT scans measure radiographic density of the tissues being studied.

- CT was developed directly from conventional X-ray technology with only two differences from conventional X-rays:
  - Rather than taking one view (as in conventional X-ray), the X-ray beam is rotated around the patient to take multiple different views of multiple slices of the patient
  - The X-ray data acquired in this way are reconstructed by a computer to obtain a detailed image of all the structures in the slices (including bone, air, soft tissues)

2.5.2 Indications

- Orbital trauma: fractures, foreign bodies
- Orbital infection

2.5.3 Contraindications

- Pregnancy

2.5.4 Advantages

- Excellent for bony detail
- Quick and readily available
- Minimal patient cooperation required

2.5.5 Disadvantages

- Uses ionising radiation

2.5.6 Interpretation

- Define image plane: axial, coronal, sagittal
- Terminology: isodense (structures of intermediate density similar to that of brain tissue and appears grey), hyperdense (structures appear as brighter areas than that of brain tissue), hypodense (structures appear darker than that of brain tissue)
- Define mass:
  - Tissue of origin: is mass from a normal orbital structure such as the lacrimal gland, optic nerve, or extraocular muscle(s)
  - Position of the mass: intraconal space, extraconal space, subperiosteal space, extraocular muscles, tenon's space, extraorbital space
  - Imaging clues to the biologic behaviour of a mass: "pusher" (benign well circumscribed

lesions) — push adjacent structures aside, "eater" (malignant) — infiltrative lesions
- Relationship to adjacent bone: slow growing benign masses "push" the bone or cause fossa formation. Aggressive malignant tumours "eat" the bone or cause bone erosion.
- Shape of the mass: cavernous haemangiomas are usually "round", benign mixed tumours of the lacrimal gland are said to be "oval", "kink" of an enlarged optic nerve (a sharp change in the direction of the nerve) strongly suggests a glioma
- Size of the mass
- Internal characteristics of the mass: homogenous (majority of tumours), heterogenous (combination of solid and cystic components in a child's tumour — lymphangioma, layering of fat and keratin debris in a cystic mass — dermoid cyst, small areas of calcification in a soft tissue orbital mass — malignancy, "tram tracking" of an optic nerve tumour — optic nerve meningioma, hyperostosis of the sphenoid wing — sphenoid wing meningioma)
- Contrast enhancement of the mass: meningioma, rhabdomyosarcoma, inflammatory lesions such as sarcoidosis

2.5.7 CT Scan Images of Common Orbital Disorders Occurring in Adults

2.5.7.1 TED (Fig. 2.46)

2.5.7.2 Orbital Pseudotumour (Idiopathic Orbital Inflammatory Disease) (Fig. 2.47)

2.5.7.3 Cavernous Haemangioma (Fig. 2.48)

2.5.7.4 Lymphoid Lesions of the Orbit (Tables 2.1 and 2.2)

2.5.7.5 Metastatic Tumours to the Orbit (Tables 2.3 and 2.4)

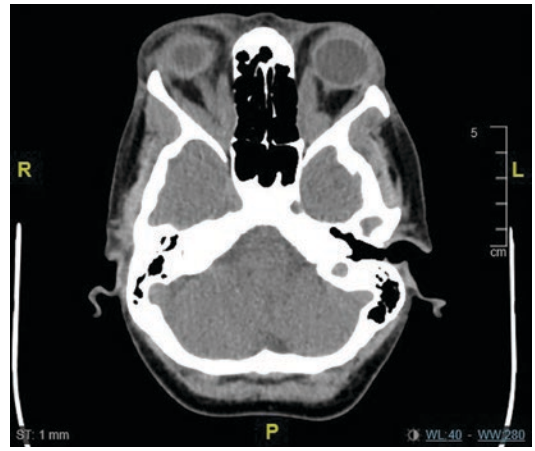

Fig. 2.46 Axial CT scan image of a patient with TED showing multiple enlarged extraocular muscles

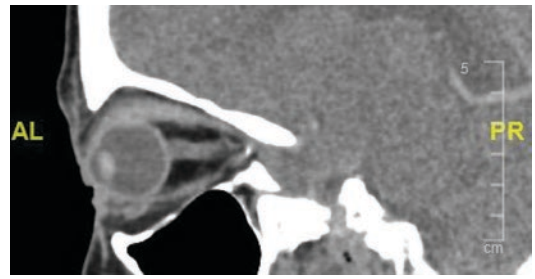

Fig. 2.47 Sagittal CT scan image of a patient with orbital inflammatory disease with an enlarged SR muscle

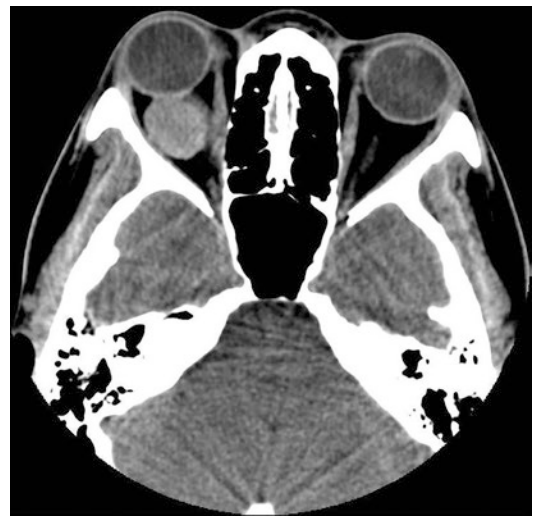

Fig. 2.48 Axial CT scan image of a patient with a right intraconal cavernous haemangioma

Table 2.1 Useful information about orbital lymphoid lesions

- Lymphoid lesions occur most commonly in elderly patients, but may occur in middle age
- In some patients, the disease may present bilaterally (an exception to the rule that orbital tumours are usually unilateral)
- A large no. of all orbital lymphoid lesions will eventually be associated with systemic disease
- Almost all periocular lymphomas are non-Hodgkin type, almost all of B-cell origin
- Most common periocular lymphoma is the MALT type (others include diffuse lymphoplasmacytic, follicle center, diffuse large cell)

Table 2.2 Approach to a patient with an orbital lymphoid lesion

History
- Any pain and rate of progression: gradual onset with slow progression of a painless orbital mass, often anterior and superior
- Any previous diagnosis of lymphoma

Examination
- Look for proptosis: axial or non-axial (depending on the position of the mass) — usually non-axial, extraconal and anterior
- Look for characteristic salmon patch on the conjunctiva (suggestive of lymphoma)
- Palpate for any orbital masses (normally felt anteriorly — smooth, usually mobile, and firm to touch — no tenderness associated with palpation): most commonly, you will see lymphoid tumours arising in the superior orbital quadrants (the extraconal space, especially with involvement of the lacrimal gland, is a common site. Although the inferior orbit is not the most common site, lymphoid lesions are the most common condition presenting there)

Investigations
- FBC with a differential count
- CT scan (see Fig. 2.49): smooth mass (lobular or irregular in shape rather than round) that is a typical "pusher", not "eater" of orbital tissues (no infiltration of orbital tissues — lesion is said to mold to the orbital tissues, bone erosion is rare)
- Incisional biopsy is required to make the final diagnosis (fresh tissue for immunopathologic staining, and formalin fixed tissue for haematoxylin and eosin staining) — required for all lymphoid lesions as they all look the same on a CT scan
- Referral to oncologists/haematologists for evaluation to rule out systemic involvement — chest and abdominal CT scan to identify abnormal nodes, bone marrow aspiration to rule out marrow involvement

Management
- Radiotherapy in the absence of systemic disease
- Chemotherapy for poorly differentiated types of lymphoma — follicular, large cell
- Monoclonal antibody (Rituximab) ± chemotherapy protocols (CHOP)

Differential Diagnosis
- Benign — benign reactive lymphoid hyperplasia
- Malignant — lymphoma
- Indeterminate — atypical lymphoid hyperplasia

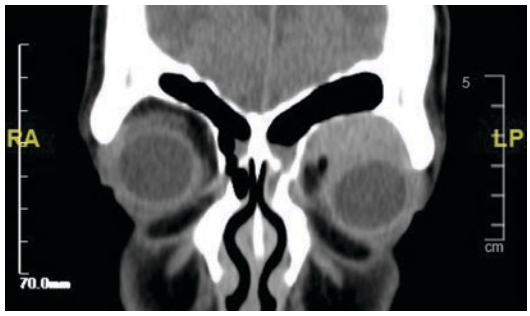

Fig. 2.49 Coronal CT scan image of a patient with a left orbital lymphoma

Table 2.3 Useful information about metastatic orbital tumours

- Lung cancer is the most common metastatic orbital tumour in men
- Breast cancer is the most common metastatic orbital tumour in women

Table 2.4 Approach to a patient with a metastatic orbital tumour

History
- Any pain and rate of progression: onset of proptosis occurring over a few days to a few weeks, sometimes with mild pain or inflammatory signs
- Ask about history of any known malignancy: up to 25% of metastatic orbital tumours will not have a known primary tumour

Examinations
- Look for proptosis: often non-axial — areas infiltrated by tumour are often outside the muscle cone, sometimes eroding the bones
- Look for enophthalmos — metastatic scirrhous breast cancer resulting from fibrosis of the involved orbital tissues
- Look for eyelid swelling and chemosis — often seen with many metastatic tumours

Investigations
- CT scan (see Fig. 2.50): infiltrative mass (tumours are "eaters" — often the tumours extends into more than one of the orbital spaces and infiltrates several orbital structures), bone erosion is commonly seen with any adenocarcinoma, diagnosis of metastatic prostate carcinoma can be made on a CT-scan alone based on the characteristic combination of both osteoclastic (destroyed bone) and osteoblastic (new bone) changes
- Incisional biopsy: make definitive diagnosis of a metastatic orbital tumour
- Referral to oncologist for systemic work up

Management
- Radiation therapy: if the orbit is the only site of metastasis
- Chemotherapy: if other areas of metastatic involvement are found

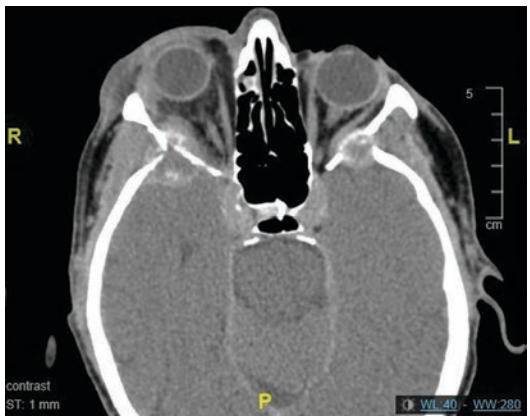

Fig. 2.50 Axial CT scan image of a patient with a metastatic neuroendocrine tumour showing bone erosion

2.5.7.6 Sphenoid Wing Meningioma (Tables 2.5 and 2.6)

Table 2.5 Useful information about sphenoid wing meningioma

- Meningioma arising from the intracranial side of the sphenoid bone and extending into the orbit secondarily

Table 2.6 Approach to a patient with a sphenoid wing meningioma

History
- Ask about any vision loss: suggests optic nerve compression

Examination
- Look for any proptosis: any proptosis and downward displacement of the eye precede vision loss, often by years
- Look for any fullness of the temple: hyperostotic bone pushes into the orbit and temporalis fossa
- Look for any corneal exposure: advanced meningioma causes disfiguring proptosis and corneal exposure
- Check optic nerve function: VA, RAPD, colour vision, VF
- Look for optic disc swelling

Investigations
- CT with contrast enhancement (see Fig. 2.51): soft tissue involvement surrounding the hyperostotic sphenoid wing
- MRI: usually performed to view the details of the soft tissues in the orbital apex and around the chiasm

Treatment
- Excision: meningioma can be debulked to relieve compression, but complete removal is not possible
- Radiation therapy: used as adjunctive therapy although tumour not very radiosensitive

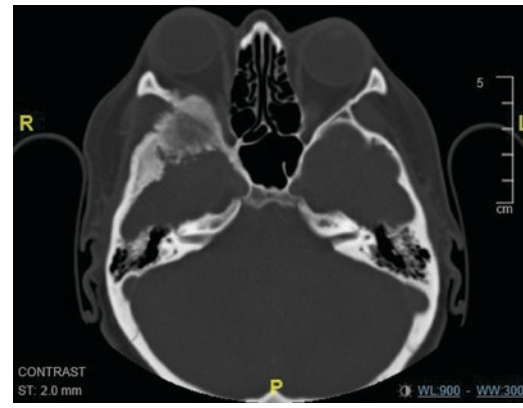

Fig. 2.51 Axial CT scan image of a patient with a right sphenoid wing meningioma

2.5.7.7 Lacrimal Gland Tumours (Table 2.7)

2.5.8 CT Scan Images of Common Orbital Disorders Occurring in Childhood

2.5.8.1 Dermoid Cyst (Fig. 2.53)

2.5.8.2 Optic Nerve Glioma (Fig. 2.54)

2.6 Magnetic Resonance Imaging (MRI)

2.6.1 Principles

- An external powerful magnetic field is applied by the MRI scanner to a patient that causes protons in the patient to align their intrinsic spins in parallel with the magnetic field.
- A radio-frequency pulse is generated from an emission-reception coil that excites these protons, causing them to flip their spins away from the direction of the magnetic field. When the pulse stops, the protons spins relax back in parallel with the magnetic field and give off energy in the form of electromagnetic waves that are detected by the same emission-reception coil to generate images.

2.6.2 Indications

- Orbital tumours
- Optic nerve tumours

2.6.3 Contraindications

- Metallic foreign bodies
- Pacemakers
- Claustrophobia
- Cochlear implants
- Aneurysmal clips
- Pregnancy

2.6.4 Advantages

- Excellent soft tissue contrast
- Lack of exposure to radiation

2.6.5 Disadvantages

- Greater patient cooperation required
- Longer examination time
- Less readily available
- More expensive for the trust

2.6.6 Interpretation

- Type of imaging sequence:
  - T1-weighted images: vitreous and CSF appears hypointense (dark) while fatty tissue appears bright. Grey matter of the brain will be hypointense as compared to white matter (grey is grey and white is white)
  - T2-weighted images: vitreous and CSF appears bright while fatty tissue appears dark. White matter is hypointense (dark) compared to grey matter (grey is white and white is grey)
  - FLAIR (T2-weighted image with CSF suppression): vitreous and CSF appears dark. Grey and white matter appearances are similar to T2-weighted images
- Terminology: hyperintense (structures appear as brighter areas than that of brain tissue), hypointense (structures appear darker than that of brain tissue)
- Define mass:
  - Tissue of origin: is mass from a normal orbital structure such as the lacrimal gland, optic nerve, or extraocular muscle(s)
  - Position of the mass: intraconal space, extraconal space, subperiosteal space, extraocular muscles, tenon's space, extraorbital space
  - Imaging clues to the biologic behaviour of a mass: "pusher" (benign well circumscribed lesions) — push adjacent structures aside, "eater" (malignant) — infiltrative lesions

Table 2.7 Approach to a patient with an enlarged lacrimal gland

Differential Diagnosis
- Infiltration of abnormal cells into the gland (most common cause of lacrimal gland enlargement): lymphoid tumours, benign reactive lymphoid hyperplasia (benign), lymphoma (malignant), atypical lymphoid hyperplasia (indeterminate)
- Sarcoidosis
- Idiopathic orbital inflammatory disease
- Tumours arising from lacrimal tissue: benign mixed tumour (benign), adenoid cystic carcinoma (malignant), adenocarcinoma (malignant)

History
- Age: elderly (lymphoid lesions), middle age (benign mixed tumour)
- Pain: orbital inflammatory disease (acute pain with associated inflammatory signs)
- Onset and progression of symptoms: differentiating adenoid cystic carcinoma (rapid progression over a few months, no pain present, symptoms or signs never present for more than 1 year) from benign mixed tumours (slowly progressive over a period of months to years, no pain, no periocular signs, no pulsations), lymphoid lesions/tumours (painless, slowly progressive — weeks to months), sarcoidosis (slowly progressive, painless)
- History of sarcoidosis

Examination
- Look for proptosis: non-axial — inferonasal/inferior displacement of the eye (proptosis occurs relatively late with lacrimal gland masses as the lacrimal gland is anterior to the equator of the eye), globe ptosis prominent with benign mixed tumour, globe ptosis less likely with lymphoid lesions
- Look for fullness or a palpable mass in the superotemporal quadrant (if you lift the upper eyelid, you may be able to see an enlarged palpebral lobe of the lacrimal gland) — soft anterior mass (lymphoid lesion), firm larger smooth convex mass (benign mixed tumour), firm non smooth mass (adenoid cystic carcinoma)
- Look for numbness or paraesthesias in the temporal region as a result of typical neurotrophic spread of adenoid cystic carcinoma
- Look for salmon patch: lymphoid lesion
- Look for associated inflammatory signs: lid swelling, chemosis (orbital inflammatory disease)
- Look for intraocular inflammation/iris nodules (Busacca, Berlin, Koeppe): sarcoidosis

Investigations
- FBC with a differential count: lymphoid lesions/tumours
- ACE, Calcium, CXR, CT Chest: sarcoidosis
- CT scan (see Fig. 2.52): round or oval well circumscribed mass in the superotemporal quadrant with globe indentation and bony moulding with adjacent fossa formation in the bone as a result of the long standing pressure changes (benign mixed tumour), erosive bone changes (malignancy — adenoid cystic carcinoma), infiltrative superotemporal mass extending across the orbital space (adenoid cystic carcinoma), well circumscribed enlargement of the lacrimal gland with the typical moulding of the mass to the surrounding tissues — a "pusher" — with no bony changes (lymphoid lesions/tumours)
- MRI scan: if you suspect intracranial extension based on the clinical examination or CT scan
- Incisional biopsy: don't perform if benign mixed tumour (need to keep pseudocapsule intact otherwise increases risk of recurrence — as benign mixed tumour grows within the lacrimal gland, it compresses adjacent glandular and orbital tissue to form a pseudocapsule — no epithelial lining — separating the tumour from the surrounding tissue), non-caseating granulomas in lacrimal tissue (sarcoidosis)

Management
- Complete excision: benign mixed tumour
- Exenteration, including bone removal and craniotomy when necessary, followed by radiation therapy: adenoid cystic carcinoma

  - Shape of the mass: cavernous haemangiomas are usually "round", benign mixed tumours of the lacrimal gland are said to be "oval", "kink" of an enlarged optic nerve (a sharp change in the direction of the nerve) strongly suggests a glioma
  - Size of the mass
  - Internal characteristics of the mass: homogenous (majority of tumours), heterogenous (combination of solid and cystic components in a child's tumour — lymphangioma, layering of fat and keratin debris in a cystic mass — dermoid cyst, small areas of calcification in a soft tissue orbital mass —

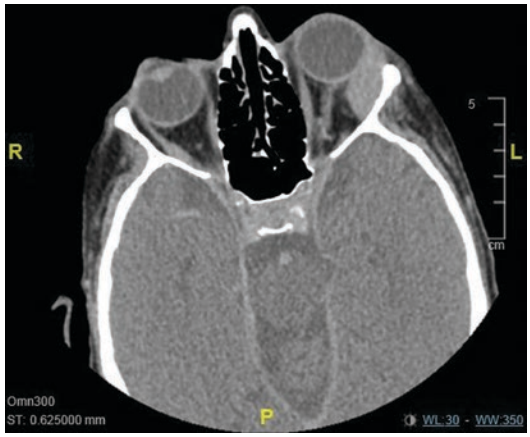

Fig. 2.52 Axial CT scan image of a patient with an enlarged left lacrimal gland

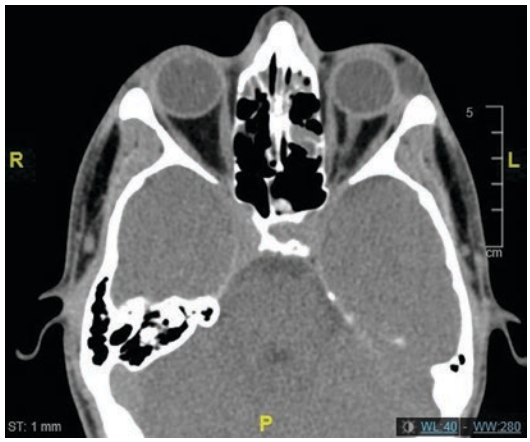

Fig. 2.53 Axial CT scan of a patient showing a left extraconal round mass with a lucent central area. This is consistent with a left orbital dermoid cyst

malignancy, "tram tracking" of an optic nerve tumour — optic nerve meningioma

- Contrast enhancement of the mass: meningioma, rhabdomyosarcoma, inflammatory lesions such as sarcoidosis

2.6.7 MRI Images on Orbital Disorders Occurring in Adulthood

2.6.7.1 Optic Nerve Sheath Meningioma (Fig. 2.55)

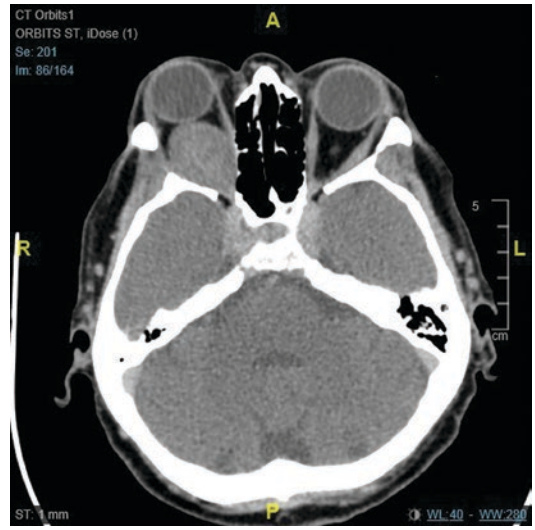

Fig. 2.54 Axial CT scan of a patient with a fusiform enlargement of the right optic nerve. This is consistent with an optic nerve glioma

2.6.8 MRI Images of Orbital Disorders Occurring in Childhood

2.6.8.1 Optic Nerve Glioma (Fig. 2.56)

2.7 Humphrey Visual Field (HVF)

2.7.1 Principles

- HVF is a type of static perimetry that involves the presentation of stationary test objects
- Entire goal of perimetry is to determine a patient's "threshold" sensitivity to a light stimulus at specific locations within the patient's visual field. Threshold refers to the intensity or brightness of the light stimulus that can be detected 50% of the time at that location.

2.7.2 Indications

- Screening, monitoring, and diagnosis of glaucomatous and neuro-ophthalmic conditions

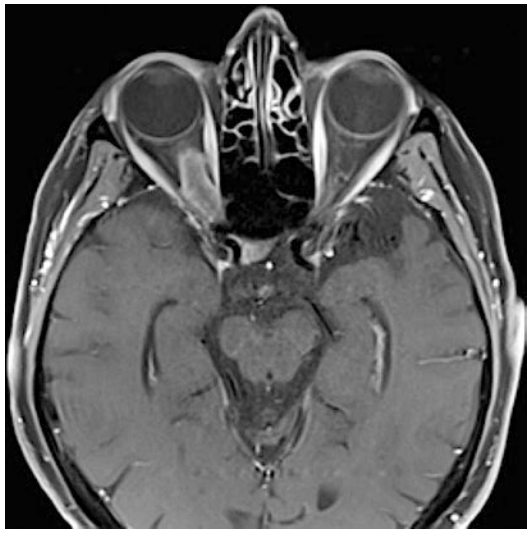

Fig. 2.55 Axial T1-weighted MRI scan image of a patient with a right optic nerve sheath meningioma with the typical 'tram track' sign (tubular thickening and enhancement of the optic nerve sheath)

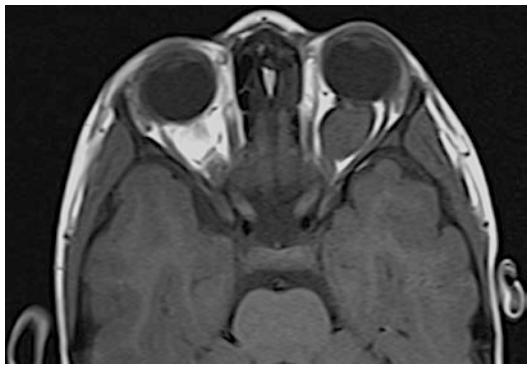

Fig. 2.56 Axial T1-weighted MRI scan image of a patient with a left optic nerve glioma

2.7.3 Interpretation (Fig. 2.57)

1. **Field parameter**
   - 10-2 HVF (test points 10° around the fovea)
   - 24-2 HVF (test points 24° around the fovea)
   - 30-2 HVF (test points 30° around the fovea)
2. **Fixation losses — reliability indices**
   - Fixation plotted, if patient moves and the machine retests and patient see spots, then a fixation loss is recorded
3. **False positives — reliability indices**
   - Patient presses the button when no actual light stimulus is present
4. **False negatives — reliability indices**
   - Patient failing to see a bright stimulus in the same spot where they previously detected a dim stimulus
5. **Numerical display**
   - Gives the threshold for all points tested (in dB)
6. **Grey scale**
   - Graphical representation of the data shown in the numerical display
   - Decreasing sensitivity is represented by the darker tones. Grey tone scales correspond to 5 dB change in threshold
7. **Total deviation**
   - Calculated by comparing the patient's measurements with age-matched controls
8. **Pattern deviation**
   - Values adjusted for any generalised depression in the overall field.
   - This highlight focal depressions in the field, which might be masked by generalised depressions in sensitivity (e.g. cataract and corneal opacities)
9. **Glaucoma Hemifield test (GHT)**
   - Compares five points on the upper field to corresponding five points on the lower field.
   - Differences between corresponding superior and inferior fields are compared with differences present in the population of normal controls
   - Outside normal limits: difference in the upper and lower set of points would not be found in 99% of patients without glaucoma
   - Borderline: difference detected would not be found in 97% of patients without glaucoma
10. **Visual field index (VFI)**
    - A global index that represents the entire visual field as a single percentage of normal
11. **Mean defect (MD) — global indices**
    - A measure of the overall field loss.
    - An average of deviations across all test locations

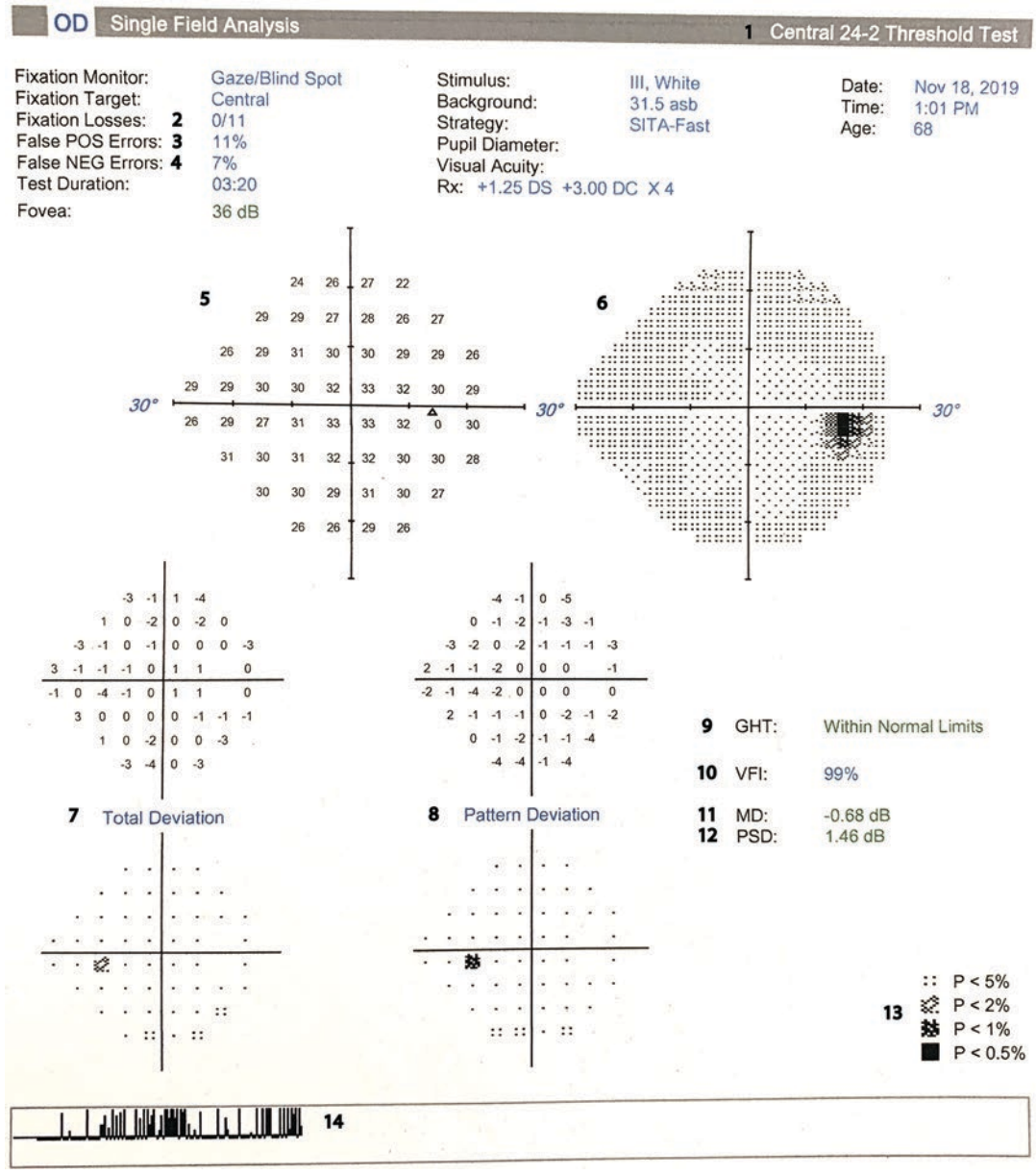

Fig. 2.57 A printout of a normal 24-2 HVF with key features indicated. 1: Field parameter. 2: Fixation losses. 3: False positive errors. 4: False negative errors. 5: Numerical display. 6: Grey scale. 7: Total Deviation. 8: Pattern Deviation. 9: Glaucoma Hemifield Test (GHT). 10: Visual Field Index (VFI). 11: Mean Defect (MD). 12: Pattern Standard Deviation (PSD). 13: Probability display. 14: Gaze tracker

12. **Pattern standard deviation (PSD) — global indices**
    - Measure of focal loss or variability within the field, taking into account any generalised depression

    Corrected pattern standard deviation (CPSD) — global indices
    - A measure of variability within the field after correction for SF

    Short-term fluctuations (SF) — global indices
    - An indication of the consistency of responses. It is assessed by measuring threshold twice at 10 pre-selected points and calculated on the

difference between the first and second measurements (>5 dB difference is abnormal)

13. **Probability display**
    - P < 0.5%: less than 0.5% of the population would attain the result
    - P < 1%: less than 1% of the population would attain the result
    - P < 2%: less than 2% of the population would attain the result
    - P < 5%: less than 5% of the population would attain the result
14. **Gaze tracker**
    - Printed at the bottom of the print out
    - Measures how often and how far from fixation the patient looked away during the test
    - Higher spikes indicate larger eye movements

2.7.4 Detecting Glaucoma Progression

- Trend-based analysis (e.g. PROGRESSOR software and PeriData):
  - Determines the actual rate of change of VF parameters through the VFI
  - VFI assigns a number from 0% to 100% (100% being a perfect age-adjusted visual field and 0% representing a perimetrically blind field) and is calculated from pattern deviation plots in eyes with a MD of better than −20 dB and from total deviation plots in eyes with a MD of worse than −20 dB
- Event-based analysis (e.g. Glaucoma Progression Analyser for the Humphrey Field Analyser):
  - Determines VF progression to be either present or absent depending on a predefined change in the VF parameters (loss of three or more test points in the same location on 3 consecutive field tests — EMGT)
  - Glaucoma progression analysis (GPA):
    Individual test locations in the visual field are flagged as possibly, likely, or probably progressed from baseline if the retinal sensitivity at that location has changed by an amount expected in fewer that 5% of stable glaucoma on 1, 2, or 3 consecutive visual fields, respectively
- Heidelberg Retinal Tomograph (HRT) — Scanning Laser Tomography:
  - A scanning laser ophthalmoscopy (SLO) that allows for 3-D reconstruction of the optic nerve
  - SLO devices employ a confocal (pinhole) aperture, generating a single point of laser light at a specific wavelength that is scanned across the optic nerve in a raster pattern (i.e. series of horizontal parallel lines)
  - Measures:
    Cup: CDR
    Rim: rim area, rim volume, Moorfields regression analysis — comparison to normative database and risk of glaucoma assessed
    RNFL: mean RNFL thickness, height variation contour
- Optic nerve head and peripapillary NFL OCT:
  - Bruch's membrane opening-minimum rim width (BMO-MRW: measures neuroretinal rim by OCT) — minimum distance between Bruch's membrane opening (BMO — anatomic end of Bruch's membrane) and the inner limiting membrane (ILM) — better way of detecting glaucomatous damage than circumpapillary RNFL thickness.

2.8 Field of Binocular Single Vision (BSV)

2.8.1 Principles

- The field of binocular single vision is plotted on a perimeter to depict the areas of the binocular field in which binocular single vision is maintained and those in which there is diplopia

2.8.2 Indications

- Monitoring change and progression in a patient's binocular diplopia
- Surgical planning for the management of a patient's binocular diplopia

2.8.3 Interpretation

- Position
- Size:
  - The field of BSV can be measured in degrees from the perimeter chart and these measurements can be compared with those of the normal field
  - Influenced by a patient's fusion amplitude; if this is good the field of BSV will be enlarged in patients with TED involving the vertically acting muscles and in congenital vertical muscle palsies
  - The greater the limitation of ocular movement, the smaller the field of BSV
  - A narrow field of BSV, often relatively centrally placed, is characteristic of mechanically caused limitation of movement in opposing directions (see Fig. 2.58)
- Shape:
  - The field is displaced away from the direction of maximum limitation of movement e.g. the field of BSV will be situated on dextro-elevation in a right CN IV palsy, with diplopia on laevodepression (see Fig. 2.59)
- Crossed out areas represents the patient's areas of diplopia

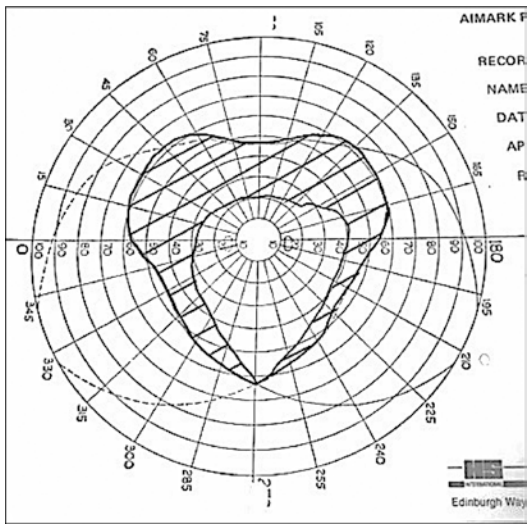

Fig. 2.58 Field of BSV of a patient with TED

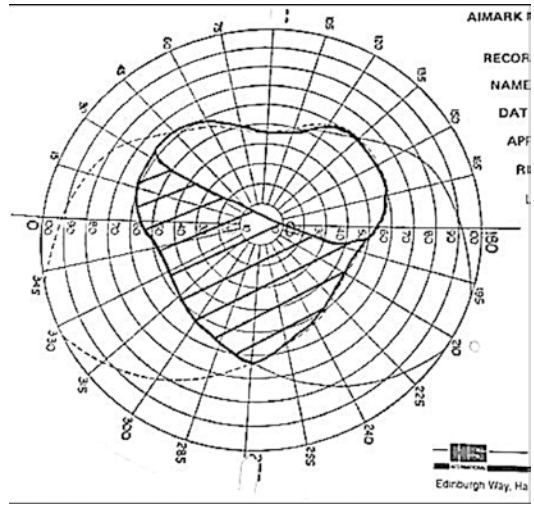

Fig. 2.59 Field of BSV of a patient with a right CN IV palsy

2.9 Corneal Topography

2.9.1 Principles

- Placido disc-based systems:
  - Consists of circular target of alternating concentric light and dark rings and a central aperture for observing the corneal reflections of these light and dark bands over the cornea
  - Examination of the reflected rings gives information about the shape of the cornea
  - The closer the mires the steeper the cornea. The wider the mires the flatter the cornea
  - Advantage: quickly captures data of the anterior corneal surface
  - Disadvantage: misses data on the central cornea as it is only able to acquire limited data points, difficult to focus and align, only captures data about the anterior corneal surface and its premise is based upon the assumption that the cornea is prolate (irregular corneal surfaces are often misdiagnosed), requires an intact epithelial surface and tear film for the instrument to obtain a clear image

- Scanning slit systems (e.g. Orbscan):
  - The scanning slit system is a reflection-based system that measures the triangulation between the reference slit beam surface and the reflected beam captured by a camera
  - Combines a 3D scanning slit beam system with an added Placido attachment
  - Forty slits (20 nasal, 20 temporal) are projected sequentially on the cornea during image acquisition to create an overlapping pattern of scanning slits.
  - The light reflected from the multiple slits of light projected through the cornea is interpreted by a camera using triangulation, and the final image is represented as a 3D topographic map including curvature, elevation and pachymetric maps of the entire corneal surface
  - Advantages: More user friendly, quicker analysis, captures data about the anterior and posterior corneal surfaces
  - Disadvantages: poor/unreliable capture of the corneal data from the periphery caused by the non-planar shape of the cornea, not useful in scarred non-reflective corneas
- Scheimpflug imaging systems (e.g. Pentacam):
  - Projection based system that is based on the Scheimpflug principle whereby a rotating camera enables the intersection of the object plane, lens plane, and image plane when they are not parallel to each other
  - Advantages: captures data about the anterior and posterior corneal surfaces, can measure scarred and non-reflective corneal surfaces, higher resolution and uniform accuracy across the whole cornea
  - Disadvantages: longer time required for image capture

2.9.2 Indications

- Screening, monitoring and planning treatment for corneal ectasias
- Refractive surgery screening and treatment
- Pre-operative IOL selection
- Post-keratoplasty astigmatism evaluation and management
- Ocular surface disorder evaluation
- CL fitting

2.9.3 General Approach to Interpreting Pentacam Printouts (Fig. 2.60)

1. **Ensure patient details are correct**
2. **Quality Specification (QS)**
   - If box is white with "OK" printed inside then all the data collected by the computer was correct. If box is yellow then some data is missing and a repeat scan is needed
3. **Maximum K reading (K Max [Front])**
   - Normal is ≤47.2 D
4. **Thinnest location**
   - Normal ≥470 μm
5. **Compare topographic vs manifest astigmatism**
   - Normal ≤1.0 D astigmatism and ≤15° axis
6. **Axial/Sagittal Curvature (Front) Map**
   - Areas of hot colours indicate areas with steep K readings
   - Cold colours indicate areas with flat K readings
   - Study shapes
     - Symmetric or central shapes: round, oval, symmetric bowtie (SB) — these shapes are normal if K Max ≤47.2 D
     - Asymmetric shapes: superior steep (SS), inferior steep (IS), asymmetric bowtie superior steep (AB/SS), asymmetric bowtie inferior steep (AB/IS)
     - Skew shapes: symmetric bowtie with skewed radial axis (SB/SRAX), asymmetric bowtie with skewed radial axis (AB/SRAX), SRAX reflects the angle between the axis of the inferior segment and the axis of the superior segment and is normal when ≤21°)

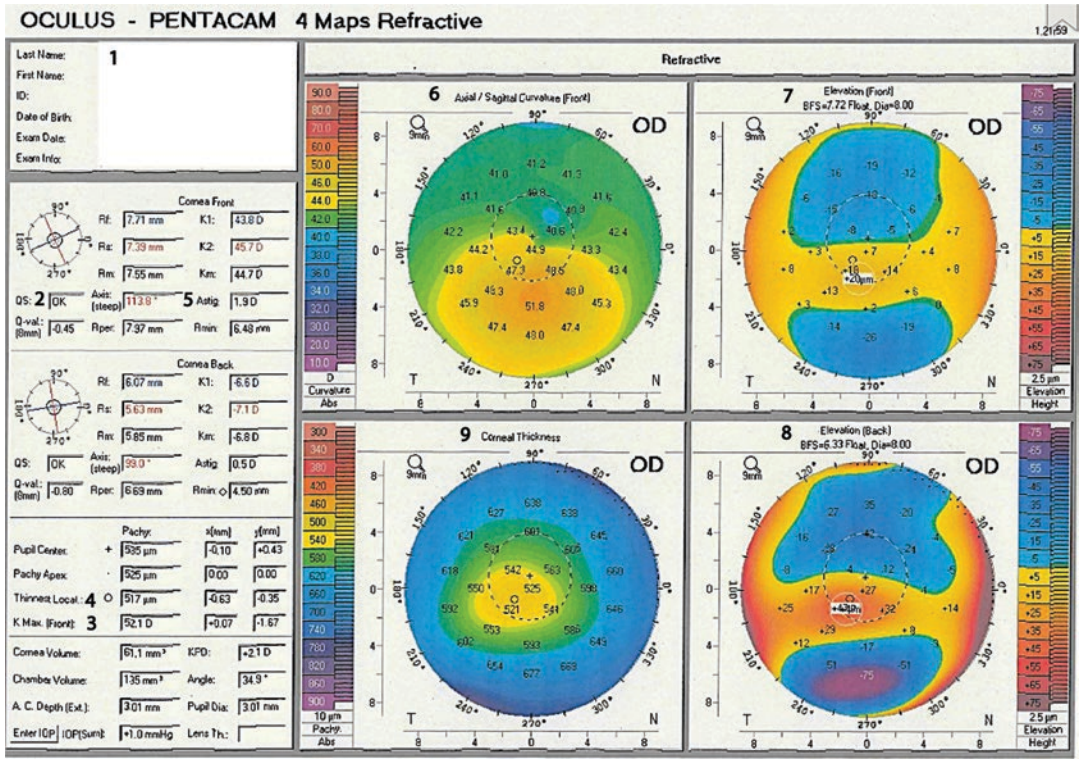

Fig. 2.60 A printout of a Pentacam printout with key features indicated. 1: Patient details. 2: Quality Specification (QS). 3: K Max (Front). 4: Thinnest location. 5: Astigmatism. 6: Axial/Sagittal Curvature [Front] map. 7: Elevation [Front] map. 8: Elevation [Back] map. 9: Corneal Thickness map

  - Special shapes: butterfly, crab claw (suggestive of PMD), vertical D, irregular (suggestive of scar, pterygium or previous refractive surgery)
- Study values
  - Compare the value two points above and the value two points below the center on the vertical meridian (I-S for 9 mm map): the difference between these two opposing points should be <2.5 D (for SS or AB/SS shapes) and <1.5 D (for IS or AB/IS shapes)

7. **Elevation (Front) Map**
- Study shapes using best fit sphere (BFS)
  - Symmetric shapes: central island when no or insignificant astigmatism, hourglass shape when significant astigmatism
  - Asymmetric shapes (skewed hour glass, tongue-like extensions, irregular)
- Study the values
  - If using the BFS float mode:
    Go to the thinnest location symbol displayed on map and click on mouse at that point and see the value: normal for myopes ≤8 and normal for hyperopes ≤7
  - If using the best-fit toric ellipsoid (BFTE) float mode:
    Look at the highest plus numbers within the central 5 mm zone (black circle): normal if numbers are ≤12
- If asymmetric shapes are present on Elevation (Front) map, one needs to exclude misalignment (poor fixation of patient during image capture), large angle kappa, exclude dry eye or excess tears, exclude corneal opacity, scar, cataract or other pathologies, exclude previous corneal surgeries

8. **Elevation (Back) Map**
   - Study the shapes using best fit sphere (BFS)
     - Symmetric shapes: central island when no or insignificant astigmatism, hourglass shape when significant astigmatism
     - Asymmetric shapes: skewed hour glass, tongue-like extensions, irregular
   - Study the values
     - If using the BFS float mode:
       Go to the thinnest location symbol displayed on map and click on mouse at that point and see the value: normal for myopes ≤18 and normal for hyperopes ≤28
     - If using the BFTE float mode:
       Look at the highest plus numbers within the central 5 mm zone (black circle): normal if numbers are ≤15
   - If asymmetric shapes are present on Elevation (Back) maps, one needs to exclude misalignment (poor fixation of patient during image capture), large angle kappa (look at X-coordinate of pupil center — if ≤0.20 then angle kappa is normal), exclude dry eye or excess tears, exclude corneal opacity, scar, cataract or other pathologies, exclude previous corneal surgeries
9. **Corneal Thickness Map**
   - Study shapes
     - Symmetric shapes
     - Asymmetric shapes: horizontal displacement of thinnest location, vertical displacement of thinnest location (dome shape, bell shape with inferior thinning for PMD, globus shape with generalised thinning to limbus)
   - Check values
     - Compare the value two points above the center with the value two points below the center and the I-S difference should be ≤30 μm
   - If asymmetrical shapes on thickness map, need to exclude misalignment (poor fixation of patient during image capture), large angle kappa (look at X-coordinate of pupil center — if ≤0.20 then angle kappa is normal), exclude dry eye or excess tears, exclude corneal opacity, scar, cataract or other pathologies, exclude previous corneal surgeries
10. **Thickness profile diagram** (see Fig. 2.61)**:**
    - Describes the change of corneal thickness in relation to location
    - Study shapes
      - Normal shape: red line takes normal slope passage and does not leave it before 6 mm zone and average of progression is <1.2
      - Abnormal shapes:
        Quick slope: red lines leave normal slope passage before 6 mm zone with high average
        S-shape: red line leaves normal slope and then returns to slope again
        Flat shape: red line is horizontal and implies cornea is oedematous like in FED or PBK
        Inverted or upwards shape: red line slopes upwards and implies PMD

2.9.4 Corneal Topography of Ectatic Disorders (Table 2.8)

2.9.4.1 Keratoconus (KC) (Fig. 2.62)

Corneal Topography Findings to Look for Specifically in KC

- Rabinowitz-McDonnell indices (Rabinowitz 1995)
  - Central corneal power ≥47.2 D:
    <47.2 D: normal cornea
    47.2–48.7 D: forme fruste KC
    >48.7 D: KC
  - Inferior-superior dioptric asymmetry (I-S value) >1.2
  - Sim-K astigmatism >1.5 D
- Skewed radial axes (SRAX) >21°
- The Rabinowitz-McDonnell indices identifies 98% of patients with KC (Rabinowitz 1995)
- Form fruste KC (FFKC) differs from KC in that the latter can be diagnosed clinically with

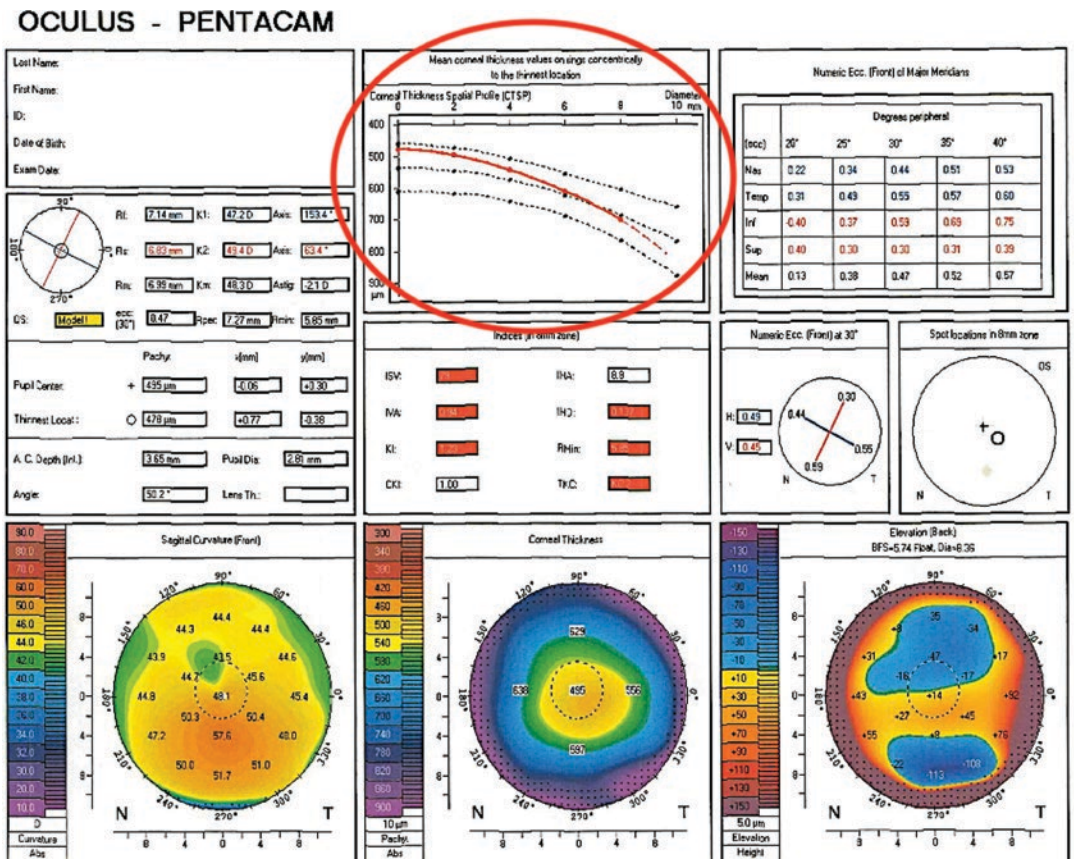

Fig. 2.61 Corneal topography with the thickness profile diagram shown in the red circle. Deviation of the red curve before the 6 mm point is an indicator of a relatively thin corneal center, commonly seen in ectatic corneal disorders

Table 2.8 Features on corneal topography suggestive of an ectatic pathology

A cornea can be considered highly suspect for ectatic pathology if the following parameters are present:

- The highest curvature point (on Sagittal Curvature [Front] map) and thinnest point (on Corneal Thickness map) coincide: highly suspect cornea
- The highest curvature point (on Sagittal Curvature [Front] map) coincides with the highest anterior (front) and posterior (back) points on the elevation maps: highly suspect cornea
- The highest curvature point (on Sagittal Curvature [Front] map), the thinnest point (on Corneal Thickness map), and the highest anterior and posterior points of the corneal surface on the elevation maps all coincide: diagnosis of ectasia can be made

use of the slit-lamp examination and characteristic pattern on corneal topography. FFKC has no identifiable slit-lamp signs, but corneal topography does.

2.9.4.2 Pellucid Marginal Degeneration (PMD)

Corneal Topography Findings to Look for Specifically in PMD

- Sagittal curvature [Front] map (see Fig. 2.63): low corneal power along central vertical axis, increased power as the inferior cornea is approached, and high corneal power along the inferior oblique meridians (crab-claw appearance)

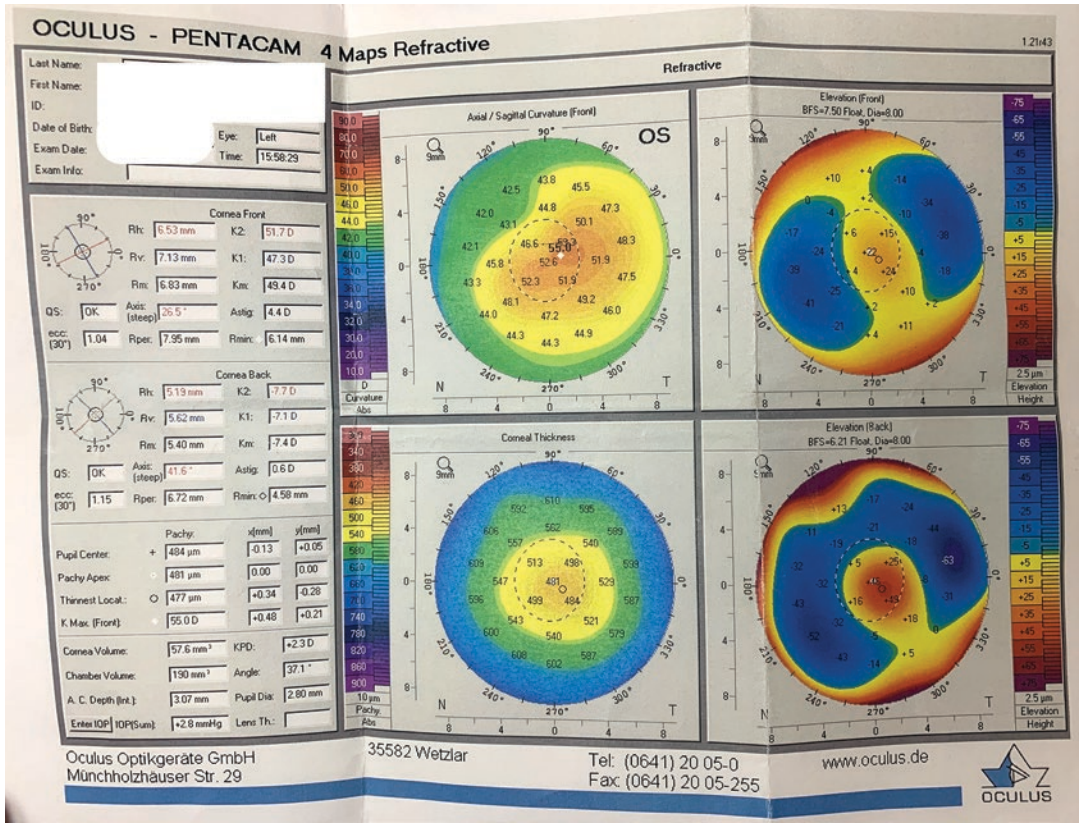

Fig. 2.62 Corneal topography of a patient with keratoconus. Note how the highest curvature point, the thinnest point, and the highest anterior and posterior points of the corneal surface on the elevation maps all coincide with each other

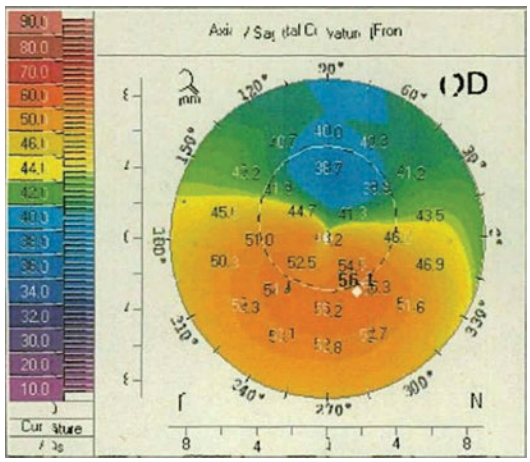

Fig. 2.63 Sagittal curvature map of a patient with PMD showing a crab-claw appearance

- Elevations maps: location of the cone and the "kissing birds" sign (this sign is absent when the cone is central or paracentral and is present when the cone is peripheral, sign only appears when the BFS float mode is used)
- Corneal thickness map: cornea thickens from the center to the periphery. If any part of the peripheral cornea is thinner than the center, this is a cause for concern. In PMD, the corneal thickness may reveal a thinning of the inferior cornea. This thinning is characterised with a special sign called the "bell" shape, which is a hallmark of PMD
- Thickness profile: in advance cases of PMD, the curve usually takes an inverted passage

2.10 Biometry

2.10.1 Optical Biometry

2.10.1.1 Principles

- Non-contact method of biometry using the IOL Master
- Axial length measured from cornea to RPE
- Utilises two coaxial partially coherent laser beams (partial coherence interferometry) from the infrared spectrum (780 nm wavelength)
- Device can measure axial length, keratometry, AC depth, corneal white to white distance
- Unable to carry out adequate measurements in dense cataracts, especially with posterior subcapsular cataracts

2.10.1.2 Indications

- IOL power calculations for cataract surgery

2.10.1.3 Interpretation (Fig. 2.64)

1. Ensure **patient details** are correct

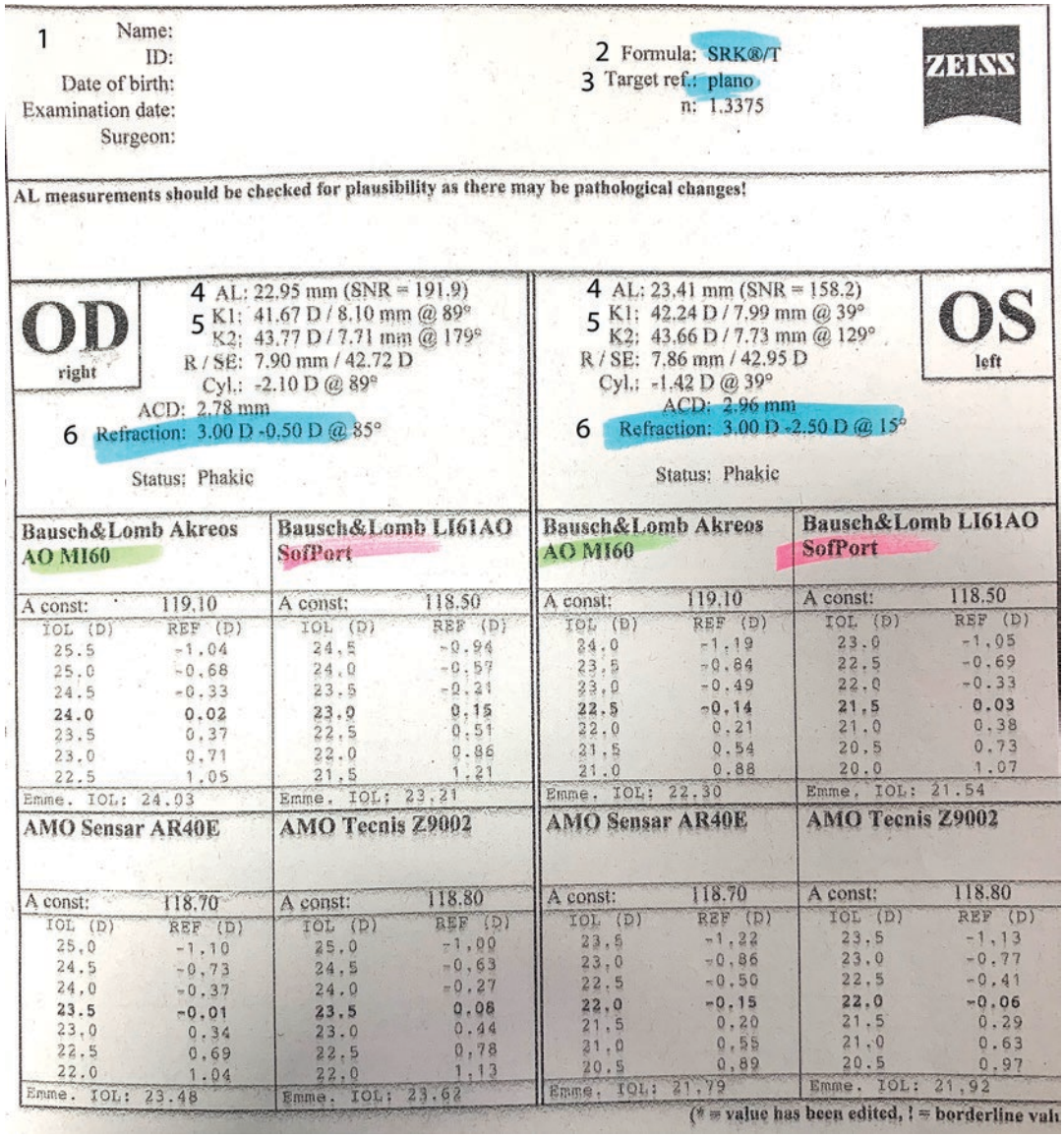

Fig. 2.64 IOL master biometry printout 1 with key features indicated. 1: Patient details. 2: Formula. 3: Target refraction. 4: Axial length values. 5: Keratometry values. 6: Refraction

2. Check correct **formula** has been used
   NICE guideline [NG77] (2017):
   - Hoffer Q: AL <22 mm
   - SRK-T or Barrett Universal II: AL 22–26 mm
   - SRK-T or Haigis: AL >26 mm
   - Special formulas for eyes that have had previous laser refractive surgery, e.g. Haigis-L
3. Check **target refraction**
   - Consider using 50% of first-eye refractive outcome prediction error to guide second-eye power calculation (The Royal College of Ophthalmologists 2018 Correct IOL implantation in cataract surgery guideline)
4. Check **axial length (AL)** and **signal-to-noise ratio (SNR)** measurements
   - When checking the quality of AL values, look for a sharp centralised peak and an even baseline on the axial length measurement signal (see Fig. 2.65)
   - The SNR is a measure of scan quality and indicates the height of the highest peak above the baseline. A good quality scan will have an SNR >2.0
5. Check **keratometry (K)** readings
6. Check **refraction** of eyes

2.10.1.4 Indications for Repeating Biometry Measurements

The Royal College of Ophthalmologists 2010 Cataract Surgery Guideline suggest repeating biometry when:

- AL <21.20 mm or >26.60 mm
- Difference in axial length between fellow eyes of >0.7 mm
- Mean corneal power <41 D or >47 D
- Difference in mean corneal power of >0.9 D
- Delta K is >2.5 D

The Royal College of Ophthalmologists 2018 Correct IOL implantation in cataract surgery guideline suggest repeating biometry when:

- Previous biometry measurements are more than 4 years old
- IOL exchange is required
- Patient has had previous corneal surgery or a progressive corneal disease
- Major eye operation since last biometry
- AL may have changed due to eye disease

2.10.1.5 Contact Lens Wear and Biometry Measurements (The Royal College of Ophthalmologists 2018 Correct IOL Implantation in Cataract Surgery Guideline)

- The following types of contact lenses should be left out before biometry for the following time periods:
  – Rigid gas permeable lenses: 2–4 weeks
  – Soft lenses: 1 week

2.10.2 Ultrasound (A-Scan) Biometry

2.10.2.1 Principles

- 10 mHz probe
- Estimation of axial length (measured from cornea to ILM) assumes that the speed of US has a constant value of 1540 m/s in the anterior chamber, 1641 m/s in the lens and 1540 m/s in the posterior chamber
- Immersion technique: saline filled scleral shell, avoiding corneal indentation
- Contact applanation technique: indentation of the cornea with possible shallowing of the AC and subsequent overestimation of the IOL power (myopic shift)

2.10.2.2 Indications

- IOL power calculations for cataract surgery if biometry results are unobtainable with optical biometry

2.10.2.3 Interpretation (Fig. 2.66)

1. Ensure **patient details** are correct
2. Check correct **formula** is used
   NICE Guidance [NG77] (2017):
   - Hoffer Q: AL <22 mm
   - SRK-T or Barrett Universal II: AL 22–26 mm
   - SRK-T or Haigis: AL >26 mm

Name:
ID: 1
Date of birth:
Examination date:

n: 1.3375

ZEISS

AL measurements should be checked for plausibility as there may be pathological changes!

Axial length values

OD right		OS left
	2	2
Phakic		Phakic
Comp. AL: 25.91 mm	(SNR = 75.1)	Comp. AL: 25.45 mm (SNR = 110.3)

3

AL	SNR	AL	SNR	AL	SNR	AL	SNR
25.93 mm	2.1			25.45 mm	7.2		
25.94 mm	2.9			25.46 mm	8.0		
25.95 mm	2.1			25.41 mm	3.0		
25.92 mm	2.1			25.46 mm	7.0		
25.91 mm	2.6			25.44 mm	7.2		
25.90 mm	2.6			25.41 mm	4.4		
25.89 mm	2.2			25.46 mm	3.5		
25.90 mm	2.6			25.46 mm	16.6		
				25.44 mm	4.6		
				25.45 mm	7.2		

4 Keratometer values

MV: 44.82/45.98 D	SD: 0.00 mm		MV: 44.58/45.98 D	SD: 0.00 mm	
K1: 44.82 D x 178°	7.53 mm		K1: 44.58 D x 21°	7.57 mm	
K2: 45.98 D x 88°	7.34 mm		K2: 45.92 D x 111°	7.35 mm	
ΔK: -1.16 D x 178°			ΔK: -1.34 D x 21°		
K1: 44.82 D x 0°	7.53 mm		K1: 44.58 D x 22°	7.57 mm	
K2: 45.98 D x 90°	7.34 mm		K2: 45.98 D x 112°	7.34 mm	
ΔK: -1.16 D x 0°			ΔK: -1.40 D x 22°		
K1: 44.82 D x 179°	7.53 mm		K1: 44.53 D x 22°	7.58 mm	
K2: 45.92 D x 89°	7.35 mm		K2: 45.98 D x 112°	7.34 mm	
ΔK: -1.10 D x 179°			ΔK: -1.45 D x 22°		

Anterior chamber depth values

ACD: 3.32 mm					ACD: 3.53 mm				
3.33 mm	3.31 mm	3.33 mm	3.31 mm	3.31 mm	3.55 mm	3.53 mm	3.53 mm	3.53 mm	3.53 mm

White-to-white values

WTW : 12.2 mm	Pup: 6.4 mm	WTW : 12.0 mm	Pup: 6.9 mm
Ix:+0.0mm Iy:+0.2mm	Px:-0.2mm Py:+0.2mm	Ix:-0.8mm Iy:+0.1mm	Px:-0.5mm Py:+0.1mm
WTW : 12.3 mm	Pup: 6.4 mm	WTW : 12.0 mm	Pup: 6.9 mm
Ix:+0.0mm Iy:+0.3mm	Px:-0.1mm Py:+0.3mm	Ix:-0.8mm Iy:+0.1mm	Px:-0.5mm Py:+0.1mm
WTW : 12.2 mm	Pup: 6.4 mm	WTW : 12.0 mm	Pup: 6.9 mm
Ix:-0.0mm Iy:+0.3mm	Px:-0.2mm Py:+0.3mm	Ix:-0.8mm Iy:+0.1mm	Px:-0.5mm Py:+0.1mm

Reference image capture

No image	No image

(* = value has been edited, ! = borderline value)

Fig. 2.65 IOL master biometry printout 2 with key features indicated. 1: Patient details. 2: Axial length measurement signal. 3: Axial length (AL) and signal-to-noise ratio (SNR) values. 4: Keratometer (K) values

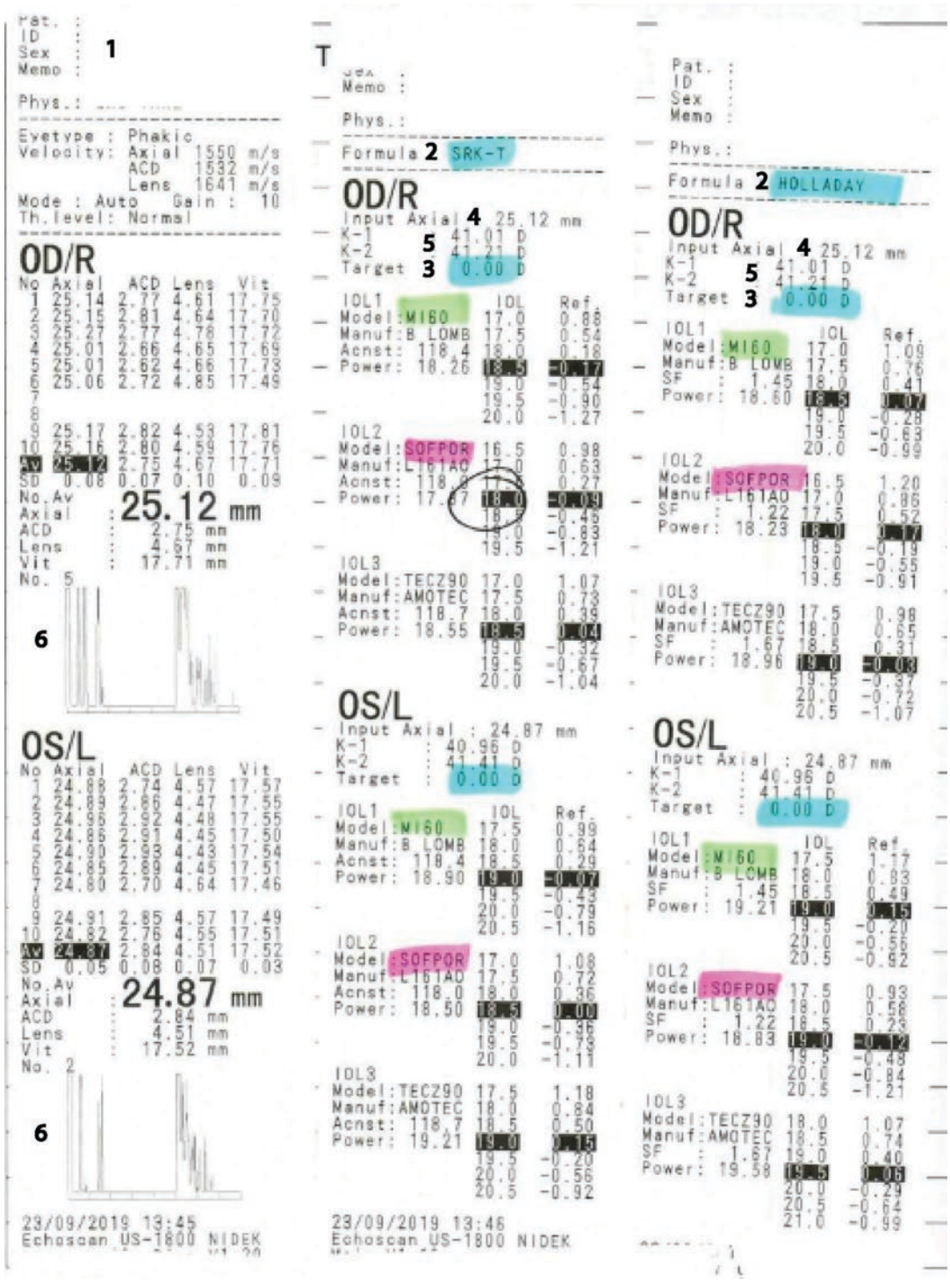

Fig. 2.66 A-scan biometry printout using the contact applanation method with key features identified. 1: Patient details. 2: Formula. 3: Target refraction. 4: Axial length. 5: Keratometry readings. 6: Identifiable peaks

- Special formulas for eyes that have had previous laser refractive surgery, e.g. Haigis-L

3. Check **target refraction**
   - Consider using 50% of first-eye refractive outcome prediction error to guide second-eye power calculation (The Royal College of Ophthalmologists 2018 Correct IOL implantation in cataract surgery guideline)
4. Check **axial length (AL)** measurements
5. Check **keratometry (K)** readings
6. Check **identifiable peaks** (see Fig. 2.67)
7. Check **refraction** of eyes

2.10.2.4 Improving the Accuracy of the A-Scan

- Immersion method rather than contact applanation technique
- Adjust velocity settings for silicone oil filled eyes
- Ensure perpendicular positioning of probe on eye with following characteristics present:
  - Equal height double corneal peaks
  - 5 high, sharply rising echoes
  - Descending orbital fat behind the scleral echo
  - Reproducibility
- Optimising the IOL constants for each IOL model for the method of axial length measurements (optical or acoustic) has a much greater impact on the predictability of the refractive outcome than choosing between modern IOL formulae.
- Optimising A constants for each IOL model according to the method of axial length measurement is much more important than optimising A constants for each surgeon when using the same method of axial length measurement

2.11 Dacryocystography (DCG) (Fig. 2.68)

2.11.1 Principles

- A fluoroscopic contrast examination of the nasolacrimal apparatus.

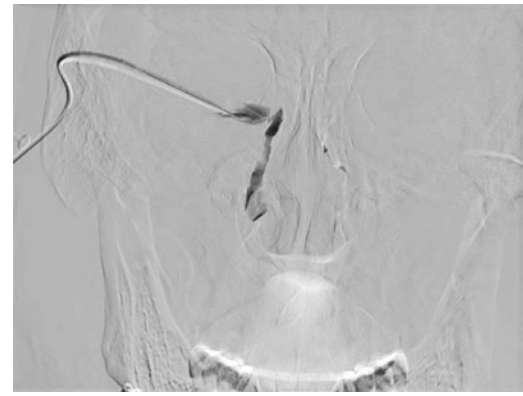

Fig. 2.68 DCG image showing a patent lacrimal drainage system on the right side

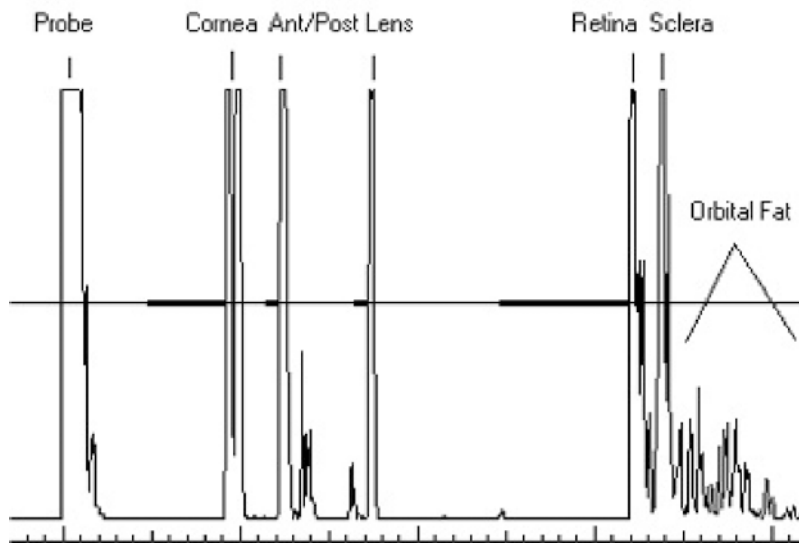

Fig. 2.67 Series of peaks that should be seen in a phakic eye on an A-scan printout

- With the patient supine, a drop of topical anaesthesia is placed into the conjunctival sac in both eyes.
- A control film is taken after intubation of both lower puncta with Portex intravenous cannulae that were fixed 5 mm into the lower canalicular systems by taping.
- A volume of 1–2 ml of an iodised oil-based contrast medium is injected simultaneously into both lacrimal systems and a series of macroradiographs are taken.
- The patient is then sat upright for 5 min before a final delayed erect oblique radiograph is taken.
- Functional NLDO is diagnosed if there was poor emptying, such that residual contrast was present in the lacrimal sac or NLD of the delayed radiograph.

2.11.2 Indications

- Functional obstruction of the lacrimal drainage system: incomplete obstructions and intermittent tearing with no anatomic pathology — location of stenosis, diverticuli, stones
- Failed lacrimal surgery — size of the sac
- Suspicion of sac tumours

2.11.3 Interpretation

- Look for any filling defects in the lacrimal drainage system

2.11.4 DCG Images of Common Pathologies of the Lacrimal Drainage System (Figs. 2.69, 2.70, 2.71, 2.72 and 2.73)

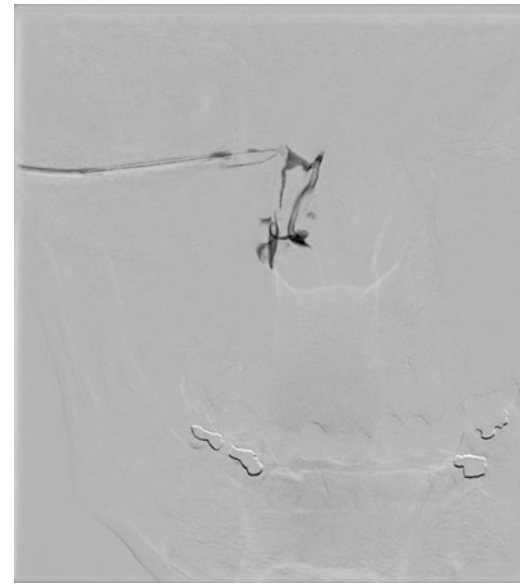

Fig. 2.69 DCG image of a patient with a patent right DCR showing a Y-shaped configuration (result of dye entering directly from the lacrimal sac into the nasal cavity)

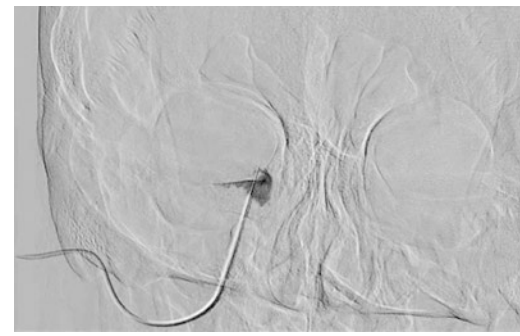

Fig. 2.70 DCG image of a patient with a complete obstruction of the right superior and inferior canaliculus with no flow of dye into the lacrimal drainage system and overflow of dye into the tear lake

2.12 Dacryoscintigraphy (DSG)

2.12.1 Principles

- Nuclear medicine procedure used as a diagnostic tool for "functional" NLDO (patients who complain of epiphora without tear overproduction, whom an increased tear line is associated with patent lacrimal systems but show easy passage on syringing)
- Useful as a physiological test of tear flow through the lacrimal system
- Patient is seated upright in front of the pinhole collimator of the gamma camera, and a drop of Technetium-99m pertechnetate (radioactive tracer isotope) is placed into the inferior fornix of both eyes and the patient is requested to blink normally.

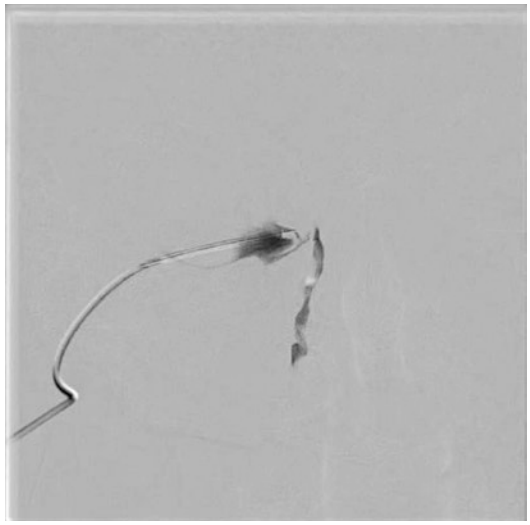

Fig. 2.71 DCG image of a patient with a right common canaliculus stenosis

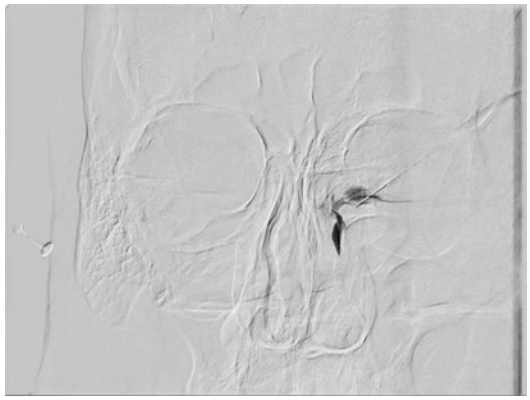

Fig. 2.72 DCG image of a patient with a left distal nasolacrimal duct obstruction

- A dynamic study is performed initially with the tracer distribution imaged every 10 s for the first 160 s. Static views are then taken routinely at 5, 10, 15, and 20 min.
- When radiotracer flows from the conjunctival sac to the nose, drainage is considered normal, and when it fails to reach the nose, the drainage is abnormal.

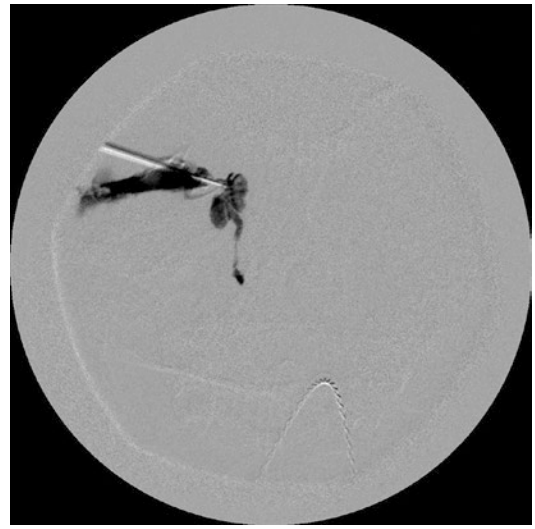

Fig. 2.73 DCG image of a patient with a complete obstruction at the level of the right nasolacrimal duct inferiorly with gross dilation of the right lacrimal sac

2.12.2 Indications

- Functional obstruction of the lacrimal drainage system
- Surgical planning (patient selection)

2.12.3 Interpretation

- Look for delays in the flow of the radioactive tracer isotope in the lacrimal drainage system (Wearne et al. 1999)
  - Presac delay (canalicular problem) — hold up at the inner canthus or failure of the tracer to reach the lacrimal sac by the end of the dynamic study
  - Preductal delay (NLD problem) — early filling of lacrimal sac, but no sign of sac emptying on the first static image at 5 min
  - Intraduct delay (NLD problem) — nuclide in the upper part of the NLD at 5 min, but no further drainage over the next 15 min.
- Better prognosis for DCR with preductal and intraductal delay.

2.13 Electrodiagnostic Tests

2.13.1 Full Field Electroretinogram (ERG) (Fig. 2.74)

2.13.1.1 Principles

- Records the mass electrical activity from the retina when stimulated by a light stimulus. The light stimuli may be either a flash stimulus or a pattern stimulus
- The rod and cone responses may be functionally dissected with ERG in the light of International Society for Clinical of Vision (ISCEV) recommendations (Marmor et al. 2009)

2.13.1.2 Indications

- To confirm or exclude a specific diagnosis e.g. hereditary retinal or macular disorders
- Monitor the progress and treatment of a known condition, e.g. Birdshot chorioretinopathy
- To provide an indication of visual potential in a diseased or injured eye

2.13.1.3 Interpretation

- ERG waveforms
  - Negative A wave: response of photoreceptors
  - Positive B wave: response of bipolar and muller cells
  - Oscillatory potentials: response of amacrine cells
- Scotopic (dark-adapted) ERG
  - Dim white flash: rod response only — B wave
  - Bright white flash (maximal ERG): mixed rod and cone response — A & B wave

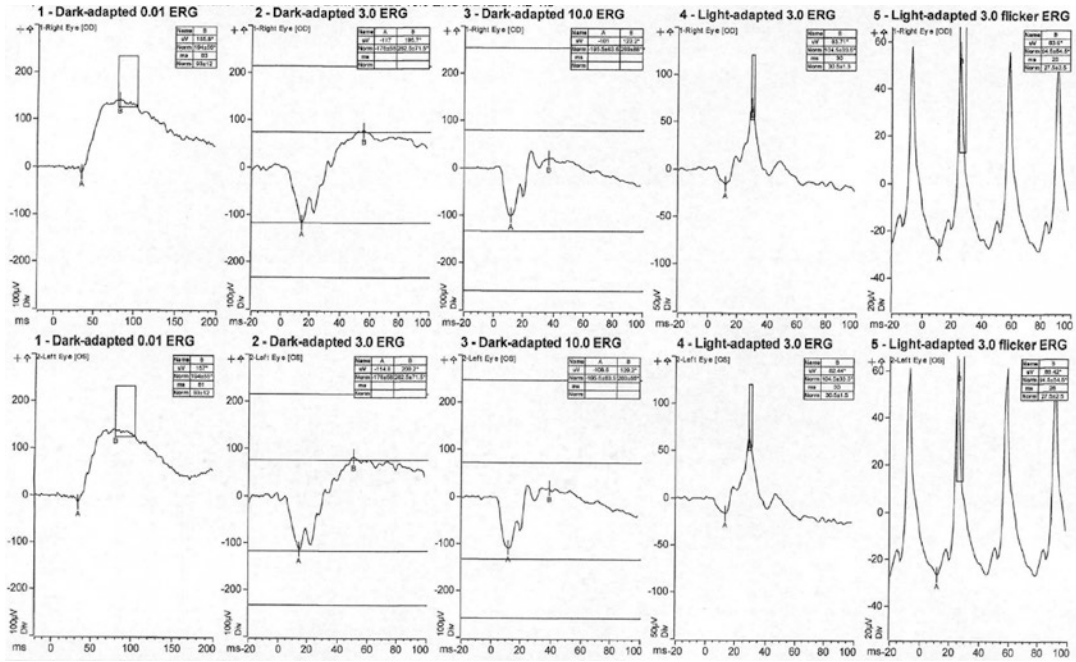

Fig. 2.74 A normal full-field ERG display. 1: Dark-adapted 0.01 ERG (rod response). 2: Dark-adapted 3.0 ERG (mixed rod and cone response — maximal ERG). 3: Dark-adapted 10.0 ERG (mixed rod and cone response with enhanced a-waves reflecting photoreceptor function). 4: Light adapted 3.0 ERG (single flash cone response). 5: Light adapted 30 Hz flicker ERG (cone response)

- Photopic (light-adapted) ERG
  - 30 Hz white light flicker stimulus: cone response
  - Photopic single flash: cone response
- Negative ERG (reduced scotopic B wave and normal A wave)
  - CRAO
  - X-linked retinoschisis
  - Congenital stationary night blindness (CSNB)
  - Myotonic dystrophy
  - Melanoma associated retinopathy (MAR)
  - Quinine toxicity
  - Birdshot chorioretinopathy
- Reduced A- and B-waves
  - Rod-cone dystrophies (e.g. RP)
  - Drug toxicity, e.g. phenothiazines
  - Total RD
  - Cancer associated retinopathy (CAR)
- Abnormal photopic and normal scotopic ERG
  - Achromatopsia
  - Cone dystrophy
- Reduced oscillatory potentials
  - Drug toxicity, e.g. vigabatrin

2.13.2 Pattern ERG (PERG)

2.13.2.1 Principles

- Objective assessment of macular function
- A reversing checkerboard evokes small potentials that arise from the inner retina

2.13.2.2 Indications

- Macular dystrophies, e.g. Stargardt's disease
- PERG can help facilitate the electrophysiological differentiation between macular and optic nerve dysfunction
- PERG serves to determine which diagnostic path to follow in patients who present with unexplained visual acuity reduction. A normal PERG is followed by VEP. If VEP is completely normal then visual loss is likely to be non-organic. If the VEP is abnormal, there is optic nerve/ganglion cell dysfunction

2.13.2.3 Interpretation

- PERG waveforms (see Fig. 2.75)
  - Small negative component at 35 ms (N35)
  - Prominent positive component at 50 ms (P50): originates from photoreceptors
  - Larger negative component at 95 ms (N95): originates from ganglion cells
- A marked reduction in the PERG P50 component amplitude, or less commonly an increase in the PERG P50 component latency, suggests dysfunction of the macular anterior to the ganglion cells. A full field ERG will then determine whether there is generalised retinal dysfunction or whether the pathology is confined to the macula
  - Abnormal PERG P50, normal ERG: indicates disease is confined to the macular (e.g. macular dystrophies or localised maculopathy) and excludes generalised retinal dysfunction
  - Abnormal PERG P50, Full-field ERG A-wave abnormality: may be suggestive of a rod-cone or a cone-rod dystrophy
  - Abnormal PERG P50, Full-field ERG B-wave abnormality (negative ERG): abnormalities of the PERG (reflect abnormal function within the central retina) can occur with causes of a negative full-field ERG (see Sect. 2.13.1.3)
- A selective reduction in the PERG N95 (with a normal PERG P50) abnormality suggests optic nerve/ganglion cell dysfunction from numerous causes including optic nerve demyelination, ischaemic optic neu-

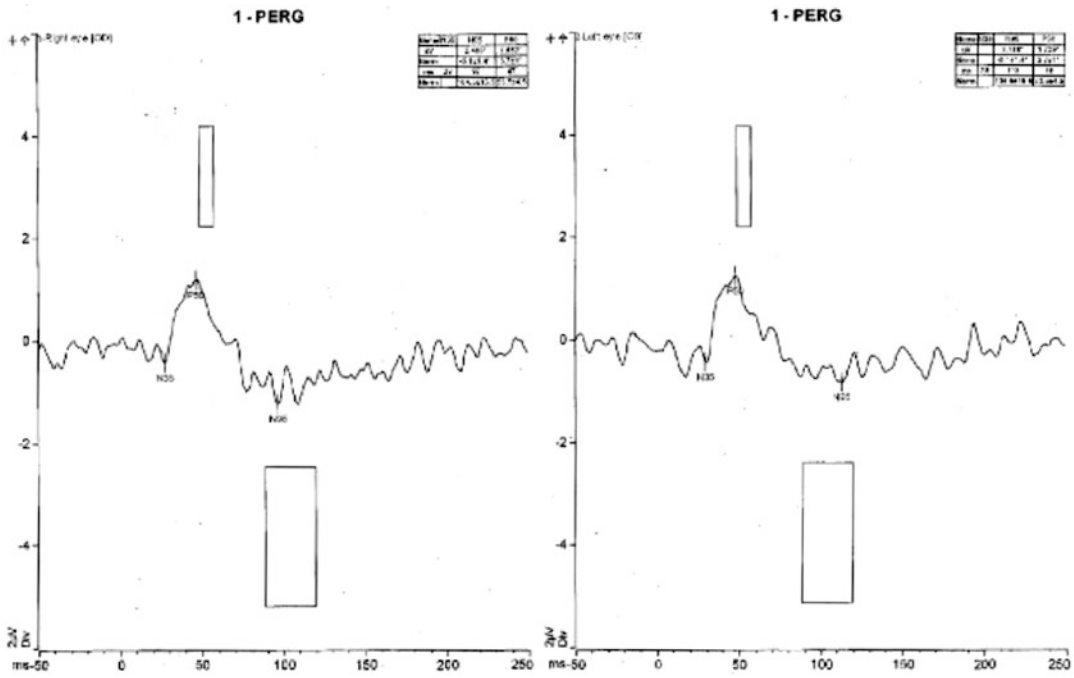

Fig. 2.75 PERG showing reduced responses affecting the N95 component (ganglion cell) more than the P50 component (retinal) in both eyes. The P50 component is of short latency in both eyes

ropathy, tobacco-alcohol amblyopia, optic nerve and chiasmal compression from pituitary tumours or craniopharyngiomas, Leber Hereditary Optic Neuropathy (LHON) and Kjer-type dominant optic atrophy (DOA). A VEP may assist in the discrimination between different types of optic nerve or chiasmal dysfunction

2.13.3 Multifocal ERG (mfERG)

2.13.3.1 Principles

- A map demonstrating the topographical variation in ERG responses across the retina (multiple small areas of the retina are stimulated)

2.13.3.2 Indications

- Detecting early outer retinal disease (pathology before the ganglion cells) that are not sufficiently extensive to significantly reduce the full-field ERG
- Decide whether a visual field defect is due to damage to the outer retina (before the ganglion cells) or damage to the optic nerve/ganglion cells
  - An abnormal mfERG provides strong evidence for an outer retinal lesion (since damage to the ganglion cells or optic nerve does not decrease the amplitude of the mfERG)
  - Seeing abnormal mfERG's in the same regions of the visual field that are abnormal

of perimetry provides reassurance of the retinal origin of the defect
- Following disease progression:
  - mfERG shows good repeat reliability and hence can be used to follow the progression of a disease. This is particularly helpful in patients who are poor visual field takers
- Differentiating organic from non-organic disorders
  - The advantage of the mfERG over the conventional full-field ERG is that is provides a topographical representation that can be compared with the patient's visual field
  - A normal mfERG does not, by itself, establish a visual deficit as non-organic. If the mfERG is normal, then a multifocal VEP should be performed to rule out damage to the optic nerve/ganglion cells

2.13.3.3 Interpretation

- mfERG waveforms:
  - Initial negative deflection (N1) followed by a positive peak (P1). There may be a second negative deflection (N2) after the positive peak
- To optimise the value of the mfERG, it is important to compare the results of the mfERG to automated visual fields obtained concurrently
  - Reduced mfERG amplitudes that correspond to areas of visual field defects suggest an outer retinal pathology as the cause of the VF defect
- Look at the printout display options (see Fig. 2.76)
  - Trace arrays:
    An array of mfERG traces from different regions of the retina
    Useful for observing areas of variation and abnormality
  - Topographic (3-D) response density plots:
    Plots show the overall signal strength per unit area of retina (combining N and P components) in a 3-D figure
    Sometimes useful as an overview or demonstration of certain types of pathology

2.13.4 Electrooculogram (EOG)

2.13.4.1 Principles

- Measures the standing potential at the RPE-photoreceptor interface: gives information regarding RPE function

2.13.4.2 Indications

- Early detection and diagnosis of Best's disease

2.13.4.3 Interpretation

- Results are expressed based on the Arden ratio (light peak/dark trough × 100): result is abnormal if Arden ratio is less than 1.4

2.13.5 Visual Evoked Potential (VEP) (Figs. 2.77 and 2.78)

2.13.5.1 Principles

- Gross electrical response recorded from the visual cortex in response to a changing visual stimulus such as multiple flash or reversing checkerboard pattern stimulus

2.13.5.2 Indications

- Rule out non-organic visual loss: a normal VEP can be useful to prove good vision in a patient suspected of non-organic visual loss
- Diagnosing and following demyelinating optic neuritis
- To provide an approximate objective measurement of visual acuity (using the reversing checkerboard pattern stimulus)

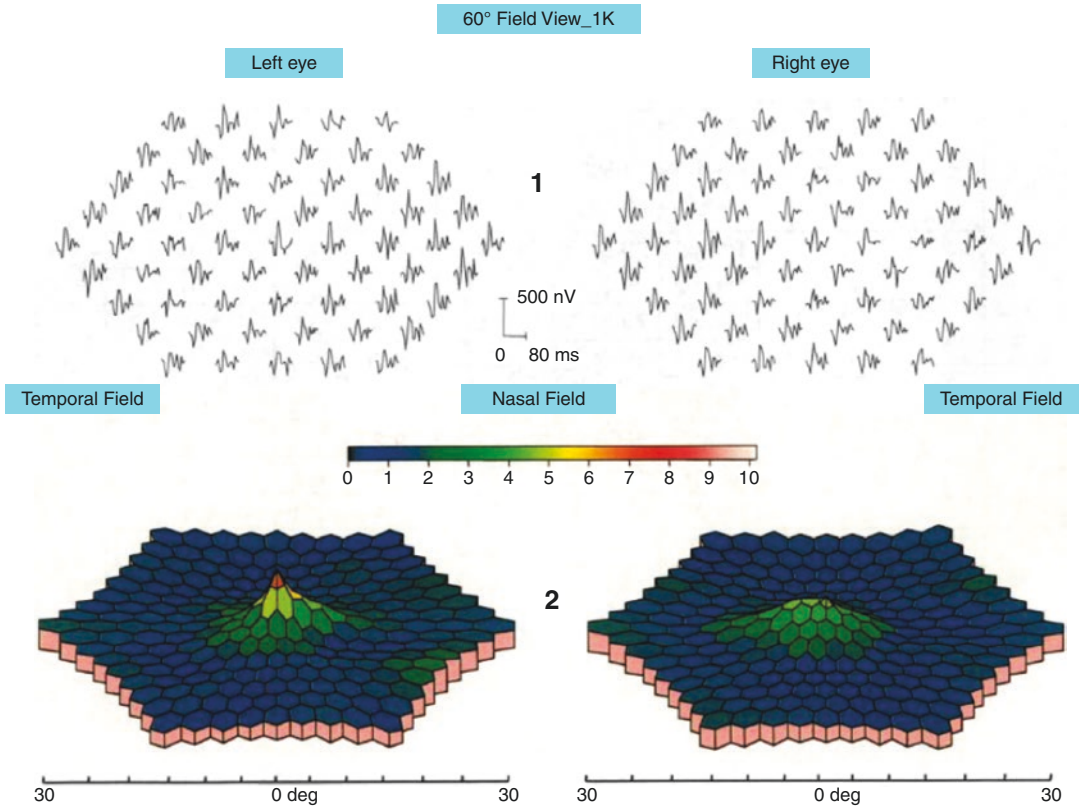

Fig. 2.76 A multifocal ERG printout display with key features identified. 1: Trace arrays. 2: Topographic response density plots

- To provide an indication of the maturity of the visual system in infants
- Detection of misrouting of optic nerve fibers in ocular albinism (using the reversing checkerboard pattern stimulus): fibers from the temporal retina which would normally project to the ipsilateral hemisphere instead decussate in the chiasm and project to the contralateral hemisphere

2.13.5.3 Interpretation

- VEP waves:
  - Negative deflection occurs at 75 ms (N75)
  - Positive deflection occurs at about 100 ms (P100): macular dominated response
  - Negative deflection occurs at 135 ms (N135)
- In acute demyelination, the VEP is usually undetectable. When VA has returned to normal, the VEP tends to show almost normal amplitudes but permanently delayed peak time
- In the detection of misrouting of optic nerve fibers in ocular albinism, stimulation of the left eye will result in a response predominantly over the right occipital lobe and vice versa

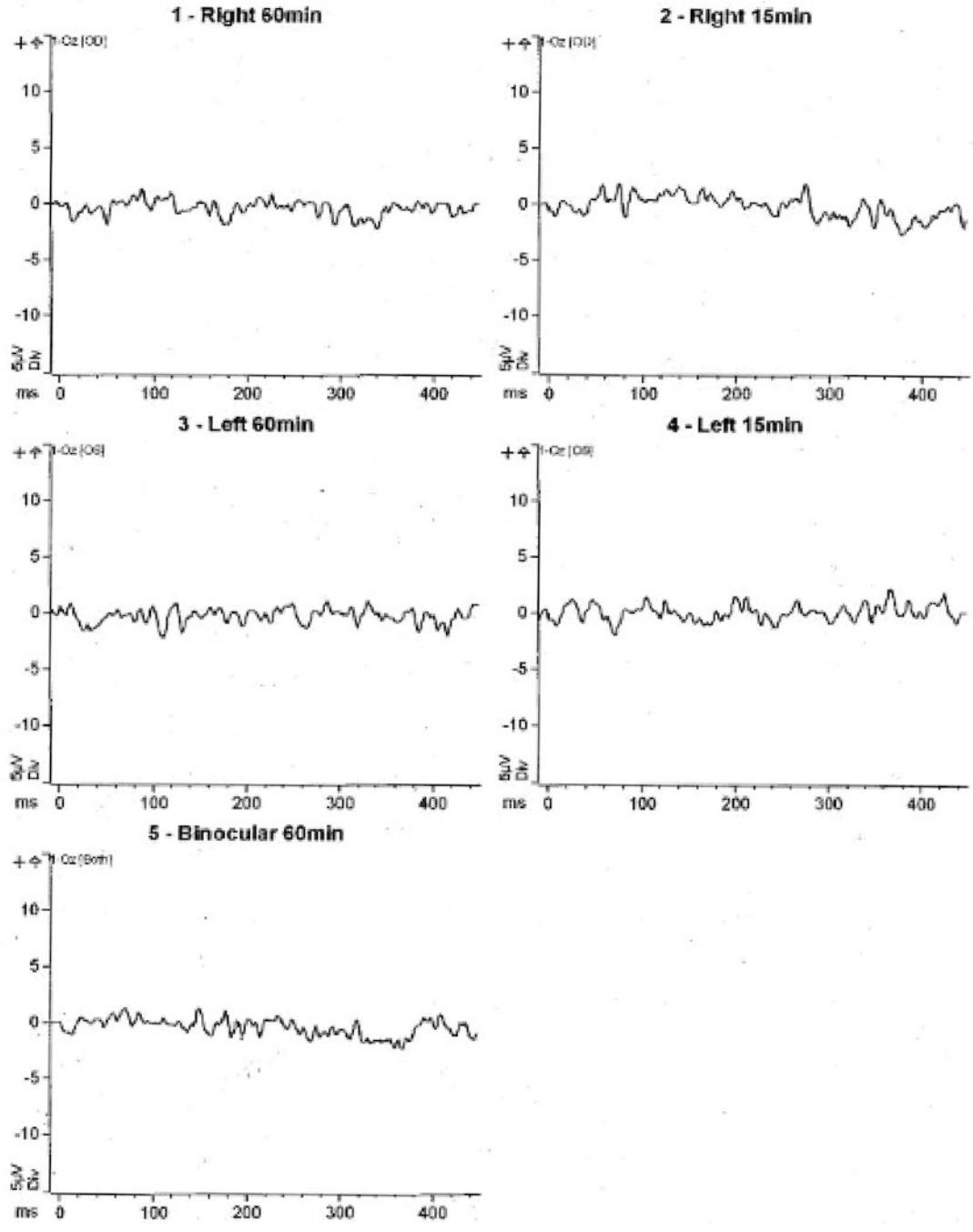

Fig. 2.77 Pattern reversal VEP of a patient with a bilateral atypical optic neuritis showing markedly reduced responses that were not measurable bilaterally

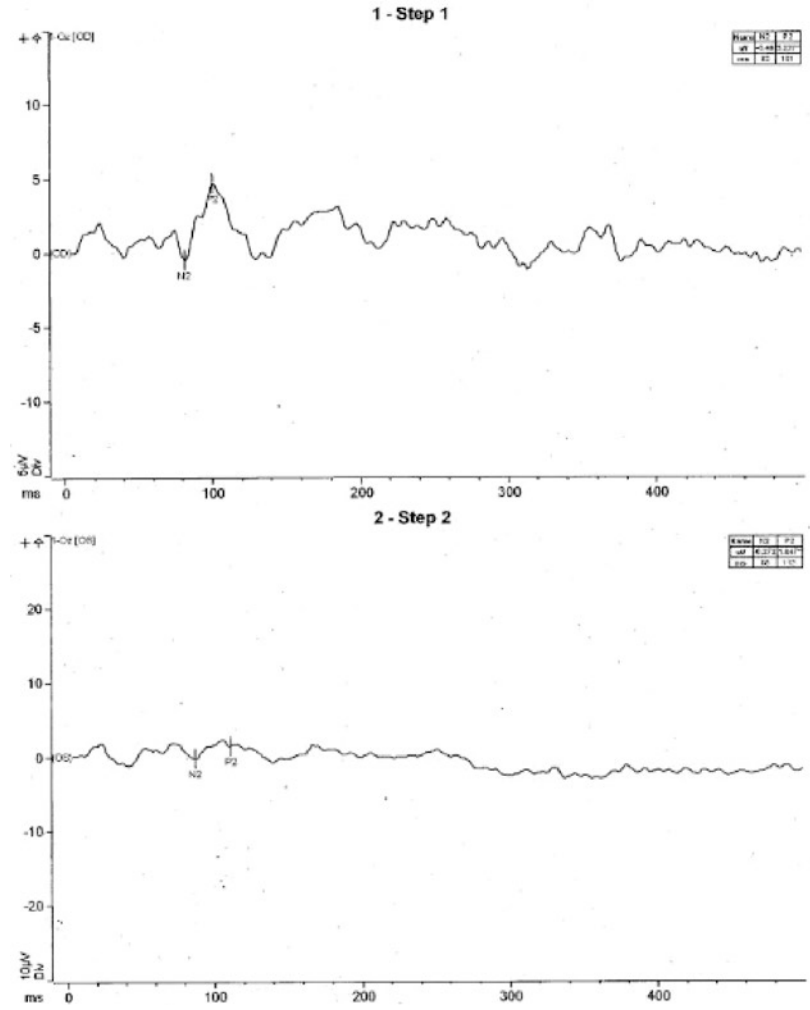

Fig. 2.78 Flash VEP of a patient with bilateral atypical optic neuritis showing low amplitude with normal latency in the right eye and markedly reduced and difficult to measure responses in the left eye

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Patient Management in Clinical Practice

3

Timothy H. M. Fung and Winfried M. K. Amoaku

3.1 Non-Proliferative Diabetic Retinopathy (NPDR) (Fig. 3.1)

3.1.1 Other Diagnoses to Consider

- Retinal vein occlusion
- Hypertensive retinopathy
- Ocular ischaemic syndrome
- Radiation retinopathy

3.1.2 Risk Factors for Diabetic Retinopathy (DR)

The Royal College of Ophthalmologists (RCOphth) Diabetic Retinopathy Guidelines 2012

- Non-modifiable
  - Genetic factors
  - Gender
  - Duration of diabetes
- Modifiable
  - Glycaemia
  - BP
  - Lipid levels
- Other
  - Carotid arterial disease
  - Pregnancy
  - Renal impairment
  - Smoking

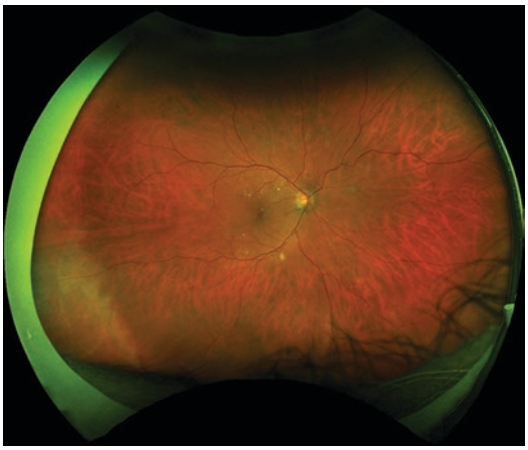

Fig. 3.1 Optos pseudocolour fundus image (right eye) of a diabetic patient with mild NPDR

3.1.3 Classification

- Proposed International Clinical Diabetic Retinopathy Severity Scale 2003
  - Mild NPDR:

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Microaneurysms (MAs) only
  - Moderate NPDR:
    More than just MA' but less than severe NPDR
  - Severe NPDR (4-2-1 rule) — one or more of the following features are present:
    More than 20 intraretinal haemorrhages in each of 4 quadrants
    Definite venous beading in 2 or more quadrants
    Prominent intraretinal microvascular abnormalities (IRMA) in 1 or more quadrants
  - Very severe NPDR:
    Two or more features of severe NPDR are present
- Public Health England NHS Diabetic Eye Screening Programme Grading Definitions 2017
  - R0: No retinopathy
  - R1 (Background DR/mild NPDR):
    Venous loop
    Microaneurysms
    Retinal haemorrhage
    Any exudate or cotton wool spot in presence of other non-referable DR features
  - R2 (pre-proliferative DR/moderate NPDR):
    Venous beading
    Venous reduplication
    Multiple blot haemorrhages (if uncertain, refer only in the presence of IRMA that are definitely seen)
    - Blot haemorrhages (located in OPL and INL) are larger than the width of the smallest of the four branches of the central retinal vein as it crosses the edge of the disc

    IRMA (check that they can still be seen on the colour image as well as the red-free image that has not been enlarged)

3.1.4 Examination

- Microaneurysms (MAs): small red dots
- Intraretinal haemorrhages: dot and blot haemorrhages, flame haemorrhages
- Hard exudates: sharply demarcated yellow-white deposits within the retina
- Cotton wool spots (CWS — patches of relative ischaemia affecting the NFL of the retina): small white patches with wispy borders situated in the inner retina
- Venous beading: localised areas of change in vessel calibre with alternating regions of relative dilation and constriction
- Venous loops
- Intraretinal microvascular abnormalities (IRMA): segments of dilated and tortuous retinal vasculature without crossing both arterioles or veins in the underlying retina
- Subretinal fibrosis

3.1.5 Investigations

- Blood test for diagnosis of diabetes mellitus:
  - Venous fasting glucose ≥7.0 mmol/L and/or
  - Oral glucose tolerance test (75 g anhydrous glucose) with a 2-h value ≥11.1 mmol/L and/or
  - Random venous glucose ≥11.1 mmol/L
- FFA:
  - MAs appear as hyperfluorescent dots visible during the arteriovenous transit phase
  - Intraretinal haemorrhages appear hypofluorescent blocking normal fluorescence from the underlying choroid
  - Exudates appear hypofluorescent
  - CWS appear hypofluorescent
  - IRMA appear hyperfluorescent during the arteriovenous transit phase and are often situated at the borders of areas of capillary non-perfusion

3.1.6 Treatment

- Modification of life-style:
  - Smoking cessation
  - Weight loss
  - Exercise
- Modification of systemic risk factors:
  - Hyperglycaemia control:
    DCCT (The Diabetes Control and Complications Trial Research Group

1995): Type 1 DM — tight control of HbA1C at mean of 7.2% was associated with 76% reduction in onset of retinopathy and slowed progression of DR by 54%, 60% reduction in onset of neuropathy, and 54% reduction in onset of nephropathy at 6.5 years

UKPDS (UK Prospective Diabetes Study Group 1998): Type 2 DM — tight control of HbA1C at mean of 7% was associated with a 25% reduction in the onset of microvascular disease

ACCORD (The ACCORD Study Group and ACCORD Eye Study Group 2010): Type 2 DM — intensive control of HbA1C reduced progression of DR by 42% and reduced development of PDR from 10.2% to 6.5%: avoid Pioglitazone in the presence of macular oedema, personalized HbA1C target should be set, usually between 48–58 mmol/mol (6.5–7.5%)

– BP control:

UKPDS (UK Prospective Diabetes Study Group 1998): Type 2 DM — tight control of BP at mean of 144/82 was associated with a 37% reduction in the onset of microvascular disease and 32% reduction in diabetes related deaths

– Lipid control:

ACCORD (The ACCORD Study Group and ACCORD Eye Study Group 2010): Type 2 DM — 40% reduction in the odds of having progression of DR over 4 years in patients allocated to fenofibrate in combination with a statin, compared to simvastatin alone): consider adding fenofibrate to a statin for NPDR in type 2 DM, avoid statins in pregnancy

3.1.7 Follow-Up

- Mild NPDR: discharge to community for DRSS screening or 12 months follow up if seen in hospital eye service
- Moderate NPDR: 3–6 months
- Severe NPDR: less than 3 months

3.1.8 Prognosis

- In the Diabetic Retinopathy Study (DRS) (The Diabetic Retinopathy Study Research Group 1981), 50% of untreated severe DR will develop proliferative diabetic retinopathy (PDR) within 15 months
- In the Early Treatment Diabetic Retinopathy Study (ETDRS) (Early Treatment Diabetic Retinopathy Study Research Group. ETDRS report number 12. 1991b):
  – 6.2% risk of progression to PDR at 1 year for mild NPDR
  – 11.3% risk of progression to PDR at 1 year for moderate NPDR
  – 20.7% risk of progression to PDR at 1 year for severe NPDR

3.2 Diabetic Macular Oedema (DMO) (Fig. 3.2)

3.2.1 Other Causes of Macular Oedema to Consider

- Inflammatory disorders: post-operative (cataract, VR, corneal), post-laser (PI, PRP), post-cryotherapy, uveitis
- Retinal vascular diseases: DR, RVO, OIS, hypertensive retinopathy, radiation retinopathy, MacTel

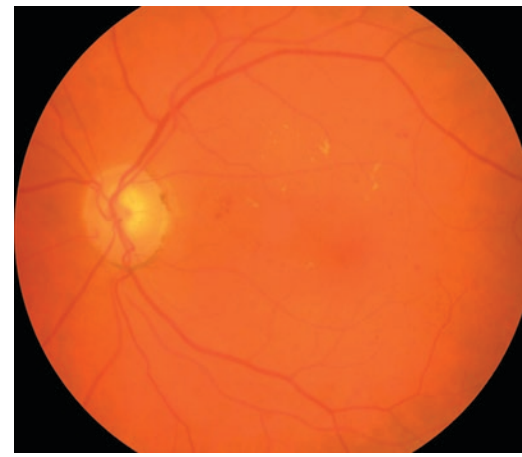

Fig. 3.2 Colour fundus image of a patient with DMO

- Choroidal vascular disease: CNV
- Drugs: latanoprost, topical adrenaline, glitazones, niacin, chemotherapy agents (e.g. paclitaxel)
- Inherited retinal dystrophies: RP, autosomal dominantly inherited CMO
- Disorders of vitreoretinal interface: VMT, ERM
- Optic nerve head abnormalities: optic disc pit, optic disc coloboma
- Tumours of the choroid/retina

3.2.2 Classification

- Proposed International Clinical Diabetic Macular Edema Severity Scale, 2003
  - Mild DME:
    Some retinal thickening or exudates in the posterior pole, distant from the center of the macula
  - Moderate DME:
    Retinal thickening or exudates near the center of the macula but not involving the center
  - Severe DME:
    Retinal thickening or exudates involving the center of the macula
- Public Health England NHS Diabetic Eye Screening Programme Grading Definitions 2017
  - M0: No maculopathy
  - M1:
    Exudate within 1 DD of the centre of the fovea
    Circinate or group of exudates within the macula:
    - A group of exudates is an area of exudates that is greater than or equal to half the disc area and this area is all within the macular area
    - To work out the area, the outer points of the exudates are joined and compared to half the area of the optic disc
    - Any MA or haemorrhage within 1 DD of the centre of the fovea only if associated with a best VA of 6/12 or worse

3.2.3 Examination

- Exudates within the macular
- MAs or retinal haemorrhages within the macular
- Clinically significant macular oedema — CSMO (Early Treatment Diabetic Retinopathy Study Research Group. ETDRS report number 9. 1991a):
  - Retinal thickening at or within 500 μm of the centre of the macula and/or
  - Exudates at or within 500 μm of the centre of the macula, if associated with thickening of the adjacent retina and/or
  - Zone or zones of retinal thickening 1-disc area or larger, any part of which is within 1 DD of the center of the macula

3.2.4 Investigations

- OCT
  - Exudates appear as hyperreflective foci within the retina
  - Macular oedema
  - Traction from ERM or VMT causing underlying macular oedema in the absence of retinal vascular leakage demonstrable by FFA
- FFA
  - Petaloid pattern of leakage from macular oedema
  - Enlarged foveal avascular zone from ischaemic diabetic maculopathy

3.2.5 Treatment

- Focal/grid laser
  - **ETDRS** (Early Treatment Diabetic Retinopathy Study Research Group. ETDRS report number 9. 1991a): focal/grid laser reduced the risk of moderate vision loss (loss of ≥15 letters from baseline) by 50% at 3 years in eyes with mild or moderate NPDR with CSMO

  - Indicated if CMT <400 μm and CSMO is not center involving (RCOphth Diabetic Retinopathy Guidelines 2012)
- Anti-VEGF therapy
  - Aflibercept (Eylea)
    NICE Guidance [TA346]: option for treatment of DMO if CMT ≥400 μm at the start of treatment
    Regimen: a single injection every month for 5 consecutive months, followed by one injection every 2 months with no requirement for monitoring between visits for the first 12 months
    Clinical trials:
    - **VISTA** study (Brown et al. 2015)
    - **VIVID** study (Brown et al. 2015)
  - Ranibizumab (Lucentis)
    NICE Guidance [TA274]: option for treatment of DMO if CMT ≥400 μm at the start of treatment
    Regimen: given monthly and continued until maximum VA is reached — VA stable for 3 consecutive months:
    Clinical trials:
    - **RISE** study (Nguyen et al. 2012; Brown et al. 2013)
    - **RIDE** study (Nguyen et al. 2012; Brown et al. 2013)
    - **RESTORE** study (Mitchell et al. 2011)
- Dexamethasone implant (Ozurdex)
  - NICE Guidance [TA349]: option for treatment of DMO if eye is pseudophakic and CSMO does not respond to non-corticosteroid treatment or such treatment is unsuitable
  - Regimen: A single implant is injected into the vitreous and remains in the vitreous for up to 270 days before fully dissolving
  - Clinical trials:
    MEAD study (Boyer et al. 2014)
    BEVORDEX study (Gillies et al. 2014)
    PLACID study (Callanan et al. 2013)
- Fluocinolone implant (Iluvien)
  - NICE Guidance [TA301]: option for the treatment of chronic CSMO that is insufficiently responsive to available therapies if an eye is pseudophakic
  - Regimen: A single 190 μm of Fluocinolone Acetonide implant is injected with daily release of 0.2 μg/day for 36 months
  - Clinical trials:
    FAME study (Cunha-Vaz et al. 2014)

3.2.6 Follow-Up

- Center involved DMO: 1–3 months
- Non-center involved DMO: 3–6 months
- Stable treated DMO: 3–6 months

3.2.7 Focal and Grid Laser Techniques

Diabetic Retinopathy Clinical Research Network (DRCR.net) laser techniques (Writing Committee for the Diabetic Retinopathy Clinical Research Network et al. 2007)

- Focal treatment
  - Topical anaesthetic
  - Spot size: 50 μm
  - Burn duration: 0.05–0.1 s
  - Burn intensity: mild grey-white burn evident beneath all MAs
  - Directly treat all leaking MA's in areas of retinal thickening between 500 and 3000 μm from the center of the macula
  - Follow up: 3–4 months
- Grid treatment
  - Topical anaesthetic
  - Spot size: 50 μm
  - Burn duration: 0.05–0.1 s
  - Burn intensity: light grey burn
  - Burn separation: two visible burn widths apart
  - Apply to all areas with oedema not associated with MA's: 500–3000 μm superiorly, nasally and inferiorly from center of macula; 500–3500 μm temporally from macular center; no burns placed within 500 μm of optic disc
  - Follow up: 3–4 months

– Complications: pain, worsened VA, choroidal detachment or RD, CNV membrane, vitreous haemorrhage

3.3 Proliferative Diabetic Retinopathy (PDR) (Fig. 3.3)

3.3.1 Other Causes of Neovascularisation to Consider

- Retinal vein occlusion
- Ocular ischaemic syndrome
- Radiation retinopathy
- Occlusive retinal vasculitis — MS, sarcoid, Behcet's disease

3.3.2 High-Risk PDR

- Defined by the Diabetic Retinopathy Study (The Diabetic Retinopathy Study Research Group 1981) with patients at higher risk of visual loss and requires prompt PRP treatment
  - Neovascularisation of the disc (NVD — new vessels on or within 1 DD of the optic disc): NVD ≥1/4 disc area or any size NVD with vitreous and/or pre-retinal haemorrhage
  - Neovascularisation elsewhere in the retina (NVE): NVE ≥1/2 disc area with vitreous and/or pre-retinal haemorrhage

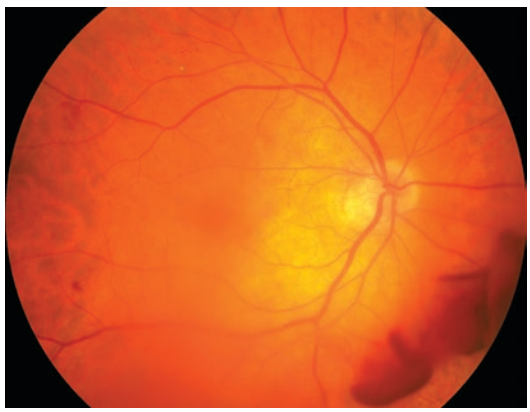

Fig. 3.3 Colour fundus image of a patient with PDR with an active NVE and a vitreous haemorrhage

3.3.3 PDR in Pregnancy

3.3.3.1 NICE Guidance [NG3]

- Diabetic patients planning pregnancy should be informed on the need for assessment of DR before and during pregnancy
- Statins and drugs blocking the renin-angiotensin system should be discontinued before conception and always at first antenatal booking if still being taken
- Ideally, all patients with PDR should be identified and treated prior to conception
- Rapid optimisation of poor glycaemic control should be deferred at least until after retinal assessment
- Retinal assessment during and after pregnancy:
  - Newly pregnant women with pre-existing DM should be offered retinal assessment by digital imaging following their first antenatal clinic (i.e. first trimester, typically 8–12 weeks) appointment (unless they have had a retinal assessment in the last 3 months) and again at 28 weeks (third trimester) if the first assessment is normal. If any DR is present, an additional retinal assessment should be performed at 16–20 weeks (second trimester)
  - At term, DR should not be considered a contraindication to vaginal birth
  - Women who have NPDR diagnosed during pregnancy should have ophthalmological follow up for at least 6 months following the birth of the baby
  - Tropicamide alone should be used if mydriasis is required during pregnancy
- Women with gestational DM are not at increased risk for the development of DR and do not need such monitoring.

3.3.4 Treatment

- Modification of life-style (see Sect. 3.1.6)
- Modification of systemic risk factors (see Sect. 3.1.6)
- Pan-retinal photocoagulation (PRP)

  - Indications (The Royal College of Ophthalmologists Diabetic Retinopathy Guideline 2012): presence of NVD/NVE/NVI/NVA — PRP performed on same day or within 2 weeks of diagnosis, consider PRP for severe/very severe NPDR in older patients with type 2 DM, where retinal view is difficult, prior to cataract surgery, in only eye where first eye lost to PDR, where regular clinic attendance is likely to be poor, difficult to examine patient for other reasons
  - Prognosis (The Diabetic Retinopathy Study Research Group 1981): PRP reduces severe vision loss (<5/200 at two consecutive visits) from high risk PDR by 50% at 2 years
- Vitrectomy
  - Indications (The Royal College of Ophthalmologists Diabetic Retinopathy Guideline 2012): non-clearing (within 3 months for type 2 diabetic and 1 month for a type 1 diabetic) severe vitreous haemorrhage (confirmation of attached retina not possible with ophthalmoscopic examination), significant recurrent vitreous haemorrhage despite maximal PRP, tractional RD involving or threatening the fovea, combined tractional rhegmatogenous RD which involves or threatens to involve the fovea, diffuse CSMO associated with posterior hyaloidal traction
  - Prognosis (The Diabetic Retinopathy Vitrectomy Study Research Group 1988): early vitrectomy (for those with severe vitreous haemorrhage with VA 5/200 or worse) increased chance of 20/40 vision from 12% to 36% in type 1 diabetics

3.3.5 Prognosis

- 25% with type 1 DM and 16% with type 2 DM will develop PDR after 15 years of DM (Klein et al. 1984)

3.3.6 PRP Laser Technique

3.3.6.1 RCOphth Diabetic Retinopathy Guideline 2012

- Topical anaesthetic
- Spot size: 400 μm spot size (if 200 μm is preselected on laser interface, a Mainster 165 PRP lens with a spot magnification factor of 1.96 will produce a theoretical retinal spot size of 392 μm. If other fundus lens is selected, it is expected that appropriate adjustments will be made to spot size selection)
- Burn duration: 20 ms
- Burn intensity: barely visible grey-white burn (titrate power down by up to 50 mW in the periphery)
- Burn separation: 1 visible burn width apart for early or moderate PDR, 0.5 burn width apart for severe PDR
- Retinal surface coverage: burns applied as far peripheral as possible up to the ora serrata, no closer than 3000 μm temporal to fovea, no closer than 500 μm nasal to the optic disc, no further posterior than one burn within the temporal arcades
- No. of sessions to complete full primary PRP: 1–2 sessions within 2 weeks for mild (NVD or NVE <1/3 disc area and flat) and moderate (NVD or NVE >1/3 disc area) PDR, 2–3 sessions in 3–4 weeks for severe (NVD or NVE with tractional RD) PDR, 3–4 sessions within 4 weeks for young patients with type 1 diabetes with PDR (increased risk of developing macular oedema post PRP)
- Follow up: 4 months for early PDR, 3 months for moderate PDR, 2 weeks for PDR in pregnancy. Regression of new vessels is characterised by blunting of the NV growing tips or replacement with fibrosis
- Complications:
  - Related to damage to posterior ocular structures:
    Retinal tear
    Choroidal haemorrhage
    Choroidal neovascularisation

Vitreous, pre-retinal or subhyaloid haemorrhage
Inadvertent optic disc or foveal damage
- Related to loss of visual function:
  Diminished or loss of peripheral visual field — implications for driving
  Diminished colour vision and contrast sensitivity
  Reduced or loss of dark adaptation — effect on night vision
- Related to the destructive nature of the procedure:
  Pain during and shortly after treatment
  Corneal epithelial defects and recurrent erosions
  Mydriasis
  Iris burns and damage/lenticular burns or opacification
- Related to contraction of fibrovascular tissue:
  Progressive traction RD
- Related to break down of blood-retinal barrier breakdown:
  Exudative RD/choroidal detachment/choroidal effusion
  Macular oedema

3.4 Branch Retinal Vein Occlusion (BRVO) (Fig. 3.4)

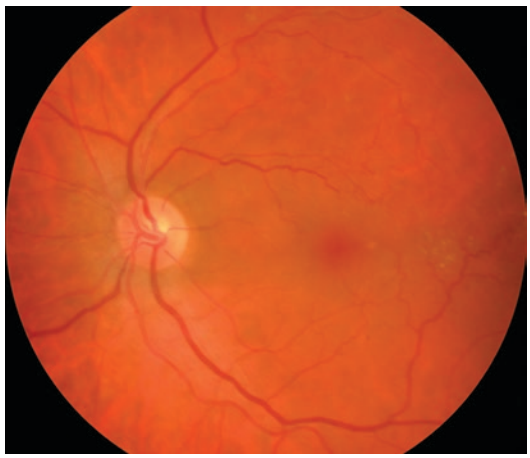

Fig. 3.4 Colour fundus image of a patient with a chronic non-ischaemic BRVO

3.4.1 Other Diagnoses to Consider

- Macular telangiectasia
- Diabetic retinopathy
- Radiation retinopathy
- Susac syndrome: small BRAO (may be multiple) and capillary occlusions, sensorineural hearing loss, subacute encephalopathy, hyperintense lesions in the corpus callosum on T2 MRI
- Behcet's disease
- Sarcoidosis

3.4.2 Risk Factors

- Arteriosclerosis: HTN, DM, smoking, hyperlipidaemia (including secondary to hypothyroidism)
- Glaucoma
- Ocular inflammatory disease: Behcet's disease, PAN, sarcoidosis, SLE
- Haematological: Protein C, protein S or antithrombin deficiency, activated protein C resistance, factor V Leiden, myeloma, Waldenstrom's macroglobulinaemia, antiphospholipid syndrome

3.4.3 Examination

- Acute BRVO: wedge shaped segmental distribution of intraretinal haemorrhage in a quadrant of the fundus, narrowed branch retinal vein passing under a retinal artery, dilated and tortuous retinal vein, cotton wool spots
- Chronic BRVO: telangiectatic vessels (dilation of capillaries) forming collaterals that cross the horizontal raphe, microaneurysms, exudates, sclerosed retinal vein ±NVE > NVD > NVI
- Check for RAPD
- Check the IOP
- Look for NVI on anterior segment examination
- Perform gonioscopy for NVA

3.4.4 Investigations

3.4.4.1 RCOphth Retinal Vein Occlusion (RVO) Guidelines 2015

- BP
- Bloods: FBC, ESR, glucose
- OCT: CMO
- FFA (if uncertain diagnosis): delayed filling of the occluded retinal vein, capillary non-perfusion — >5 DD is defined as an ischaemic BRVO (The Branch Vein Occlusion Study Group 1984, 1986), macular ischaemia, telangiectatic vessels forming collaterals that cross the horizontal raphe

3.4.5 Treatment

- Control of cardiovascular risk factors: HTN, hyperlipidaemia, smoking, DM
- Neovascularisation: sectoral PRP — branch vein occlusion study — BVOS (The Branch Vein Occlusion Study Group 1984, 1986) recommended that laser photocoagulation be applied only after NV is observed, which reduces the likelihood of vitreous haemorrhage from about 60% to 30%
- Macular oedema:
  - Laser photocoagulation
    BVOS (The Branch Vein Occlusion Study Group 1984, 1986):
    - An RCT that aimed to answer three questions: (1) can laser photocoagulation improve VA compared to observation in eyes with macular oedema from BRVO that reduces the vision to 6/12 or worse; (2) can sectoral PRP prevent the development of NV; (3) can sectoral PRP prevent vitreous haemorrhage
    - Wait for at least 3 months if VA 6/12 or worse before considering laser therapy to allow clearing of intraretinal haemorrhages to permit FFA and evaluation of macular oedema and macular ischaemia
    - If perfused macular oedema accounts for the visual loss, and vision continues to be 6/12 or worse without spontaneous improvement, consider grid macular photocoagulation (0.1 s duration, 100 μm spot size, power titrated to produce a "medium" white burn) to the leaking area demonstrated by FFA
    - After 3 years of follow-up, 65% of treated eyes gained two or more lines of vision compared to 37% of untreated eyes
  - Dexamethasone implant (Ozurdex)
    NICE Guidance [TA229]: recommend as an option for treatment of macular oedema due to a BRVO when treatment with laser photocoagulation has not been beneficial or treatment with laser photocoagulation is not considered suitable because of the extent of retinal haemorrhages
    GENEVA study (Haller et al. 2010): A RCT that evaluated the effects of a single dexamethasone implant compared to sham injection for the treatment of macular oedema secondary to BRVO and CRVO. Increase in BCVA of ≥15 ETDRS letters was achieved in 30% of the Ozurdex 0.7 mg group, 26% of the Ozurdex 0.35 mg group, and 13% of the sham group 60 days after injection (peak response) and was maintained through day 90 in BRVO patients. There was no difference between either Ozurdex groups and the sham group at day 180.
  - Ranibizumab (Lucentis)
    NICE Guidance [TA283]: recommend as an option for treatment of macular oedema due to a BRVO when treatment with laser photocoagulation has not been beneficial or treatment with laser photocoagulation is not considered suitable because of the extent of retinal haemorrhages
    BRAVO study (Campochiaro et al. 2010): A RCT to evaluate the efficacy and safety of Lucentis in the treatment of macular oedema from BRVO. Patients were randomised into three groups: (1) sham injection; (2) 0.3 mg Lucentis; and (3) 0.5 mg Lucentis. In the first 6 months, injections were given monthly. At 6 months, both Lucentis groups

gained +16.6 and +18.3 ETDRS letters (0.3 and 0.5 mg groups, respectively) compared with a gain of +7.3 letters in the control group. At 6 months, 55.2% and 61.1% of patients receiving Lucentis 0.3 and 0.5 mg gained ≥3 ETDRS lines compared to 28.8% in the sham injection group

– Aflibercept (Eylea)
  NICE Guidance [TA305]: recommend as an option for treatment of visual impairment caused by macular oedema following BRVO
  VIBRANT study (Campochiaro et al. 2015): A RCT that evaluated the efficacy and safety of Eylea compared to macular grid laser in the treatment of macular oedema from BRVO or HRVO. After 6 months of treatment, 26.7% of the laser group gained ≥3 ETDRS lines compared to 52.7% in the Eylea group. Mean change in letters from baseline was +6.9 letters in the laser group compared to +17.0 letters in the Eylea group.

3.4.6 RCOphth RVO Guidelines 2015 Treatment Algorithm

3.4.6.1 Non-ischaemic BRVO

- Baseline
  – If VA better than 6/12, it is reasonable to regularly observe progress for 3 months
  – If VA is 6/12 or worse with macular oedema and haemorrhages that are not masking fovea:
    FFA is recommended to assess foveal integrity
    If no macular ischaemia is identified, regularly observe for 3 months if macular oedema is mild and in opinion of clinician likely to spontaneously improve (30% chance)
    If mild to moderate macular ischaemia is present consider treatment with ranibizumab or dexamethasone implant (Ozurdex) if spontaneous improvement is unlikely
    If severe macular ischaemia is present — no treatment is recommended and regularly observe for NV formation
  – If VA is 6/12 or worse with macular oedema and haemorrhages that are masking fovea:
    Monthly ranibizumab or baseline dexamethasone implant (Ozurdex) for 3 months
    Perform FFA at 3 months to assess foveal integrity
    If severe macular ischaemia is found to be present at 3 months, no treatment will likely be beneficial and further therapy should be carefully considered
- At 3 months follow up
  – Consider modified grid laser photocoagulation if persistent macular oedema, no or minimal macular ischaemia and other treatments unsuccessful or unavailable
  – If VA 6/9 or better or no macular oedema detected, continue to observe if initially observed. If on anti-VEGF or dexamethasone implant (Ozurdex) therapy, continue as suggested in macular oedema due to CRVO
- Further follow up:
  – If under observation only, follow up 3 monthly intervals for 18 months
  – In case of recurrence or new macular oedema, consider re-initiating intravitreal ranibizumab or dexamethasone implant (Ozurdex) therapy

3.4.6.2 Ischaemic BRVO

- Watch carefully for NV
- If NVE: consider sector laser PRP applied to all ischaemic quadrants ± off license bevacizumab (Avastin)
- Follow up at 3 monthly intervals for up to 24 months

3.4.7 Prognosis

- BVOS (The Branch Vein Occlusion Study Group 1984, 1986):
  – Only eyes with ischaemic BRVO (>5 DD of retinal capillary non-perfusion) are at risk of developing NV — 40% of these eyes develop NV, and of these 40%, 60% will experience periodic vitreous haemorrhage

- Retinal or disc NV, or both, may develop at any time within the first 3 years after an occlusion but are most likely to appear within the first 6–12 months after the occlusion
- Up to 10% of patients with BRVO in one eye will develop any type of RVO in the fellow eye

3.5 Central Retinal Vein Occlusion (CRVO) (Fig. 3.5)

3.5.1 Other Diagnoses to Consider

- Diabetic retinopathy
- Ocular ischaemic syndrome
- Radiation retinopathy
- Hypertensive retinopathy

3.5.2 Risk Factors

- Arteriosclerosis: HTN, DM, smoking, hyperlipidaemia (including secondary to hypothyroidism)
- Glaucoma
- Ocular inflammatory disease: Behcet's disease, PAN, sarcoidosis, SLE

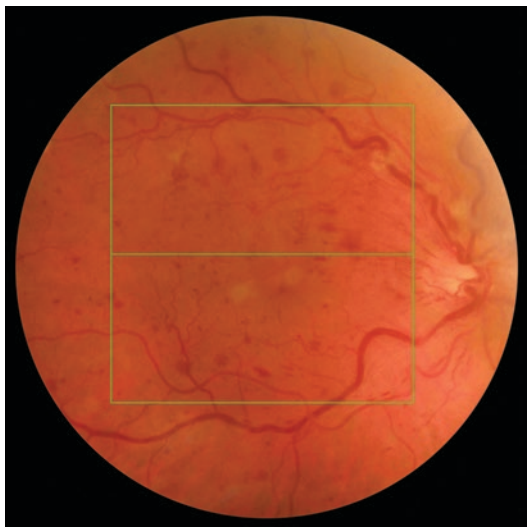

Fig. 3.5 Colour fundus image of a patient with an acute non-ischaemic CRVO

- Haematological: Protein C, protein S or antithrombin deficiency, activated protein C resistance, factor V Leiden, multiple myeloma, Waldenstrom's macroglobulinaemia, antiphospholipid syndrome
- Pharmacological: oral contraceptive pill
- Eye disease case-control study group (Risk factors for central retinal vein occlusion, The Eye Disease Case-Control Study Group 1996): HTN, DM (ischaemic CRVO), glaucoma, cardiovascular disease (ischaemic CRVO)

3.5.3 Examination

- Acute CRVO: retinal haemorrhages (flame shaped and deep blot type) in all 4 quadrants of the fundus with a dilated tortuous retinal venous system, cotton wool spots, optic disc swelling, CMO
- Chronic CRVO: optociliary shunt vessels (collateral vessels connecting the choroidal and the retinal vasculature — do not leak on FFA), telangiectatic capillary bed, persistent dilatation and tortuosity, perivenous sheathing, NVI > NVD > NVE, CMO, glaucomatous optic neuropathy
- Check for an RAPD
- Check the IOP
- Look for NVI on anterior segment examination
- Perform gonioscopy for NVA

3.5.4 Investigations

3.5.4.1 RCOphth RVO Guidelines 2015

- BP
- Bloods: FBC (leukaemia), ESR (myeloma), glucose
- OCT: CMO
- FFA (if uncertain diagnosis): delayed filling of the occluded retinal vein, capillary non-perfusion, macular ischaemia, telangiectatic vessels forming collaterals that cross the horizontal raphe

3.5.5 Treatment

- Control of cardiovascular risk factors: HTN, hyperlipidaemia, smoking cessation, DM
- Neovascularisation:
  - Full scatter PRP: central vein occlusion study — **CVOS** (The Central Vein Occlusion Study Group 1997) recommended that laser photocoagulation be applied only after NV is observed, with greater resolution of NVI/NVA by 1 month after PRP in 56% of no early treatment eyes (no NVI or NVA present) compared with 22% of early treatment eyes (NVI or NVA present)
- Macular oedema:
  - Dexamethasone implant (Ozurdex)
    NICE Guidance [TA229]: recommend as an option for the treatment of macular oedema following CRVO
    GENEVA study (Haller et al. 2010): A RCT that evaluated the effects of a single dexamethasone implant compared to sham injection for the treatment of macular oedema secondary to BRVO and CRVO. Increase in BCVA of ≥15 ETDRS letters was achieved in 29% of the Ozurdex 0.7 mg group and 9% of the sham group 60 days after injection but not at 90 or 180 days.
  - Ranibizumab (Lucentis)
    NICE Guidance [TA283]: recommend as an option for treatment of visual impairment caused by macular oedema following CRVO
    CRUISE study (Brown et al. 2010): A RCT to evaluate the efficacy and safety of Lucentis in the treatment of macular oedema from CRVO. Patients were randomised into three groups: (1) sham injection; (2) 0.3 mg Lucentis; and (3) 0.5 mg Lucentis. In the first 6 months, injections were given monthly. At 6 months, both Lucentis groups gained +12.7 and +14.9 ETDRS letters (0.3 and 0.5 mg groups, respectively) compared with a gain of +0.8 letters in the control group. At 6 months, 46.2% and 47.7% of patients receiving Lucentis 0.3 and 0.5 mg gained ≥3 ETDRS lines compared to 16.9% in the sham injection group
  - Aflibercept (Eylea)
    NICE Guidance [TA305]: recommend as an option for treatment of visual impairment caused by macular oedema following CRVO
    CORPERNICUS study (Boyer et al. 2012): comparison of Eylea and sham injection — the proportion of patients who gained ≥15 letters from baseline in the Eylea and sham groups was 56.1% and 12.3% at week 24, respectively
    GALILEO study (Holz et al. 2013): comparison of Eylea and sham injection — the proportion of patients who gained ≥15 letters from baseline in the Eylea and sham groups was 60.2% and 22.1% at week 24, respectively
- Delay in initiating treatment up to 6 months results in fewer visual gains compared to immediate initiation of treatment. Therefore, treatment should be initiated as soon as the diagnosis is established (RCOphth RVO Guidelines 2015)
- Careful consideration should be given to further therapy in such eyes that do not improve in terms of Snellen VA or OCT central subfield thickness after three loading injections at monthly intervals and treatment with anti-VEGF is not recommended if no response occurs after six injections (RCOphth RVO Guidelines 2015)
- No robust data on outcomes of switching steroid to an anti-VEGF agent or switching between anti-VEGF agents or combining steroids with anti-VEGF agents for macular oedema due to CRVO (RCOphth RVO Guidelines 2015).

3.5.6 Follow Up

- Non-ischaemic CRVO (may resolve completely without any complications): initial follow up every 3 months for 6 months, follow up for at least 2 years but the development of disc

collaterals and the resolution of macular oedema for at least 6 months should allow the discharge of the patient from clinical supervision (RCOphth RVO Guidelines 2015)
- Ischaemic CRVO: follow up after 6 months should be every 3 months for 1 year (RCOphth RVO Guidelines 2015)
- RCOphth RVO Guidelines 2015 recommends that oestrogen containing HRT and OCP should not be commenced in women with history of RVO. However, the continued use in a patient who develops RVO does not appear to be associated with a higher rate of recurrence.

3.5.7 RCOphth RVO Guidelines 2015 Treatment Algorithm

3.5.7.1 Non-ischaemic CRVO

- Baseline:
  - Measurements: VA, colour fundus photography, FFA, OCT, IOP, gonioscopy
  - If VA is 6/96 or better — commence on either anti-VEGF therapy or dexamethasone implant (Ozurdex)
  - If VA less than 6/96 — offer treatment, high risk of NV
  - If VA better than 6/12 — reasonable to observe for spontaneous resolution
- Choice of agent: anti-VEGF preferred in eyes with previous hx of glaucoma and younger patients who are phakic, dexamethasone implant (Ozurdex) may be better choice in patients with recent cardiovascular events and in those who do not favour monthly injections
- Re-treatment: monthly intravitreal anti-VEGF injections are continued until maximum VA is achieved (defined as stable VA for 3 consecutive monthly assessments), once maximum VA is achieved monitor and resume treatment if VA loss occurs due to macular oedema (or treat and extend)
- Stopping treatment: consider stopping anti-VEGF therapy if after 3 consecutive monthly treatments, VA has not improved by at least five letters and CMT has not reduced from baseline/recommend stopping anti-VEGF therapy is recommended after 6 consecutive monthly treatments, VA has not improved by at least five letters and CMT has not reduced from baseline
- Switching agents: no RCT that provides evidence that switching to another anti-VEGF agent or intravitreal steroids may be effective. Consider switching from anti-VEGF to steroids or vice versa if response is poor or suboptimal.

3.5.7.2 Ischaemic CRVO

- Features suggestive of an ischaemic CRVO (RCOphth RVO Guidelines 2015)
  - Poor VA
  - RAPD
  - Presence of multiple dark deep intraretinal haemorrhages
  - Presence of multiple cotton wool spots
  - Degree of venous dilation and tortuosity
  - FFA showing greater than ten-disc areas of capillary non-perfusion on seven field FFA
  - ERG: reduced b wave amplitude, reduced b:a ratio (negative ERG) and prolonged b-wave implicit time
- If NV occurs and AC angle is open: urgent PRP, review 2 weeks post PRP (RCOphth RVO Guidelines 2015)
- If NV occurs and AC angle is closed ± raised IOP: urgent PRP with cyclodiode/GDI (RCOphth RVO Guidelines 2015)
- Consider prophylactic PRP in ischaemic CRVO without NV if limited follow up is likely and FFA shows >30-disc areas of capillary non-perfusion (RCOphth RVO Guidelines 2015).

3.5.8 Prognosis

- At 3 years, there was a 45% chance of developing neovascular glaucoma after onset of ischaemic CRVO — highest risk if VA <6/60 or >10 DD of non-perfusion on FFA (The Central Vein Occlusion Study Group 1997)

- Overall, 34% of initially perfused eyes converted to non-perfused status after 3 years (The Central Vein Occlusion Study Group 1997)
- Risk of CRVO in contralateral eye is 5% by 1y (RCOphth RVO Guidelines 2015).

3.6 Cilioretinal Artery Occlusion (CLRAO) in a Young Patient (Fig. 3.6)

3.6.1 Causes

- Embolic: cardiac valvular disease, arrhythmias, cardiac septal defects, cardiac myxoma, intravenous drug use (talc)
- Coagulopathies: antiphospholipid syndrome, protein C and S deficiency, lupus anticoagulant, anti-thrombin III deficiency, activated protein C resistance, factor V Leiden, leukaemia, lymphoma
- Collagen vascular diseases: SLE, PAN, Wegener's granulomatosis
- Pharmacological: cocaine, OCP
- Infective: syphilis, toxoplasmosis, mucormycosis, lyme disease
- Retinal migraines (vasospasm): ≥2 attacks of a fully reversible monocular positive and/or negative visual phenomena with migraine without aura begins during the visual symptoms or follows them within 60 minutes

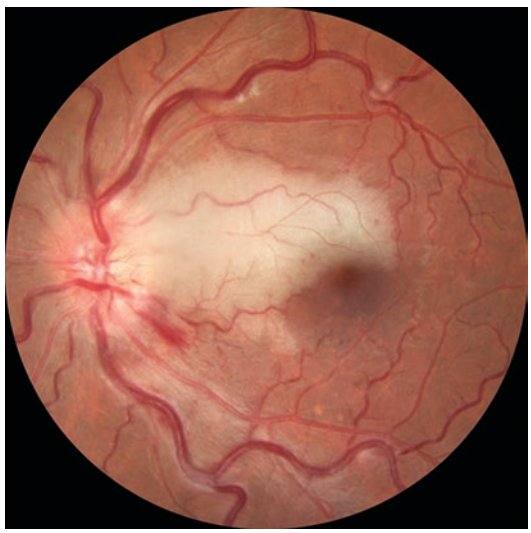

Fig. 3.6 Colour fundus image of a patient with a cilioretinal artery occlusion

3.6.2 Examination

- Retinal whitening secondary to inner retinal oedema extending from the temporal disc into the macula in the distribution of cilioretinal artery perfusion

3.6.3 Investigations

- Hypercoagulability evaluation for young patients with a suggestive history (e.g. FHx, prior history, miscarriage): factor V Leiden mutation, protein C/S and anti-thrombin deficiencies, homocysteine levels, antiphospholipid antibodies
- Syphilis serology: VDRL
- Vasculitis screen: ANA, ANCA
- Transthoracic/trans-oesophageal echocardiography
- ECG
- Carotid doppler US
- OCT: inner retinal oedema (acute) and inner retinal atrophy (chronic)
- FFA: look for filling of the cilioretinal artery during the choroidal phase

3.6.4 Treatment

- No proven treatments for CLRAO exist
- Refer to stroke (TIA) clinic for carotid doppler ± echocardiography if embolus identified
- Treat neovascularisation with PRP

3.6.5 Prognosis

- Isolated CLRAO: 90% of eyes achieve 6/12 or better vision
- CLRAO associated with CRVO: 70% of eyes achieve 6/12 or better vision
- CLRAO in conjunction with AION: 0% of eyes achieve 6/12 or better vision

3.7 Usher Syndrome (Fig. 3.7 and Table 3.1)

3.7.1 Other Diagnoses to Consider

- RP
- CSNB
- Vitamin A deficiency
- Choroideremia
- Gyrate atrophy
- MAR
- CAR

3.7.2 History

- Night blindness
- Positive FHx

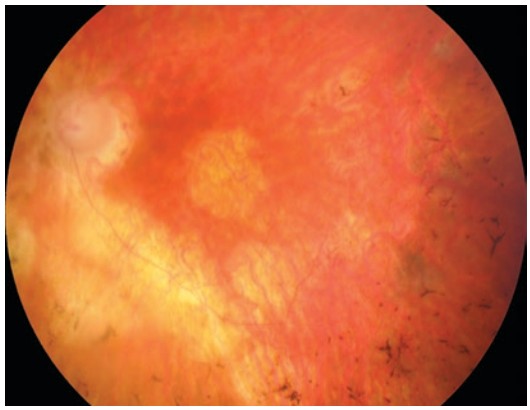

Fig. 3.7 Colour fundus image of a patient with Ushers syndrome showing RP changes

Table 3.1 Useful facts about Ushers syndrome

- AR condition that results in RP with associated congenital hearing loss
- Occurs in 1 of every 10 deaf children (5% of all cases of congenital deafness)
- Subdivided into three groups:
  - Type 1: most severe form, associated with delayed sitting and walking due to abnormal vestibular function
  - Type 2: normal vestibular function
  - Type 3: sensorineural hearing loss is postlingual (as opposed to the prelingual loss in USH1 and USH2) with patients acquiring normal speech

3.7.3 Examination

- Peripheral retinal atrophy with bone spicule like pigmentation
- Retinal arteriolar attenuation
- Waxy pallor of the optic disc

3.7.4 Investigations

- VF: constricted (ring scotoma)
- EDTs: abnormal ERG
- Audiogram: sensorineural hearing loss

3.7.5 Treatment

- Cochlear implantation for sensorineural deafness
- Visual impairment registration and referral to low vision aids service
- Sensory visual impairment service (specialist schools)
- Sense Usher service
- Royal National Institute of Blind people (RNIB) website/telephone helpline

3.8 Rhegmatogenous Retinal Detachment (RD) (Fig. 3.8 and Table 3.2)

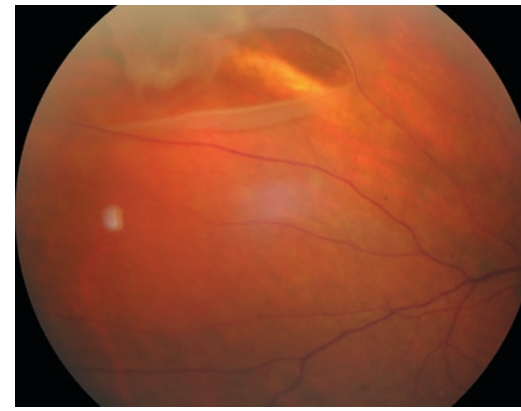

Fig. 3.8 Colour fundus image of a patient with an acute rhegmatogenous retinal detachment secondary to a large horse-shoe retinal tear

Table 3.2 Useful facts about rhegmatogenous RD

- Incidence of RD is approximately 10 in 100,000 (Saidkasimova et al. 2009)
- Approximately 90% of patients with acute symptoms of PVD have a retinal tear at the time of initial examination. Approximately 10% of retinal tears are not seen at initial presentation or develop later (Sharma et al. 2004)

3.8.1 Risk Factors

- Hereditary/congenital/developmental/degenerative
  - Myopia
  - Retinal breaks
  - Male gender
  - Hereditary vitreoretinopathies, e.g. Sticklers syndrome
  - Lattice degeneration
  - Cystic retinal tuft
  - Degenerative retinoschisis
- Prior ocular surgery
  - Aphakia/pseudophakia
  - Nd:YAG posterior capsulotomy
  - Other surgery involving vitreous gel
- Prior ocular trauma
- Inflammatory
  - CMV retinitis
  - ARN
- Other
  - Fellow eye non-traumatic RD, e.g. giant retinal tear (GRT)

3.8.2 Retinal Tears

- 15% of eyes with a symptomatic PVD develop retinal tears (full thickness defects in the retina) of various types
- 60% of retinal tears occur in the superotemporal quadrant
- Tears with persistent vitreoretinal traction
  - Symptomatic horseshoe-shaped retinal tears: treatment required
  - Symptomatic operculated retinal tear with vitreoretinal traction on a nearby retinal vessel: treatment required
- Tears without persistent vitreoretinal traction
  - Symptomatic operculated retinal tears without vitreoretinal traction on a nearby retinal vessel: no treatment required unless the possibility of vitreoretinal traction cannot be excluded
- Retinal holes
  - Asymptomatic atrophic retinal holes within areas of lattice degeneration or in the outer layers of degenerative retinoschisis: no treatment required
- Retinal dialysis
  - Tear of the retina from its insertion at the ora serrata
  - Vitreous adherent to the posterior retina (no tendency for posterior flap to fold over)
  - Most secondary to trauma and are most commonly found in the inferotemporal quadrant
  - Treatment: observation if signs of chronicity (e.g. tidemarks and retinal cysts) present, laser demarcation if limited RD, segmental scleral buckles if extensive RD
- Giant retinal tear (GRT)
  - A retinal tear of more than 3 clock hours of circumferential extent
  - Posterior vitreous is detached (hence posterior flap has a tendency to fold over) and the vitreous gel is adherent to the anterior flap
  - Associated with high myopia, Marfan syndrome, Stickler syndrome, trauma
  - Treatment: vitrectomy, endolaser and silicone oil for affected eye ± prophylactic 360° laser or cryopexy for fellow eye.

3.8.3 Lincoff Rules

- Describes how the location of a retinal break determines the distribution of subretinal fluid (Lincoff and Gieser 1971)
  - For superotemporal or superonasal RDs, the primary break lies within 1.5 clock hours of the highest border of the RD
  - For total or superior RDs that cross the 12 o'clock position, the primary break is at 12 o'clock or in a triangle with the apex at the ora serrata at 12 o'clock and sides extend 1.5 clock hours to either side
  - For inferior RDs, the higher side of the RD indicates on which side of the optic disc the primary break is located
  - For inferior bullous RDs, the primary break is located superiorly.

3.8.4 History

- Symptoms (flashes/floaters) and signs (Weiss ring: detachment at optic disc) of PVD
- Visual field defect for RD that has progressed sufficiently posteriorly.

3.8.5 Examination

- Pigmented cells ("tobacco dust") in the vitreous — sign associated with a high chance of associated retinal tear
- Dilated fundus exam with 360° indentation with indirect ophthalmoscopy (for patients who present acutely with flashes and floaters) to exclude the presence of tractional retinal tears (RCOphth Guidelines - see Sect. 3.8.8)
- Subclinical RD: SRF extending more than 1 DD from the break but not posterior to the equator
- Signs of chronicity (see Fig. 3.9): tidemarks (present from 3 months: imply stability of the extent of the detachment), intraretinal cysts (present from 1 year), PVR.

3.8.6 Investigations

- B-scan: if poor fundal view present (Fig. 3.10)

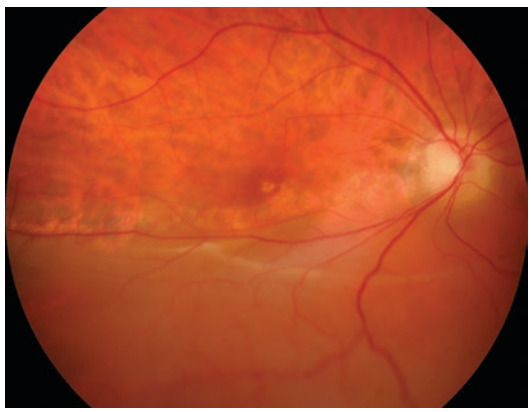

Fig. 3.9 Colour fundus image of a patient with a chronic rhegmatogenous RD with progression of subretinal fluid beyond a tide mark

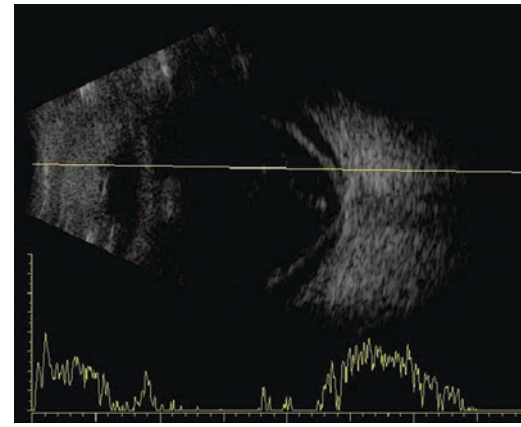

Fig. 3.10 B-scan of a patient with a total rhegmatogenous RD

3.8.7 Treatment

- Round hole RD
  - Laser demarcation:
    For asymptomatic RD's or those with minimal symptoms
  - Segmental scleral buckling
- Detachment due to retinal dialysis
  - Laser demarcation
  - Segmental scleral buckling
- Detachment secondary to U (horseshoe) tears
  - Laser demarcation:
    Small asymptomatic peripheral detachment
    Although laser photocoagulation creates an instant adhesion this is not up to full strength for up to 14 days — rapidly progressing fluid may extend through the area of demarcation before a strong enough adhesion develops
  - Pneumatic retinopexy
    Detachments with breaks limited to one quadrant, usually superior
  - Scleral buckling
    Young patients
    Anteriorly located small holes with localised RD in phakic patients
  - Vitrectomy
    Older patients with a liquefied vitreous
    Wide and bullous RD
    Presence of breaks in multiple quadrants
    Presence of RD with marked traction with different anterior posterior depth of breaks

Absence of an apparent retinal break in a pseudophakic patient
GRT RD
Macular hole RD

- Prophylactic therapy for asymptomatic retinal tears in phakic non-fellow eyes is usually not recommended except for an inferior retinal dialysis and for a non-traumatic GRT that occurred in the first eye
- Maximum strength of chorioretinal adhesion following laser photocoagulation is achieved between 3 and 14 days later (stronger adhesion than normal appears within 24 h of the application of treatment).

3.8.8 The RCOphth Ophthalmic Services Guidance for the Management of Acute Retinal Detachment 2010

- Retinal tears
  - Tractional (horseshoe) retinal tears should be treated urgently with laser photocoagulation or cryotherapy
  - Asymptomatic retinal breaks and atrophic round holes do not require any treatment
  - Asymptomatic retinal breaks and atrophic round holes with localised subretinal fluid may require treatment (localised RD is often asymptomatic, progresses very gradually if at all) but does not need to be treated as an emergency — non urgent referral is recommended to a local retinal specialist or department to determine what management is best tailored to the patient needs
- Reduce progression of RD
  - Bed rest
  - Dependent posturing: posture with tear at the lowest location
- RD surgery
  - Urgent surgery required if RD is reaching within 1 DD of the fovea, particularly with a superior bullous detachment
  - Where there is imminent danger of foveal detachment and expertise and facilities to operate urgently are unavailable locally, a transfer should be agreed to a suitably equipped and staffed unit with an available VR surgeon.

3.9 Macular Hole (MH) (Fig. 3.11 and Table 3.3)

3.9.1 Differential Diagnosis

- Lamellar hole
  - Absence of a contractile ERM
  - Defects in the inner fovea with cleft between the inner and outer retina
  - Bi- or tri-lobulated red central circular defect on biomicroscopy
  - Negative Watzke-Allen test (thin beam of light projected over hole — broken or thinned centrally in MH)
- Pseudohole
  - Presence of a contracted ERM with thickening of the macula
  - U or V shape of the fovea

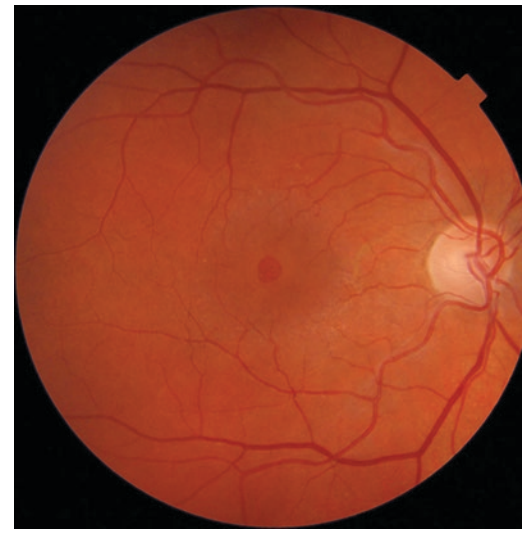

Fig. 3.11 Colour fundus image of a patient with a full thickness macular hole

Table 3.3 Key facts about macular holes

• Round opening in the foveal center
• Occurs in middle-aged or elderly patients
• More common in females
• Incidence is approximately 7.8 per 100,000 population (McCannel et al. 2009)
• Prevalence of 1/3300 (McDonnell et al. 1982)

3.9.2 Risk Factors

- Age ≥65 years old
- Female sex

3.9.3 Causes

- Idiopathic: due to abnormal vitreofoveal traction
- Secondary
  - Trauma: sudden axial compression of the eye resulting in equatorial expansion and retinal rupture of the fovea
  - Pathological myopia
  - VMT/ERM
  - Chronic CMO.

3.9.4 Classification

- Biomicroscopy (Gass Classification)
  - Stage 1a (impending MH): focal central yellow spot, loss of foveal depression
  - Stage 1b (occult MH): yellow foveolar ring
  - Stage 2 (full thickness MH): central round <400 μm diameter retinal defect
  - Stage 3 (full thickness MH): central round ≥400 μm diameter retinal defect, no Weiss ring
  - Stage 4 (full thickness MH): stage 3 with Weiss ring (PVD)
- OCT (see Fig. 3.12)
  - Stage 1a: inner foveal cyst
  - Stage 1b: inner foveal cyst completed by disruption of the outer retina up to the RPE, posterior hyaloid still attached to the intact roof of the cyst
  - Stage 2: disruption in roof of the cyst with a partially detached operculum from hole edge
  - Stage 3: complete absence of the roof with vitreous completely detached form the retinal surface over the posterior pole and is not connected to the hole edge
  - Stage 4: OCT unable to diagnose stage 4 MH, stage 4 MH remains a diagnosis from biomicroscopy with the presence of a Weiss ring

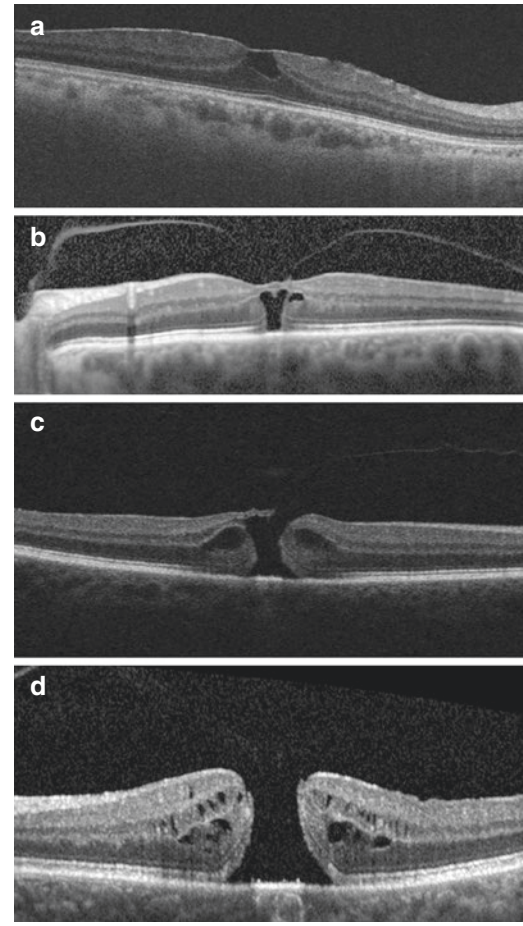

Fig. 3.12 OCT staging of macular holes (**a**) Stage 1a, (**b**) Stage 1b, (**c**) Stage II and (**d**) Stage III

- The International Vitreomacular Traction Study Classification System (Duker et al. 2013)
  - Vitreomacular adhesion (VMA): vitreous adhesion to central macula with no demonstrable retinal morphologic changes
  - Vitreomacular traction (VMT): vitreous adhesion to central macula with demonstrable changes by OCT but no full thickness tissue dehiscence; may include the following: cystoid changes in macula, elevation of fovea above RPE, tissue cavitation, loss of foveal contour
  - Small full thickness MH: hole ≤250 μm, may be round or have a flap adherent to vitreous; operculum may or may not be present

- Medium full thickness MH: hole >250 μm but ≤400 μm; may be round or have a flap adherent to vitreous; operculum may or may not be present
- Large full thickness MH: hole >400 μm; vitreous more likely to be fully separated from macula
- Impending MH: term used when a full thickness MH is observed in one eye and VMA or VMT is observed on OCT in the fellow eye
- Lamellar MH: partial thickness foveal defect that typically appears on biomicroscopically as a round or oval, well-circumscribed, reddish lesion. Anatomic OCT-based features of lamellar MH include the following: (1) a defect in the inner fovea (may not have actual loss of tissue); (2) maintenance of an intact photoreceptor layer (lamellar MH can be distinguished from full thickness MH on OCT by the presence of intact photoreceptors at the base); (3) an irregular foveal contour; (4) intraretinal splitting (schisis), typically between the outer plexiform and outer nuclear layers
- Macular pseudohole: Anatomic OCT-based features of macular pseudohole include the following: (1) invaginated or heaped foveal edges; (2) steep macular contour to the central fovea with near-normal central foveal thickness; (3) concomitant ERM with central opening; (4) no loss of retinal tissue

3.9.5 Examination

- Yellow spot (stage 1a)
- Yellow foveal ring (stage 1b)
- Central red round area at the fovea (stage 2–4)
- Positive Watzke-Allen test: shine a vertical thin beam of light using the slitlamp over the macular hole — narrowing or gap in the beam of light is seen in macular holes (Tanner and and Williamson 2000).

3.9.6 Investigations

- OCT: measurements in MH include base diameter (BD — linear dimension of MH at the level of the RPE layer) and minimum linear diameter (MLD — minimum horizontal diameter in the scan in an area excluding the operculum)

3.9.7 Treatment

- Idiopathic MH
  - Observation:

    For stage 1 MH: high rate of spontaneous resolution. Surgery has shown no benefit (Smiddy et al. 1988; de Bustros 1994)
  - Medical

    NICE Guidance [TA297] — Ocriplasmin is an option for treating VMT in adults only if:
    - An ERM is not present and
    - They have a stage 2 FTMH with a diameter of ≤400 μm and/or
    - They have severe symptoms
  - Surgical

    Vitrectomy + ILM peeling + gas tamponade for holes without VMA
- Traumatic MH
  - High spontaneous closure rate (50%). Recommended to wait 4 months from the trauma before surgical intervention (Yamashita et al. 2002).

3.9.8 Prognostic Factors for Treatment of Idiopathic MH

- Preoperative VA: eyes with better preoperative VA achieve higher rates of anatomical closure and visual gain
- Preoperative BD and MLD measurement: smaller preoperative MLD and BD measurements are associated with better visual outcomes and anatomical closure
- Duration of symptoms: anatomical closure and visual outcomes were higher in patients with a shorter duration of symptoms.

3.9.9 Face Down Posturing for Idiopathic MH

- Cochrane review (Solebo et al. 2011) of three RCT's that directly compared face-down posturing following idiopathic MH surgery with no face-down posturing:
  - For MH ≤400 μm, face down posturing had no significant effect on successful hole closure
  - Two of the RCT's found that there was a significant benefit of face-down posturing for successful closure when the diameter was >400 μm
  - Face down posturing for at least 5 days postoperatively should be recommended for patients with MH >400 μm in size and holes >1 year in duration.

3.9.10 Development of Idiopathic MH in Fellow Eyes

- A fellow eye with PVD has a <1% risk of progressing to a MH (Ezra 2001)
- A fellow eye without a PVD has a 15.6% risk of progressing to a MH over 5 years (Ezra et al. 1998).

3.9.11 Success Rates for Idiopathic MH Closure

- 88% success rate for stage 2 macular holes (Ruby et al. 1994)
- 69% success rate for stage 3 and 4 macular holes (Freeman et al. 1997)
- Holes <400 μm have a 94% chance of closure compared with 56% for those 400 μm or more (Ip et al. 2002).

3.9.12 Post-Operative Complications of Surgery

- Retinal tears during surgery: 12.7% with PVD induction and 3.1% without PVD induction (Chung et al. 2009)
- Retinal detachment: 6.6–14% (Guillaubey et al. 2007)
- Re-opening of the hole: 11% (Bhatnagar et al. 2007) especially in those who have postoperative cataract extraction
- Cataract
- Endophthalmitis

3.10 Toxoplasmosis (Fig. 3.13)

3.10.1 Other Diagnoses to Consider

- Infectious: TB, syphilis, rubella, CMV retinitis, herpes simplex, toxocariasis
- Non-infectious: sarcoidosis

3.10.2 History

- Symptoms: asymptomatic, floaters, reduced vision
- Immunocompromised: post organ transplantation, HIV positive, therapeutic immunosuppression for systemic disease (e.g. SLE, RA, GPA).

3.10.3 Examination

- Acute lesions: intensely white focal lesions with overlying vitreous inflammatory haze adjacent ("headlight in the fog") to old hyper-

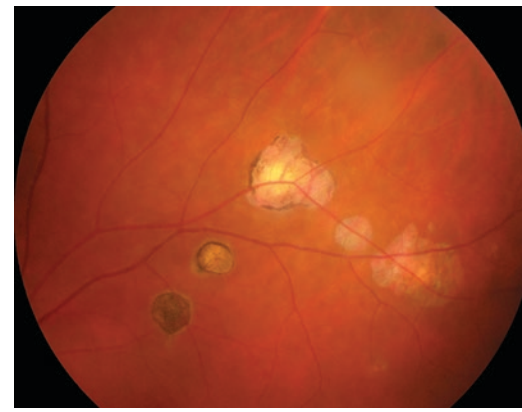

Fig. 3.13 Colour fundus image of a patient with a chronic toxoplasmosis scar

pigmented scars (satellite lesions), periphlebitis
- Chronic lesions: hyperpigmented scars with an atrophic centre devoid of all retinal and choroidal elements — the underlying sclera gives the lesion its white centre
- Check the IOP
- Perform an anterior segment examination to look for any visually significant cataract.

3.10.4 Investigations

- VDRL: rule out syphilis
- ACE, CXR: rule out sarcoidosis
- HIV serology: rule out HIV
- Pregnancy test
- Anti-toxoplasma IgM and IgG antibodies:
  - Negative IgG and negative IgM antibodies implies infection has not occurred
  - Positive IgG and negative IgM antibodies implies an infection that was in the distant past
  - Positive IgM antibodies may suggest a recently acquired infection.

3.10.5 Treatment

- Inflammation
  - In immunocompetent patients, the disease is self-limiting and does not require treatment unless sight threatening
  - Indications for treatment:
    Lesions involving the disc, macula, or papillomacular bundle
    Lesions threatening a major vessel
    Marked vitritis
    Any lesion in an immunocompromised patient
  - No corticosteroids if patient is immuno-compromised
  - Triple therapy: pyrimethamine, sulfadiazine, folinic acid, corticosteroids
  - Co-trimoxazole (trimethoprim + sulfamethoxazole) + corticosteroids
  - Intravitreal dexamethasone + clindamycin
  - Oral clindamycin
  - Spiramycin or atovaquone if maternal infection acquired during pregnancy (15% in the first trimester and 60% in the third trimester risk of fetal transmission if acquired during pregnancy)
- Cataract extraction once uveitis is inactive for ≥3 months.

3.11 Vogt-Koyanagi-Harada (VKH) Syndrome (Fig. 3.14 and Table 3.4)

3.11.1 Other Diagnoses to Consider

- Sympathetic ophthalmia: history of penetrating eye injury
- Sarcoidosis
- Posterior scleritis: T-sign on B-scan
- Uveal effusion syndrome: lacks intraocular inflammation
- Acute posterior multifocal placoid pigment epitheliopathy (APMPPE)

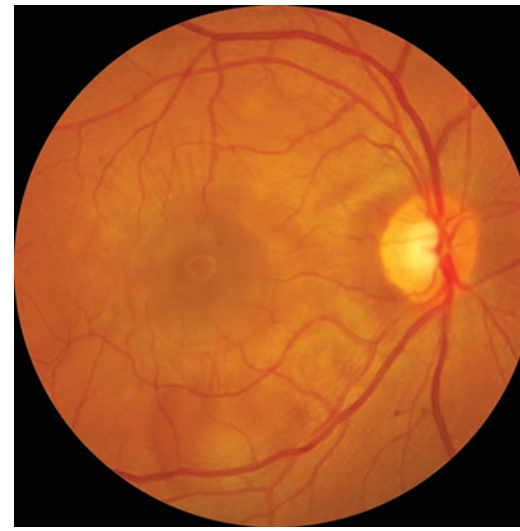

Fig. 3.14 Colour fundus image of a patient with VKH syndrome showing multiple serous RDs

Table 3.4 Key facts about VKH syndrome

• VKH syndrome is a bilateral granulomatous inflammatory panuveitis often associated with exudative RD and with extraocular manifestations
• No history of penetrating ocular trauma or surgery preceding initial onset of uveitis

3.11.2 Examination

- Systemic features
  - Cutaneous not preceding ocular/CNS disease:
    - Vitiligo
    - Poliosis
    - Alopecia
  - Neurological
    - Sterile meningism: headaches, neck stiffness, photophobia
    - Encephalitis
    - CN palsies
  - Auditory
    - Tinnitus
    - Deafness
    - Vertigo
- Ocular features
  - Prodromal stage:
    - Non-specific viral like illness
    - Meningism
  - Acute uveitic stage:
    - Bilateral panuveitis: anterior uveitis, multifocal choroiditis
    - Multiple serous RD's
    - Optic disc swelling
  - Chronic uveitic stage (convalescent phase):
    - Vitiligo
    - Perilimbal vitiligo — Sugiura's sign
    - Poliosis
    - Choroidal depigmentation: pale optic disc with bright red-orange choroid (sunset glow fundus)
    - Small yellow well circumscribed areas of chorioretinal atrophy
  - Chronic recurrent stage:
    - Acute episodic exacerbations of granulomatous anterior uveitis
    - Subretinal choroidal neovascular membrane
    - Cataracts (posterior subcapsular)/glaucoma

3.11.3 Investigations

- B-scan: choroidal thickening
- OCT: serous RD
- FFA: multifocal areas of pinpoint leakage, focal areas of delay in choroidal perfusion, large placoid areas of hyperfluorescence
- LP: CSF pleocytosis

3.11.4 Treatment

- Inflammation: high dose systemic corticosteroids ± immunosuppresants
- CNV membrane: anti-VEGF agents (avastin)
- Cataracts: cataract extraction if VA reduced and uveitis absent for a minimum of 3 months
- Glaucoma: drops, surgery

3.12 Malattia Leventinese/Doyne Honeycomb Retinal Dystrophy (Fig. 3.15)

3.12.1 Other Diagnoses to Consider

- AMD
- Fundus flavimaculatus: flecks do not hyperfluoresce on FFA, subnormal EOG, ERG and dark adaptation normal
- Sorsby macular dystrophy
- Pattern dystrophies
- Best disease (in its later stages)

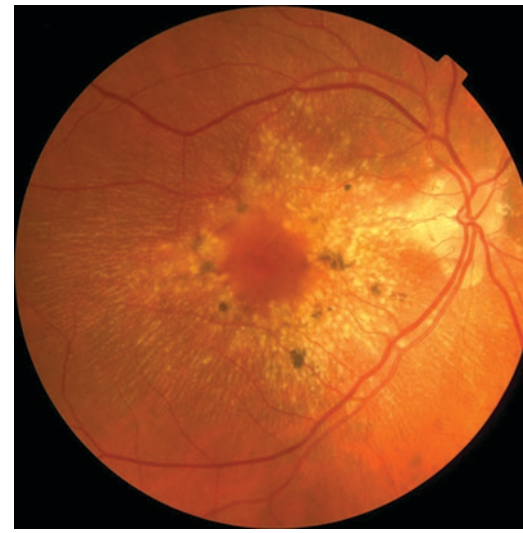

Fig. 3.15 Colour fundus photo of the right eye of a patient with malattia leventinese

3.12.2 Examination

- Presence of multiple elongated yellow-white deposits between the RPE and inner collagenous zone of Bruch's membrane in a radiating pattern throughout the macula that is present early in life (often by the second decade).
- These elongated drusen may also be found outside the arcades, especially nasal to the disc, which is unusual in other types of macular degeneration.
- These drusen may also be found in some patients in a peripapillary pattern or on the margin of the disc itself.
- Coalescence of drusen may simulate a vitelliform lesion
- RPE atrophic changes ± chorioretinal atrophy

3.12.3 Investigations

- OCT: hyperreflective thickening of the RPE-Bruch membrane complex, associated with localised dome-shaped elevations (see Fig. 3.16)
- FFA: during the arterial phase, multiple, round, sharply defined fluorescent spots corresponding to the lesions observed at ophthalmoscopy, no leakage of fluorescein is seen
- EDTs: ERG, EOG, dark adaptation normal in the initial stages
- Genetic testing: single mutation in the fibulin-3 gene

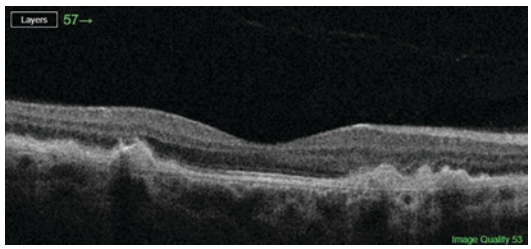

Fig. 3.16 OCT image of the same eye of the same patient as shown in Fig. 3.15 showing areas of hyperreflective thickening of the RPE-Bruch membrane complex, associated with localised dome-shaped elevations

3.12.4 Treatment

- Genetic counselling and discussion with patient
- CNV: anti-VEGF agents

3.13 Approach to the Adult Watering Eye

3.13.1 History

- "Do the tears flow down your cheek or do they stay in your eye?": watery eye (no spilling of tears onto the cheek) vs tearing eye (tears overflow onto the cheek)
- "Do the tears flow down your cheek inside when you are resting or mainly when you are outside in cold or wind?": partial obstruction (if tearing only present in the wind and cold) vs complete obstruction
- "Is the problem unilateral or bilateral?": tearing eye (i.e. obstruction in lacrimal drainage system) usually unilateral, watery eye usually bilateral
- Ask about findings suggestive of obstruction of the lacrimal system: unilateral symptoms, epiphora, history of dacryocystitis, onset after conjunctivitis (obstruction of puncta or canaliculi), facial fracture (damage to NLD), or nasal surgery (history of nasal surgery — damage to NLD)
- Ask about any pro-secretory drugs, e.g. oral pilocarpine for Sjogren Syndrome

3.13.2 Differential Diagnosis of a Watery Eye in an Adult

- Poor tear film: blepharitis/MGD
- Reflex tearing: entropion, trichiasis, reduced or incomplete blinking from parkinsonism, incomplete eyelid closure from CN VII palsy
- Inadequate lacrimal pump: ectropion, CN VII palsy (reduced strength of eyelid closure), lid laxity

3.13.3 Differential Diagnosis of a Tearing Eye in an Adult

- Result of canalicular or NLD obstruction
  - Children: congenital NLDO
  - Young adults: trauma (canalicular laceration or facial trauma), canalicular obstruction (post viral conjunctivitis with scarring of each canaliculus)
  - Middle-aged adult: dacryolith (episodes of recurrent epiphora which resolves spontaneously ± signs of acute dacryoadenitis)
  - Older adults: primary NLDO (PANDO): scarring in distal portion of NLD, symptoms include: epiphora, chronic mucopurulent discharge (chronic dacryocystitis) and acute cellulitis of the lacrimal sac (acute dacryocystitis)

3.13.4 Examination

- Examine for possible causes of a watery eye
  - Eyelid problems:
    Ectropion and entropion
    Lacrimal pump problems — CN VII palsy, lid laxity — lid distraction test (manually pulling lower eyelid away from eyeball: more than 6 mm off eyeball implies lid laxity) and snap test (measure horizontal lid laxity by pulling the lower eyelid inferiorly toward the inferior orbital rim. Eyelid with no laxity will spring back into position without a blink. Can be quantified by counting no. of blinks before eyelid returns to normal position)
    Punctal problems — eversion of punctum, canaliculitis (swelling and erythema of the canalicular portion of the eyelid, pouting punctum with dilated punctum, pressure on canaliculus expresses pus), congenital punctal atresia (one or more punta are absent), stenosis of punctum (antiglaucoma drops, phospholine iodide, following eyelid eversion such as with an ectropion — stenosis resolves once lid position restored)
  - Eyelash problems — trichiasis secondary to marginal entropion, blepharitis/MGD (keratin plugging, posterior lid telangiectasia, hyperaemia of eyelid margin)
  - Tear film abnormalities — meniscus high/low, faster TBUT (<10 s), Schirmer's test
- Examine for possible causes of a tearing eye
  - Lacrimal examination:
    Rule out dacryocystitis first: diagnosis of NLDO is made if signs of acute dacryocystitis (erythema, swelling, and tenderness in the medial canthus) are present, you can express pus/mucoid from lacrimal sac, or a mucocele is present (palpable cystic mass present in medial canthus caused by obstruction at both the NLD below and common internal punctum above causing lacrimal sac to fill with mucus)
    Evaluate tear lake with slit lamp: enlarged if obstruction present — mucoid/pus in tear lake if NLD obstructed, no debris in tear lake if punctum or canaliculi obstructed
    Evaluate cornea — rule out any pathologic changes, watch patient blink spontaneously to see how much cornea is covered with a blink
    Evaluate lid margins for signs of blepharitis or marginal entropion
    Evaluate position of punctum — normal punctum not easily visible without slight manual eversion of the eyelid
    Check lacrimal system vital signs:
    - Dye disappearance test: 2% fluorescein into each fornix. After 5 min, check to see how much dye is retained in eye. Normal result documented as spontaneous symmetric dye disappearance. An abnormal result is recorded as dye retained in right or left eye,
    - Lacrimal probing to demonstrate patency of upper and lower canaliculi using a lacrimal probe: probe should be placed vertically in the punctum for 1–2 mm. Lid pulled temporally and probe directed towards the can-

thal angle. Probe should pass easily to lacrimal sac where a hard stop (lacrimal bone) is felt. A soft stop indicates canalicular obstruction.

- Lacrimal irrigation: using a lacrimal irrigation cannula in the lower canaliculus, not the sac, you should be able to irrigate saline easily into the nose without any reflux around the cannula or out the upper canaliculus (normal NLD). If you cannot irrigate with pressure on syringe then the duct is closed (anatomic obstruction — regurgitation through same canaliculus irrigated through if obstruction in upper or lower canaliculus, regurgitation through opposite canaliculus than the one irrigating through if common canaliculus obstruction). If you can irrigate with pressure on syringe then duct is partially obstructed (functional obstruction)

Perform a nasal examination — nasal endoscopy if possible, to rule out intranasal tumours or mucosal abnormalities

3.13.5 Investigations

- Dacryoscintigraphy (DSG): indicated for functional NLDO (patient gives hx typical of PANDO but you cannot demonstrate an obstruction) and gives an estimate of the physiologic drainage of tears. If any delay is noted (delayed filling of NLD), a DCR is recommended (DCR not recommended if no filling of NLD seen)
- Dacryocystogram (DCG): useful if previous trauma, destructive disease (inflammatory) or suspected tumour
- Jones testing — considered in cases of partial obstruction to determine level of block:
  - Jones I — physiological without syringing — 2% fluorescein into lower fornix, after 5 min, assess dye recovery with a cotton bud placed at NLD opening at inferior meatus, positive if dye recovered and implies normal patency, negative if no dye recovered and implies partial obstruction or lacrimal pump failure
  - Jones II — non-physiological after syringing — wash out fluorescein from fornix, insert lacrimal cannula into the lower canaliculus and irrigate, assess dye recovery from nose as before, positive if dye recovered and implies partial obstruction of NLD, negative if no dye recovered and implies partial obstruction above the lacrimal sac (punctal or canalicular obstruction)

3.13.6 Treatment

- In all cases, eyelid and eyelash problems should be treated before lacrimal surgery
- Poor tear film: lid hygiene, lubricants, punctal plugs, punctal cautery
- Reflex tearing: treat entropion, lubricants
- Lacrimal pump problems: ectropion/laxity of lower eyelid — LTS, CN VII palsy — lubricants, LTS, gold weight placement in upper eyelid
- Punctal stenosis: discontinue treatment with any known offending eye drop, two- (vertical cut of punctum and horizontal cut of canaliculus) or three-snip (excision of a small triangle of the posterior wall of the vertical and horizontal portion of the canaliculus) punctoplasty
- Punctal eversion: if no lid laxity present — medial spindle procedure (combination of a posterior lamella shortening procedure and a mechanical inversion of the lid margin) only, if lid laxity present — LTS ± medial spindle procedure (LTS alone may return punctum to normal position — check at slit-lamp to assess for this)
- Canaliculitis: curette the canaliculus through a dilated punctum ± punctoplasty (keep curetting until you do not retrieve any more sulfur granules or "stones") — topical antibiotic drops post-operatively
- Canalicular obstruction: canalicular reconstruction over stents (lacerations or localised obstructions following trauma), DCR with Lester-Jones tube placement (Pyrex tube that carries the tears from the conjunctival cul-de-sac through a DCR ostium into the nose,

Table 3.5 Key facts about a Lester-Jones tube

Anatomy
- The proximal end of the tube lies at the medial commissure and the distal end lies within the middle meatus of the nose

Indications
- Symptomatic epiphora secondary to extensive scarring of both upper and lower canaliculi
- Congenital atresia or complete absence of the canaliculi with epiphora
- Symptomatic epiphora secondary to lacrimal pump failure, e.g. chronic facial palsy
- Failed re-do DCR
- Chronic epiphora due to eyelid malpositions which eyelid surgery has failed to or is unable to control, e.g. ichthyosis, severe chronic eczema

Complications
- Tube displacement — scleritis from local scleral indentation and irritation
- Tube obstruction
- Lacrimal sac infection

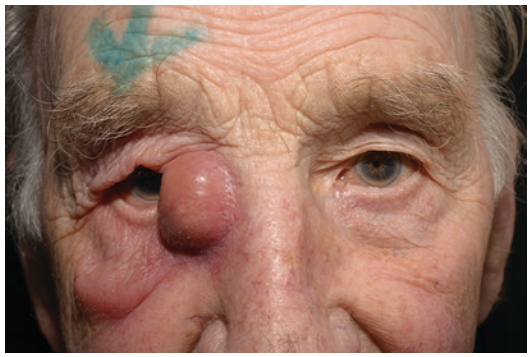

Fig. 3.17 Facial photo of a patient with a lacrimal sac abscess

bypassing the obstructed canaliculi — see Table 3.5)
- Acute dacryocystitis: do not probe or irrigate, oral or IV antibiotics, if lacrimal sac abscess (see Fig. 3.17) is present — incision and drainage of the lacrimal sac through an external incision will speed recovery but risks formation of a fistula, DCR (external/endonasal) delayed until inflammation has settled
- Chronic dacryocystitis (mucopurulent discharge but with no signs of cellulitis): topical antibiotics and DCR (external/endonasal), do not probe or irrigate
- Suspected dacryolith: if more than two episodes occur within a year, a DCR (external/endonasal) is a reasonable therapeutic option.
- Functional NLDO (anatomically the NLD is open on irrigation but the tears do not seem to pass into the nose spontaneously under normal conditions): DCR or silicone stent intubation of the NLD (remove stents at 6 months post op — success about 75%)

3.13.7 Dacryocystorhinostomy (DCR)

- Treatment for congenital (when blockage sufficient to prevent passage of a probe) and acquired NLD obstruction
- External DCR (gold standard): the obstructed NLD is by-passed by forming an anastomosis of the lacrimal sac and nasal mucosa through a nasal ostium created by an external skin incision.
- Endonasal DCR: the ostium and anastomosis are made from the inside of the nose, using an endoscope

3.14 Approach to the Paediatric Watering Eye

3.14.1 History

- Onset: soon after birth or if it is more recent
- Photophobia: suggests congenital glaucoma, uveitis, corneal disease (e.g. cystinosis), FB in conjunctival sac
- Eye rubbing or poking: suggests a retinal dystrophy such as LCA
- Watery nose on same side as the watery eye: suggests excessive lacrimation rather than blocked tear drainage

3.14.2 Examination

- External examination
  - Tearing, red macerated skin, stickiness may be seen
  - In NLDO, tear lake is thickened, brimming the lower lid margin — measures 2 mm or more with fluorescein staining of the tear film (normally <1 mm)
  - Secondary bacterial conjunctivitis with generalised conjunctival redness
  - Perilimbal conjunctival injection more specific for keratitis or uveitis
  - Generalised corneal haze with secondary corneal epithelial oedema may be a sign of glaucoma — estimate horizontal corneal diameter using a ruler held close to the lid
  - Congenital swelling over the nasolacrimal sac is probably a dacryocystocele
- Slit lamp examination
  - Puncti: presence or absence, ectropion
  - Lid: epiblepharon with inturned eyelashes, blepharitis
  - Conjunctiva: inspect inferior conjunctival fornix looking for diffuse redness and swelling of the conjunctiva — suggesting chlamydia conjunctivitis
  - Cornea: crystals, abrasions, FB, ulcers, KP's, Haab striae and corneal oedema
  - AC: hypopyon,
  - Iris: posterior synechiae
  - Lens: cataract
- Fluorescein testing
  - Staining with abrasions or epithelial oedema
  - Dye disappearance test
- IOP
- Fundus examination
  - Disc cupping in glaucoma
  - Posterior segment pathology, e.g. retinoblastoma (can present as a red watery eye with a pseudo-hypopyon)
- Cycloplegic refraction, fundus examination
  - Unilateral myopia in a child with unilateral glaucoma

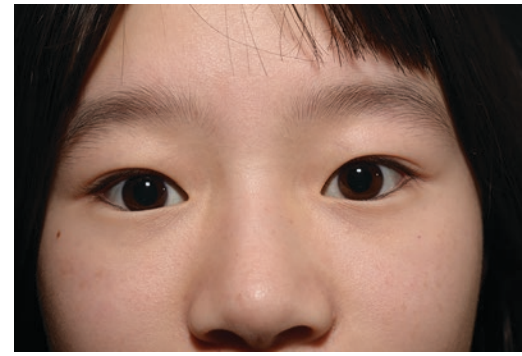

Fig. 3.18 Facial photo of a patient with an epiblepharon

3.14.3 Differential Diagnosis

- Reflex tearing (lacrimation)
  - Lids:
    Blepharitis
    Epiblepharon (see Fig. 3.18): irritation from inturned eyelashes
  - Conjunctiva:
    Conjunctivitis: infective (viral, bacterial), allergic, chemical
    Conjunctival sac or subtarsal FB
  - Cornea:
    Corneal FB
    Corneal abrasion
    Keratitis
    Cystinosis
  - Congenital glaucoma (see Sect. 9.4): horizontal corneal enlargement, Haab striae, buphthalmos, increased CDR, raised IOP
  - Anterior uveitis
- Decreased lacrimal drainage
  - NLDO
  - Lid malposition
  - Punctal malposition
  - Punctal occlusion (punctal atresia)
  - Anomalous drainage system (blocked or absent) with craniofacial abnormalities

Fig. 3.19 Facial photo of a patient with a congenital NLDO showing a positive 'fluorescein dye disappearance test'

Table 3.6 Key facts about CNLDO

- Caused by a persistent membranous obstruction at the valve of Hasner — in more than 90% of patients, this membrane will spontaneously rupture within the first year of life
- Diagnosis is made on a history of a watery eye that has been present from the first few weeks of birth — usually unilateral but may be asymmetrically bilateral

3.14.4 Congenital Nasolacrimal Duct Obstruction (CNLDO) (Fig. 3.19 and Table 3.6)

3.14.4.1 Examination

- Child is well with no evidence of irritation or photophobia
- Periocular skin may become red and excoriated
- Stickiness or crusting of the lashes
- Eye remains white without evidence of active infection, although conjunctivitis may complicate the condition
- Increased tear meniscus
- Mucocele may develop — contents can be expressed into the conjunctival sac

3.14.4.2 Investigations

- Dye disappearance test:
  - Fluorescein 1% is instilled into each lower conjunctival fornix and cobalt blue light from the slitlamp illuminates the eyes
  - Tear meniscus evaluated at 5 min
  - Normally fluorescein disappears from tear meniscus by 5 min but remains present in children with obstruction
  - Grading (MacEwan and Young 1991):
    0 = no fluorescein
    1 = thin fluorescing marginal tear strip
    2 = more fluorescein persists, higher tear film
    3 = wide, brightly fluorescing tear strip, spillage

3.14.4.3 Treatment

- Conservative (for the first year of life as high rate of spontaneous resolution):
  - Crigler massage: must push index finger posterior to the anterior lacrimal crest to empty the sac, idea is to massage as often as necessary to empty the sac — massage may build up enough pressure in the sac so that the membrane is broken
  - Antibiotics if conjunctivitis present (avoid antibiotics in watery white eyes)
- Syringing and probing (performed when spontaneous resolution of the tearing and mattering does not occur by 1 year of age) — 90% success rate:
  - Procedure performed under GA in an outpatient setting
  - Patient preparation — spray a vasoconstricting agent in the nose
  - Dilation of the punctum using a Nettleship dilator
  - Passage of probe into the sac until a "hard" stop is felt
  - Rotation of the probe 90° and passage of the probe into the NLD about 15 mm aiming slightly posteriorly and laterally
  - Fluorescein-stained saline irrigation using a disposable cannula
  - Confirmation that probe is in the nose (suction fluorescein tinged saline irrigation fluid — suction is in nose whilst canaliculus is irrigated with fluorescein stained saline)
  - Apply topical antibiotic ointment
- NLD intubation with silicone stents (performed when probing fails):
  - The upper and lower canalicular stents are tied so that the knot lies underneath the inferior turbinate

  - Leave stents in place for 6 months
  - A small amount of tearing will often remain with the stents in place, especially when child has a cold (no discharge should be seen however)
  - Remind parents that tears do not flow through the stents and that any residual tearing usually resolves when the stents are removed
  - If prolapse of stents occur — stents cannot be repositioned because the knot is up in the duct so just tape the loop to the cheek
- DCR (indicated with persistent epiphora despite probing and intubation).

3.15 Approach to the Patient with Proptosis

3.15.1 History

- Pain: caused by inflammation, infection, acute pressure changes (haemorrhage), and a highly malignant tumour growing into bone or nerves (neoplasms in general do not cause pain until a complication related to the neoplasm arises)
- Progression: rapid (hours to days — suggest inflammation or infection), intermediate (weeks to months — suggests more chronic types of inflammatory processes such as thyroid disease), slow (months to years — suggests a benign neoplasm or lymphoma)
- Past medical history: any previous neoplasm elsewhere such as lymphoma or breast carcinoma, any past trauma of the face (caused facial asymmetry that may accentuate or diminish the appearance of a proptotic eye), any history of thyroid disease

3.15.2 Examination

- Orbital examination: start by evaluating the change in the position of the eye in terms of axial and non-axial displacement, next palpate the orbital rims and soft tissues to see if any abnormality is present, then you will check briefly for any pulsations, last you will search for other clues in the periocular area that may give you information to develop a differential diagnosis
- Proptosis: axial displacement in anterior direction (thyroid orbitopathy with enlargement of the EOM, optic nerve tumours or a benign cavernous haemangioma). Measure axial displacement with Hertel exophthalmometer.
  - Inferior displacement (problems arising in the area of the lacrimal gland, defects in the orbital roof due to trauma, encephalocele, or frontal sinus mucocele formation)
  - Lateral displacement (problem in the ethmoid sinus — subperiosteal abscess — an acute process — arising in the ethmoid sinus and extending into the subperiosteal space, sinus carcinomas — slowly progressive process, mucocele — very slowly progressive process)
  - Upward displacement (lymphoid lesion, maxillary sinus tumours)
  - Medial displacement (enlarged lacrimal gland).

    Measure non-axial displacement with a Ruler or McCoy Tri-Square
- Palpation: start with palpation of the orbital rims and then move toward the eye, palpating the superior and inferior fornix for any anterior masses — if present determine size, shape and position, determine if there is any tenderness in the area of the lesion (infectious or inflammatory disorders will often cause the skin to be erythematous and warm to touch)
- Pulsation: pulsations of the eye suggests either an arterial vascular malformation in the orbit (if high flow you may be able to hear a bruit or feel a thrill) or the absence of orbital bone that allows the normal pulsations of the brain to push on the eye (e.g. absence of sphenoid wing in NF-1), venous lesions do not pulsate but they will usually show enlargement with the Valsalva manoeuvre (orbital or conjunctival varix) or with the head in a dependent position
- Periocular changes: temporal flare of the lateral position of the upper lid and lid lag seen

on downgaze (thyroid orbitopathy), conjunctival salmon patch (orbital lymphoma), fullness of the temple (sphenoid wing meningioma), periocular skin malignancy (intraorbital spread of cutaneous carcinoma)

3.15.3 Investigations

- Orbital imaging serves two purposes — providing diagnostic information (what the mass is) and providing information used to plan orbitotomy (want to know the best surgical approach to biopsy the mass)
- CT for bony orbital trauma
- MRI for imaging of the orbital apex, chiasm, optic nerve tumours, FLAIR sequence for optic neuritis due to demyelinating disease, STIR sequence for thyroid orbitopathy

3.15.4 Orbital Disease Occurring in Adults

3.15.4.1 Differential Diagnosis

- Axial displacement:
  - Enlarged EOMs — thyroid orbitopathy, orbital pseudotumour
  - Intraconal mass — cavernous haemangioma
  - Optic nerve tumour — optic nerve meningioma
- Nonaxial displacement:
  - Inferior displacement — lacrimal gland (benign mixed or lymphoid tumour), frontal sinus (mucocele), orbital roof (sphenoid wing meningioma)
  - Lateral displacement — ethmoid sinus (abscess or mucocele)
  - Superior displacement — maxillary sinus (carcinoma), orbital fat (lymphoid tumour)
  - Medial displacement (rare) — benign mixed tumour of lacrimal gland
- Enophthalmos:
  - Scirrhous carcinoma of the breast — infiltrative sclerosing tumour

3.15.4.2 Thyroid Eye Disease (Fig. 3.20 and Table 3.7)

Other Diagnoses to Consider

- Allergic conjunctivitis — acute in onset from a new exposure, causes itching, papillary conjunctival reaction, not associated with eyelid retraction or proptosis
- Myasthenia gravis — diplopia worsens throughout the day and improves after rest (not variable in TED), may present with ptosis (not associated with TED)
- Orbital myositis — causes enlargement and inflammation of the muscle body and tendon insertion (muscle body only in TED), not associated with eyelid retraction, usually unilateral (bilateral presentation unlikely for orbital myositis, TED can present unilaterally or bilaterally)
- Orbital tumours — typically unilateral in presentation causing proptosis and ocular motility disturbances, unlikely to cause eyelid retraction or lid lag
- Carotid-cavernous fistula — patient may hear pulse-synchronous tinnitus, presentation may include pulsatile proptosis, dilated conjuncti-

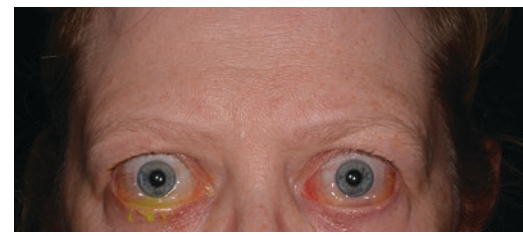

Fig. 3.20 Facial photo of a patient with TED showing superior and inferior lid retraction, proptosis, chemosis, caruncular oedema and upper lid oedema

Table 3.7 Key facts about TED

• Most common cause of unilateral or bilateral proptosis • Affects women five to six times more often than men • Onset most common in the early 40s and mid-60s • TED is most commonly associated with Graves disease (90%) but may occur in 3% of Hashimoto's thyroiditis, 6% euthyroid, and 1% primary hypothyroidism

val and episcleral vessels, elevated IOP, enlarged EOM, would not cause eyelid retraction or temporal flare
- CPEO — slowly progresses over 5–15 years with most patients presenting with ptosis, all cardinal directions of gaze are affected, with downgaze most likely spared (TED conversely typically affects downgaze and nasal gaze)
- Inflammatory orbitopathy (e.g. GPA) — GPA typically presents with a mix of upper and lower respiratory tract and renal pathologies. Patients may have conjunctivitis, episcleritis, scleritis, and/or uveitis (other than conjunctivitis, these findings are uncommon in TED patients)
- IgG4-related orbitopathy — painless swelling of the EOM's, lacrimal glands, and infraorbital nerves in combination with paranasal sinus disease, multi-organ fibrosis and sclerosis (pancreas, liver, salivary glands, retroperitoneum) may co-exist

History

- Any pain and rate of progression: gradual onset, slow progression without pain. No pain is associated, but discomfort, more like pressure or orbital fullness, is often present
- Any diplopia (restrictive strabismus) or blurred vision (optic nerve compromise)
- Ask about symptoms of hyper- or hypo-thyroidism
- Past medical history often reveals systemic thyroid disease
- A family history is common
- Ask about risk factors for TED: smoking, history of thyroid disease (hyper- or hypo-thyroidism), poor control of thyroid function is a risk factor for reactivating TED

Examination

- Check lids
  - Measure the eyelid position and function (PA, MRD1, LF)
  - Look for lid swelling and erythema
  - Look for upper and lower lid retraction
  - Look for temporal flare of the upper eyelid — lid just keeps getting higher toward the lateral canthus (peak of normal eyelid is just nasal to the pupil)
  - Look for lid lag in downgaze.
  - Look for lagophthalmos
- Check proptosis
  - Measure the degree of proptosis using an exophthalmometer
  - Axial, usually bilateral, but can be quite asymmetric
- Check optic nerve function for compressive optic neuropathy
  - VA
  - RAPD
  - Colour vision: first sign of early optic nerve compression is reduced colour vision
  - 24-2 HVF
  - Serial visual evoked potentials (VEP — provides objective assessment of optic nerve function — important to know that patient is euthyroid before evaluating the result, as hypothyroid patients without optic nerve compression can show a delay in the P100 component of the VEP)
- Slit lamp examination
  - Check corneal sensation
  - Look for conjunctival and caruncular injection and/or chemosis
  - Look for signs of corneal exposure, superior limbic keratoconjunctivitis
  - Check IOP in primary position and upgaze (more than 5 mmHg difference)
  - Perform a dilated fundus exam to look for optic disc swelling or pallor and choroidal folds
- Check extraocular muscle involvement
  - Mechanical restriction of ocular movement ± pain on looking in the direction of limited movement
  - Retraction of the globe occurs when movement away from the site of the restriction is attempted (commonly seen on upgaze)
  - In order of decreasing frequency, the muscles involved are: IR muscle (restricted up gaze), MR muscle (restricted abduction), SR muscle (restricted downgaze), LR muscle (restricted adduction although LR is usually spared even when enlargement is evident on CT scan)
  - Common ocular posture is hypotropia of the more affected eye, sometimes with associated ET

  - An abnormal head posture, commonly chin elevation, is often adopted, ± face turn: purpose is to avoid an uncomfortable position of gaze, to centralise a field of binocular single vision
  - Enlarged vertical fusion amplitude
- Systemic examination
  - Examine for goitre, palmar erythema, atrial fibrillation, and pretibial myxedema
  - Look for signs of hyperthyroidism (warm peripheries, tachycardia, atrial fibrillation, hair loss) or hypothyroidism (bradycardia, dry thin hair, dry coarse skin)

Investigations

- Thyroid functions tests (TSH, T4 — most patients will have a high T4 and a low TSH level, although in 5–10% of patients, thyroid orbitopathy will be associated with a euthyroid condition) and thyroid autoantibodies (anti-TSH receptor, anti-thyroid peroxidase, anti-thyroglobulin antibodies)
- In some patients, the diagnosis is so obvious that no imaging is necessary
- CT scan with axial and coronal cuts (see Fig. 2.46): enlarged extraocular muscles, proptosis (>1/3 of eye in front of imaginary line from medial to lateral canthus), CT is preferred imaging modality for planning orbital decompression
- MRI (T2 STIR): better soft tissue resolution and used for grading disease activity, enlarged muscle bellies with sparing of the tendons
- Orthoptic review: Hess/Lees chart, field of binocular single vision, field of uniocular fixation
- Serial visual evoked potentials (VEP — provides objective assessment of optic nerve function — important to know that patient is euthyroid before evaluating the result, as hypothyroid patients without optic nerve compression can show a delay in the P100 component of the VEP)
- Forced duction test: confirm presence and extent of mechanical restrictions

Disease Stratification

- If TED is suspected, determine disease activity and disease severity in order to assess the urgency of treatment
- Disease activity — grade disease activity using the Clinical Activity Score — CAS (Mourits et al. 1997) — at initial visit, patients are given a CAS score of 1–7, 1 point for each sign or symptom (ocular pain at rest in the last 4 weeks, ocular pain on eye movement in the last 4 weeks, eyelid swelling that is considered to be due to active TED, eyelid erythema, conjunctival injection considered to be due to active TED, chemosis, inflammation of caruncle or plica semilunaris); At follow-up visits, add the three following criteria (increase of at least 2 mm proptosis during a period of one to three months, decrease in uniocular motility in any one direction of at least 5° during a period of one to three months, decrease in VA equivalent to 1 Snellen line during a period of one to three months) for a potential CAS score of 10 (1 point for each sign or symptom)
- TED is considered "active" if the CAS is 3 or more at the initial visit or 4 or more at the follow up visits
- Disease severity:
  - EUGOGO classification scheme (Bartalena et al. 2008):
    Mild TED: lid retraction less than 2 mm, exophthalmos less than 3 mm above normal, mild soft tissue involvement, transient or no diplopia, corneal exposure responsive to lubricants — insufficient to justify immunosuppressive/surgical treatment
    Moderate-severe TED: lid retraction at least 2 mm, exophthalmos at least 3 mm above normal, moderate to severe soft tissue involvement, constant diplopia — sufficient impact on QOL to justify immunosuppression if active or surgical intervention if inactive
    Sight threatening TED: optic nerve neuropathy and/or corneal breakdown — warrant immediate intervention
  - NOSPECS:
    No signs or symptoms
    Only signs no symptoms
    Soft tissue involvement
    Proptosis
    EOM involvement
    Cornea involvement
    Sight loss

Rundle's Curve

- Depicts schematically the typical course of disease severity with time
- Characterised by an active phase of increasing severity, a regression phase of decreasing severity, and an inactive plateau phase

Treatment

- Achieve a euthyroid state without post-treatment hypothyroidism — seek consultation with an endocrinologist if the patient is not seeing one. Treatment of hyperthyroidism — carbimazole or propylthiouracil, radioactive iodine — short course of prophylactic oral steroid to prevent new onset or progression of TED, thyroidectomy. Treatment of hypothyroidism — levothyroxine
- Promotion of smoking cessation
- Before initiating treatment, determine where the patient's condition falls in the natural history of the disease. Try to determine whether patient is in the "active" stage (swelling or redness of the orbital, lid, and conjunctival tissues — eyelids look "wet" as though you could squeeze oedema fluid out, eyelid swelling and any diplopia are much worse in the mornings) or "chronic" stage (morning eyelid swelling and diplopia are gone, signs of acute inflammation are no longer present, any remaining proptosis and lid retraction probably will not change) of the disease
- Mild TED/CAS <3 — most patients will require only medical management during the active stage — monitor patients for corneal exposure and treat irritation with lubricating drops and ointment, elevate head of the bed to reduce morning swelling or diplopia, sunglasses to decrease photophobia and feelings of dryness, prisms for diplopia
- Moderate-severe TED/CAS ≥3 — consider immunosuppression (systemic corticosteroids — IV methylprednisolone or oral prednisolone, rituximab, etanercept, AZT) or orbital radiotherapy (2000 rad — for patients with restrictive myopathy but not for acute optic nerve compression — contraindications include history of skin cancer, age less than 35 years old)
- Sight threatening TED — admit patient, IV methylprednisolone 1 g every day for 3 days (maximum total dose of 8 g — if dose exceeds measure LFT's as small risk of acute liver damage). Surgical decompression (fat and/or bony decompression) if the steroid therapy fails and if systemic steroid therapy is contraindicated or has intolerable side effects.
- Surgical (decompression then strabismus surgery then lid surgery) — when you have confirmed that there has been no change over 3–6 months, the patient may want to consider procedures to improve the remaining proptosis, lid retraction, and strabismus (to correct diplopia: conservative — prisms, botulinum injection, and Bangerter foils, surgical —indicated when there is diplopia in primary gaze and downgaze and stable inactive TED with stable myopathy for at least 6 months)

Prognosis

- Poor prognostic factors: smoker, male, older age at onset, diabetes, reduced vision, rapid progression at onset, longer duration of active disease

3.15.4.3 Orbital Pseudotumour (Table 3.8)

Other Diagnoses to Consider

- Bacterial orbital cellulitis — patient usually sick (febrile, weak, etc.), onset usually takes place over a few days, pain usually less than with orbital pseudotumour
- Orbital haemorrhage — onset usually more sudden, with progression occurring over a few minutes, rather than hours

History

- Any pain and rate of progression — acute/abrupt onset of pain with rapid progression occurring over hours to a day or at most two
- Past medical history is only helpful for children in whom a viral syndrome may precede the onset

Table 3.8 Key facts about orbital pseudotumour

• Any of the orbital tissues may become infiltrated with inflammatory cells (dacryoadenitis or myositis)
• Both young and old people are affected

Examination

- Look for proptosis
- Look for periocular signs of acute inflammation predominate — lid swelling, chemosis
- Look for limited motility
- With palpation, the tissues are tense and warm, but no distinct mass will be present. The inflamed areas are tender to touch. There are no pulsations.

Investigations

- FBC, CRP: normal
- CT scan (see Fig. 2.47): poorly circumscribed (poorly defined margins) mass may be present in any orbital space, dacryoadenitis, myositis (diagnosis can usually be made clinically if the onset and pain are typical)

Management

- Rapid response to oral prednisolone (80 mg/day) is characteristic. Treatment should be continued for 6–8/52 with a tapering schedule.

3.15.4.4 Cavernous Haemangioma (Table 3.9)

History

- Any pain and rate of progression — painless and slow progression

Examination

- Vision: not affected unless the mass pushes directly on the eye causing a hyperopic shift
- Look for proptosis: unilateral, axial
- The typical cavernous hamangioma is too far posterior to be palpable
- There are no associated periocular signs
- Although lesion is vascular, there is low flow so no pulsations are seen

Investigations

- CT scan (see Fig. 2.48): well circumscribed oval or round mass, usually in the muscle cone (intraconal)

Table 3.9 Key facts about cavernous haemangioma

• Most common benign orbital tumour in adults • Most common around age 40

Management

- Observation: repeat CT scan at three to four months or sooner if any visual loss, pain or change in proptosis occurs
- Removal via orbitotomy: if diagnosis is uncertain, vision loss is present, or the patient does not want observation, excisional biopsy (removal) is recommended.

3.15.4.5 Optic Nerve Meningioma (Table 3.10)

History

- Any pain and rate of progression — no pain, rate of progression is very slow over months to years
- Any vision loss — patient's usually note vision loss from compression of the nerve before tumour is large enough to cause proptosis

Examination

- Look for proptosis — usually minimal at the time of presentation — if present, the proptosis is axial
- No external signs of disease are present
- Palpation of the orbit is normal
- No abnormal pulsations of the eye are seen
- Look for optic disc swelling — may be present
- Look for optociliary shunt vessels — compression of the CRA can occur so that blood flow is shunted to the retina via the ciliary vessels

Investigations

- CT scan: enlargement of the optic nerve, calcification of the arachnoid (parallel radiodense lines on the sides of the nerve — tram tracking)
- MRI scan (see Fig. 2.55): to determine extent of the tumour into the orbital apex and chiasm — will be able to see posterior extent of the tumour without the artefact of the bones in the apex obscuring the soft tissue detail as on a CT scan

Table 3.10 Key facts about optic nerve meningioma

• Most often seen in middle-aged adults • Benign tumour originates in the arachnoid villi of the meningeal sheath of the optic nerve

- Incisional biopsy: if diagnosis cannot be made clinically

Treatment

- Observation: recommended if VA is good
- Excision: debulking of an optic nerve meningioma cannot be done without damage to the vision, so no attempt to excise is usually done until useful vision is lost (blind eye) or the tumour is extending toward the optic canal as seen on serial MRI examination
- Meningioma's in patients younger than 35 behave more aggressively, suggesting that earlier excision should be considered

3.15.5 Orbital Diseases Occurring in Childhood

- Malignancy is a less common cause of proptosis
- Congenital abnormalities are more common causes — choristoma (normal tissue in an abnormal anatomic location, e.g. dermoid cyst), and hamartoma (normal tissue in abnormal quantity, e.g. haemangioma or glioma)
- Thyroid orbitopathy is a rare cause of proptosis in children
- Infection is a common cause of proptosis in children
- Rhabdomyosarcoma must be considered in any child with rapidly progressive proptosis

3.15.5.1 Differential Diagnosis

- Dermoid cyst
- Capillary haemangioma
- Orbital cellulitis
- Lymphangioma
- Rhabdomyosarcoma
- Optic nerve glioma

3.15.5.2 Dermoid Cyst (Fig. 3.21 and Table 3.11)

Other Diagnoses to Consider

- Lateral anterior dermoid: lacrimal gland mass, lipodermoid, teratoma, plexiform neurofibroma

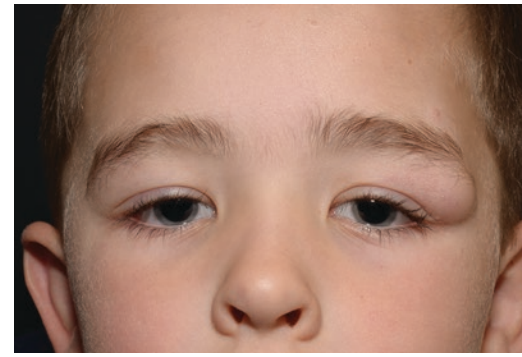

Fig. 3.21 Facial photo of a patient with a left dermoid cyst

Table 3.11 Key facts about dermoid cysts

- A choristoma containing skin and skin appendages such as hair and oil glands
- In utero, a bit of skin is "pinched" in a suture line where the tissue gradually forms a cyst. The lining of the cyst is normal skin. The contents of the cyst include keratin, oil and hair
- If the cyst wall does not contain skin appendages, it is called an epidermal cyst

- Medial anterior dermoid: mucocele, haemangioma, encephalocele
- Cyst with spontaneous rupture: orbital cellulitis, orbital pseudotumour
- Deep dermoid with mass effect: primary cranial nerve palsy

History

- Onset — first few months of life, deep orbital dermoid cysts, such as those originating from the sphenozygomatic suture, present later, usually in young adults
- Pain — painless
- Progression — mass increases in size very slowly
- Diplopia — mass effect of a deep dermoid cyst

Examination

- Location of cyst (forms differentials): cyst can occur at any suture line, but it is most commonly seen at the frontozygomatic suture line (frontonasal suture next most common)
- Palpate cyst: smooth to palpation, can be either freely moveable or attached firmly to the bone. No mass palpable for a deep orbital dermoid cyst

- Displacement of globe/proptosis: mass effect of a deep orbital dermoid cyst
- Ocular motility: deficits caused by a deep orbital dermoid cyst

Investigations

- Imaging of the typical frontozygomatic dermoid cyst in an infant is *not* required if you can feel around the equator of the mass, suggesting that the entire mass is outside of the orbital cavity
- If the mass is firmly fixed to the bone or you cannot feel around the mass, there may be a component of the cyst extending into the bone or in the orbit itself. Imaging is not absolutely necessary, but it may help you to plan your operation because some bone removal may be required in rare patients.
- If mass is nasal (differentials — haemangioma, encephalocele), order a scan if you are not absolutely sure that the mass is a dermoid cyst
- CT scan: well circumscribed round mass adjacent to the bone, contents of the cyst may have the density of water or oil; occasionally one can see an interface between the oil and water layers (dermoid cyst); deep orbital dermoid cyst usually diagnosed on CT (large well circumscribed mass within an area of bone moulding to accommodate the slow growth of the cyst), as there may be no characteristics in the history or examination to make a definitive diagnosis.

Treatment

- Excision of cyst: rupture during removal may lead tio recurrence

3.15.5.3 Capillary Haemangioma (Fig. 3.22 and Table 3.12)

History

- Onset and pain — not present at birth but appears in the first few months of life, painless

Examination

- Look for a blush of red or blue to skin with little elevation (cutaneous haemangioma) and/or bluish elevation with no surface vascularisation (subcutaneous haemangioma) on the lid/forehead

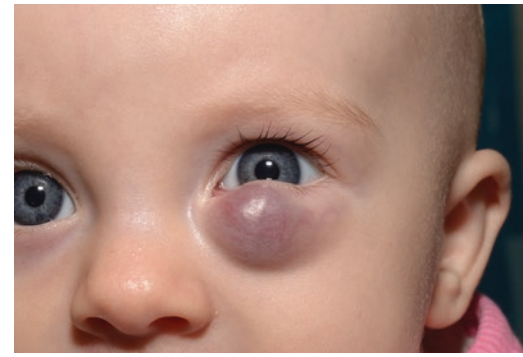

Fig. 3.22 Facial photo of a patient with a lower eyelid capillary haemangioma

Table 3.12 Key facts about capillary haemangiomas

- The most common orbital hamartoma.
- Haemangiomas, if untreated, have three phases: initial growth phase (ends before 6 months of age), stable phase, spontaneous involution phase (begins at 1 year of age up until age 8)

- Look for proptosis: subcutaneous portion of haemangioma may extend into the orbit causing displacement of the eye inferiorly or proptosis
- Look for ptosis: any large eyelid lesion can cause ptosis
- Cycloplegic refraction: during the growth phase look for astigmatism and amblyopia
- Slight changes in size occur with crying, probably as a result of vascular engorgement (low flow lesion so no pulsations are present)

Treatment

- Indications — amblyopia, astigmatism, or bony orbital asymmetry develops
- Intralesional steroid injection (Triamcinolone [Kenalog, Squibb] 40 mg/mL + betamethasone 6 mg/mL) — helpful if an upper eyelid mass causes amblyopia — follow up 6 weeks post injection
- Oral prednisolone — 1–2 mg/kg/day — if a mass is in the orbit causing proptosis or if the haemangioma is very large — include paediatrician in this treatment
- Systemic propranolol (Leaute-Labreze et al. 2015) — 3 mg/kg/day for 6 months
- Surgical excision with subsequent reconstruction of the resultant skin defect

Table 3.13 Key facts about orbital cellulitis

- Infection of the ethmoid sinus (sinusitis) spilling into the orbit is the usual cause
- Other causes: dacryocystitis, dental abscess, penetrating orbital trauma (septal perforation), surgical (strabismus and retinal surgery)
- Preseptal cellulitis — in younger children, in whom the orbital septum is not fully developed there is a high risk of progression and so should be treated similarly to orbital cellulitis. Unless there is an obvious cause for the preseptal cellulitis, such as an insect bite, you should consider the possibility of an ethmoid infection causing the eyelid swelling. Preseptal inflammation without evidence of a skin wound should be considered sinus in origin until proven otherwise. Order a CT scan to find out

3.15.5.4 **Orbital Cellulitis** (Table 3.13)

Differential Diagnosis of Inflammatory Proptosis

- Inflammation:
  - Orbital inflammatory disease: onset over days or weeks, afebrile, children are more likely to have anterior/posterior uveitis, normal FBC
  - Sarcoidosis: anterior/posterior uveitis, arthropathy, skin rash
  - Wegener's granulomatosis: bilateral, globe displacement with orbital mass, nasal blockage/discharge/bleeds, hearing loss, pain over paranasal sinuses
  - Ruptured dermoid cyst: globe displacement
- Penetrating orbital trauma
- Neoplasia:
  - Benign orbital tumours — lymphangioma, haemangioma
  - Malignant orbital tumours — rhabdomyosarcoma, leukaemia, metastatic disease
- Endocrine:
  - TED: lid retraction

Classification

- Chandler classification of orbital complications of sinusitis (Chandler et al. 1970):
  - Class I: Inflammatory oedema (preseptal cellulitis)
  - Class II: Orbital cellulitis
  - Class III: Subperiosteal abscess (SPA)
  - Class IV: Orbital cellulitis
  - Class V: Cavernous sinus thrombosis

History

- Any pain and rate of progression — proptosis develops over a few days with associated pain
- Recent history of URTI
- History of sinus disease
- History of any dental abscess
- History of dacryocysitis
- History of trauma — septal perforation
- History of surgery — lacrimal procedure, orbitotomy, lid operation, strabismus operation
- History of diabetes or immunocompromised (more for adults) — fungal orbital cellulitis

Examination

- Child looks sick (unlike with orbital pseudotumour) — weak, tired, and febrile (check temperature)
- Mild to advanced signs of orbital inflammation (similar to orbital pseudotumour) — proptosis, swollen, red, tender and warm lids, chemosis, limited extraocular movements (mechanical limitation)
- Look for optic nerve compromise — VA, RAPD, Colour vision
- Look for dacryocystitis
- Look for an insect bite/FB from trauma

Investigations

- FBC (raised WCC), CRP, Blood cultures
- CT orbits and sinus (see Fig. 3.23) — sinus disease, abscess formation in the orbit (subperiosteal/intraorbital abscess) ± intracranial, cavernous sinus thrombosis

Treatment

- Consult with ENT (sinus drainage) and paediatricians
- Broad-spectrum IV antibiotics and nasal decongestants (ephedrine) ± IV fluid: improvement should occur within 24–48 h. Daily review.
- Any Intraconal/orbital abscess should be drained
- Indications for early drainage of a SPA (Garcia and Harris 2000): age more than 9, presence of frontal sinusitis, non-medial location of SPA, large SPA, suspicious of anaerobic infection (e.g. presence of gas in abscess on CT), recur-

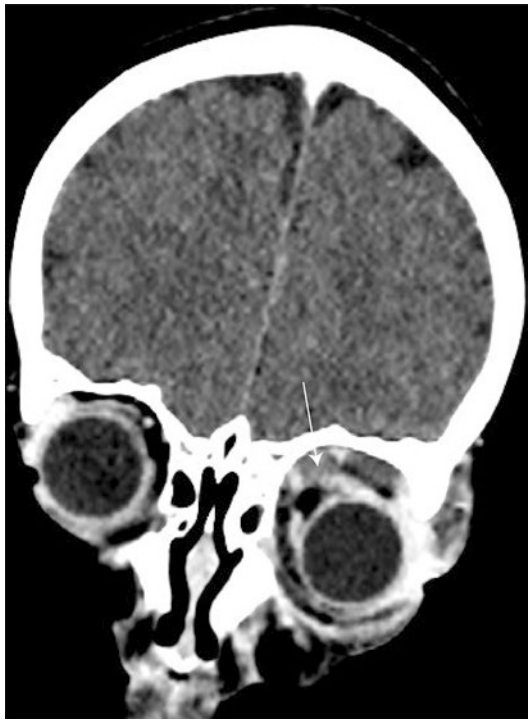

Fig. 3.23 Coronal CT scan image of a patient with an orbital cellulitis showing a superior subperiosteal abscess (white arrow)

rence of SPA after prior drainage, evidence of chronic sinusitis (e.g. nasal polyps), acute optic nerve compromise, infection of dental origin

Complications

- Subperiosteal and orbital abscess
- Cavernous sinus thrombosis: CN III, IV, V_1, VI CN palsies, retinal venous dilatation + optic disc swelling
- Meningitis
- Septicemia
- Brain abscess
- Optic neuropathy
- CRAO

3.15.5.5 Optic Nerve Glioma (Table 3.14)

History

- Pain and rate of progression: slowly progressive, no pain
- History of NF-1/Family history of NF-1 (first degree relative)

Table 3.14 Key facts about optic nerve glioma

• Occurs primarily in children in the first decade of life. Most tumours are unilateral
• Gliomas originate within the optic nerve tissue itself

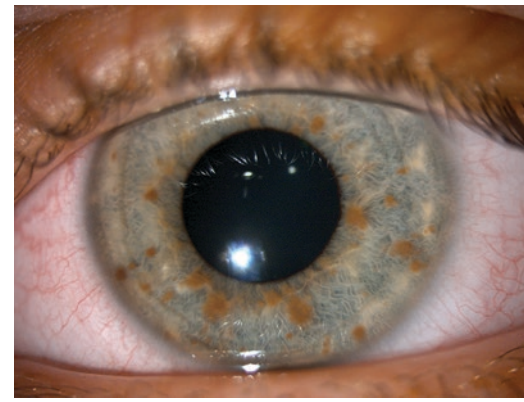

Fig. 3.24 Anterior segment image of a patient with NF-1 showing lisch iris nodules

Examination

- Look for axial proptosis: suggests an Intraconal mass
- Check optic nerve function: VA, RAPD, Colour vision — optic nerve compromise
- Look for signs of NF-1: café-au-lait spots, plexiform neurofibroma, lisch iris nodules (see Fig. 3.24), axillary/inguinal freckling
- Look for optic disc swelling

Investigation

- CT scan (see Figs. 2.54 and 2.56): enlarged nerve, often fusiform in shape, mass causes eccentric enlargement of the nerve, no calcification
- MRI scan: to delineate posterior extent of tumour — optic nerve tumour is characteristically bright on a T2-weighted scan — chiasm can be involved in up to 50% of cases of optic nerve glioma
- Incisional biopsy: only if diagnosis is in question

Treatment

- Observation with serial MRI scans performed every 6 months or so — majority of optic nerve gliomas are benign (hamartomas) and little or no growth posteriorly along the nerve will be seen over time

- Excision: only recommended for blind eyes with disfiguring proptosis or posterior spread threatening the chiasm, usually performed through a transcranial orbitotomy, removing the entire nerve
- Chemothetrapy/radiotherapy: for chiasmal or midbrain involvement

3.15.5.6 Rhabdomyosarcoma

History

- Pain and rate of progression: rapidly progressive painless proptosis over a period of several days to a few weeks. 70% occur in the first decade of life

Examination

- Look for proptosis: typically non-axial with the superonasal quadrant being involved most commonly, typically proptosis is relatively advanced somewhat out of scale to the short duration of symptoms
- Look for periocular ecchymosis (differential: neuroblastoma metastatic to orbit — bilateral periocular ecchymoses are typical)
- Look for enlarged preauricular or cervical lymph nodes
- Palpate for smooth mass in the anterior orbit, sometimes fixed to bone. No abnormal pulsations.
- Tumour may involve facial structures outside the orbit so look for masses elsewhere, including in the nose

Investigations

- CT scan: well circumscribed orbital mass with associated bone destruction, if mass extends outside orbit — you will see extensive soft tissue involvement and bone destruction
- MRI scan: if any of the cranial bones are involved, an MRI scan will be necessary to determine the extent of intracranial involvement
- Incisional biopsy

Treatment

- Early oncology consultation for systemic work up
- Combination of chemotherapy and radiotherapy

3.16 Approach to the Patient with Ptosis

3.16.1 Classification of Ptosis

- Simple congenital ptosis (see Fig. 3.25)
  - Eyelid is ptotic because of a dystrophy of the levator muscle itself (muscle is fibrotic and infiltrated with fat) — "simple" implies that the only problem causing the ptosis is the dystrophic levator muscle
  - Almost always bilateral, often asymmetric
  - Ranges from mild to severe
  - Reduced levator function
  - Weak or absent skin crease
  - Lid hang up on downgaze
- Involutional ptosis (aponeurotic ptosis)
  - Ptosis is caused by the aponeurosis separating from the tarsal plate
  - The term "disinsertion" is used, implying a slippage of aponeurosis off the tarsal plate or thinning of the aponeurosis ("dehiscence") itself
  - Associated with normal, or near normal, levator function (muscle is normal)
  - A high skin crease is the result of the levator fibers to the skin being dragged upward with the disinserted aponeurosis
  - Lid margin remains low throughout downgaze: lid drop on downgaze

Fig. 3.25 Facial photo of a patient with a simple congenital ptosis

  - Ranges from mild to severe
  - May be bilateral or unilateral
- "Unusual" types of ptosis
  - "Unusual" types of ptosis are usually associated with reduced levator function, but levator function also can be normal
  - Congenital causes:

    Superior rectus weakness:
    - Congenital ptosis associated with SR weakness in 5% of cases but has little clinical implication

    Marcus Gunn jaw winking (see Fig. 9.29):
    - Miswiring of CN V (pterygoid muscles) to CN III causing the drooping upper eyelid to elevate with movements of the mouth

    Blepharophimosis syndrome (see Fig. 3.26):
    - Ptosis (bilateral, symmetric, poor levator function),
    - Epicanthus inversus (medial canthal fold of skin extending from lower eyelid to upper eyelid)
    - Telecanthus
    - Blepharophimosis of the eyelids (horizontal aperture of eyelid narrowed laterally and medially)
  - Acquired causes:

    Neurogenic (abnormal innervation and normal muscle):
    - Myasthenia Gravis (see Figs. 9.30 and 9.31):
      - Reduced Ach receptors at neuromuscular junction
      - Diplopia
      - Variable ptosis: change in lid position from minute to minute or changes occurring throughout the day
      - Test fatigability: ask patient to look up for 30–60 s and eyelid will fatigue and slowly drop
      - Investigate with edrophonium testing: IV injection of Tensilon results in temporary elevation of the ptotic eyelid
      - Investigate with ice pack test: cooling of eyelid allows eyelid to elevate temporarily
      - Treatment with systemic oral pyridostigmine, thymectomy, immunosuppression, surgical ptosis correction if medical treatment unsuccessful although variability remains (presence of diplopia precludes possibility of successful eyelid elevation)
    - CN III palsy:
      - Ptosis with normal or reduced levator function
      - Non-comitant strabismus
      - Mydriasis
      - Aberrant regeneration with the ptotic eyelid elevating with contraction of the MR or IR muscle, pupil constriction with eye movements
    - Horner's syndrome:
    - Mild ptosis with normal levator function, miosis, lower lid elevation

    Myogenic (normal innervation and abnormal muscle — reduced levator function is typical, facial muscle activity and ocular motility are also reduced):
    - Oculopharyngeal dystrophy (see Fig. 3.27):
      - Autosomal dominant inheritance
      - Progressive bilateral ptosis (good levator function initially) with facial weakness and difficulty swallowing (ask patient to drink glass of water rapidly)

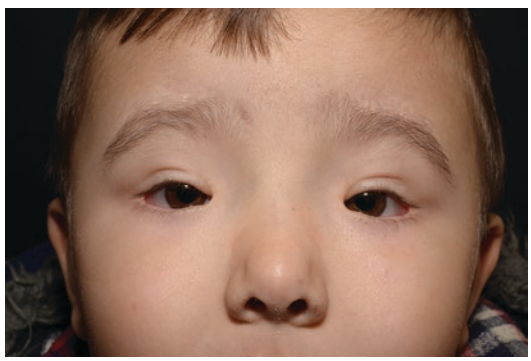

Fig. 3.26 Facial photo of a patient with BPES

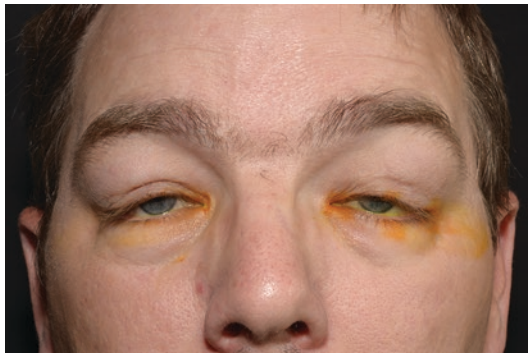

Fig. 3.27 Facial photo of a patient with oculopharyngeal dystrophy

- Myotonic dystrophy:
  - Autosomal dominant inheritance
  - Slowly progressive bilateral mild or moderate ptosis
  - Failure of muscles to relax after a sustained contraction
  - Facial and peripheral skeletal muscle weakness
  - Associated abnormalities in other organ systems (frontal balding, christmas tree cataract, testicular atrophy, weak cognitive function)
- Chronic Progressive External Ophthalmoplegia (CPEO):
  - Mitochondrial inheritance
  - Bilateral symmetrical ptosis with poor levator function
  - Facial weakness
  - An extreme loss of ocular motility (often to the point of no movement — frozen globe) with no diplopia
  - Pupils are spared
  - Kearns-Sayre syndrome: CPEO, heart block, pigmentary retinopathy
- Post-traumatic (damage to levator muscle)

  Post traumatic (damage to levator aponeurosis):
- Lid swelling
- Blepharochalasis:
  - Recurrent bouts of idiopathic lid swelling with secondary dermatochalasis

  Pseudoptosis (MRD1 and levator function are normal):
- Hemifacial spasm
- CN VII palsy with aberrant regeneration
- Contralateral lid retraction

3.16.2 History

- Adult patients
  - Questions to help identify type of ptosis:

    Is the diagnosis involutional ptosis?
    - Indefinite onset
    - Gradual progression
    - No other associated eye or systemic problems
    - Ptosis usually about the same severity throughout the day

    Is the ptosis acquired or has it been present since birth? When was the onset? What is the rate of progression?
    - Most adults will have an acquired form of ptosis, usually the common involutional type. The onset is difficult to identify, as the progression is usually so gradual over several years that no particular time is clearly identified as the onset. An acute onset suggests a diagnosis other than involutional ptosis — an exception to this is the onset of involutional ptosis after cataract surgery
    - Occasionally an adult will have pre-existing congenital ptosis that has slowly gotten worse over time or may have asymmetric congenital ptosis that can no longer be ignored because the "normal" side has progressively drooped more — physical exam will confirm the reduced levator function of congenital ptosis
  - Questions to identify factors that may modify the treatment plan:

    Is there a history of previous ptosis operations?
    - History of previous lid operations may be a warning sign that the

levator aponeurosis has already been shortened so that further tightening may cause lagophthalmos

Does the patient have symptoms of "dry" eye?

Is there a history of facial nerve palsy?

- A history of CN VII palsy signals the potential for poor blinking and lagophthalmos after surgery

– Questions to help identify an "unusual" type of adult ptosis:

Positive family history

Associated diplopia

Variation in degree of ptosis: minute to minute, with eye movements, better after naps

Associated facial movement problems: history of facial nerve palsy, history of facial spasms

- Paediatric patients
  – Questions to help identify type of ptosis:

Is the diagnosis simple congenital ptosis?

- Simple congenital ptosis involves only a ptotic upper eyelid in an otherwise healthy child with no abnormal eye finding

Is the ptosis congenital?

- When a ptosis is seen in a child, it is almost always congenital. Any onset after birth suggests a different diagnosis

Is the ptosis unilateral or bilateral?

- Congenital ptosis is usually bilateral, but often asymmetric

Does the lid change position? Is the lid ever open all the way?

- Wide variations in the day are not typical of simple congenital ptosis

Does the lid position change with chewing or sucking?

- Variation of lid position from movement to movement suggests a synkinetic form of ptosis.
- Ptosis associated with abnormal lid movements caused by chewing, sucking, or other changes in jaw position is known as Marcus-Gunn jaw winking
- Ptosis associated with abnormal lid movements caused by changes in eye position is seen in CN III palsy with aberrant regeneration

Is there a family history of ptosis?

- Strict inheritance of simple congenital ptosis is rare
- A positive family history (autosomal dominant inheritance) may suggest the presence of blepharophimosis syndrome
- Congenital ptosis is not commonly associated with any ocular or systemic abnormalities. Dystophy of the levator muscle is the only abnormality present

– Questions to identify factors that may modify the treatment plan:

Is the eyelid open above the pupil? During which part of the day? (how many times is the eyelid above the pupil?): assess risk of amblyopia

Surgical repair of a simple congenital ptosis is usually done before the child starts school (age 4). Features in the history suggesting the possibility of amblyopia should alter the timing of treatment

History of previous ptosis surgery:

- Previous ptosis repair, especially levator aponeurosis advancement procedures, puts the patient at risk for corneal exposure after more advancement

– Questions to help identify an "unusual" type of congenital ptosis:

Associated strabismus

Family history: blepharophimosis syndrome

Developmental delay: many syndromes associated with ptosis

Extreme variation of ptosis from minute to minute or throughout the day: lid movement associated with chewing or sucking, lid movement associated with eye movements

3.16.3 Examination

- Adult patients
  - Measure eyelid vital signs:
    Palpebral aperture (PA): measure from upper lid margin to lower lid margin in mm (normal 9–10 mm). For the PA measurement to be meaningful in describing the upper lid position, the lower lid must be in the normal position
    Marginal reflex distance 1 (MRD1): distance of upper lid margin from the corneal light reflex (normal 4–5 mm), measures degree of ptosis, with patient at your eye level, ask him/her to look straight ahead at a distance target, shine the penlight at the patient's eye
    Marginal reflex distance 2 (MRD2): distance of lower lid margin from the corneal light reflex
    Levator function (LF): block action of the brow with your thumb and don't allow the head to tip up with eye elevation
    Skin crease height: distance from upper lid margin to the skin crease (normal 8–10 mm in women and 6–8 mm in men)
  - Does the patient have normal facial expression?
    Weakness of the facial muscles is associated with the myogenic types of unusual ptosis
    Is there hyperkinetic movement of the face suggesting hemifacial spasm or aberrant regeneration of the facial nerve?
  - Measure the motility:
    Eye movements should be normal for the patients age in involutional ptosis
    Any reduction in motility or symptoms of diplopia suggest a diagnosis of other than involutional ptosis (MG, CN III palsy, CPEO)
    Any bizarre association of the upper eyelid position (ptosis or lid retraction) with eye movements should suggest aberrant regeneration of the third nerve
  - Is the pupil normal? Are there signs of Horner's syndrome? Do you see any miosis or lower eyelid elevation to suggest that a loss of sympathetic tone is responsible for the patient's mild ptosis (Horner's syndrome — upper lid ptosis, lower lid elevation, miosis, and anhidrosis of the ipsilateral side of the face)
  - Look for risk factors that increase the chance of post-operative corneal exposure:
    Bell's phenomenon — a poor Bell's phenomenon is only a relative contraindication for ptosis repair
    Look for lagophthalmos — possibly from previous ptosis surgery, look for lower eyelid retraction from any cause,
    Slit lamp examination to evaluate the tear film and if minimal do a Schirmer's test — if corneal exposure is present preoperatively it will be worse after elevating the lid, use the maximal treatment of any corneal exposure before proceeding with ptosis repair — consider the use of punctal plugs
- Paediatric patients
  - Measure eyelid vital signs:
    Palpebral aperture (PA): measure from upper lid margin to lower lid margin in mm (normal 9–10 mm). For the PA measurement to be meaningful in describing the upper lid position, the lower lid must be in the normal position
    Marginal reflex distance 1 (MRD1): distance of upper lid margin from the corneal light reflex (normal 4–5 mm), measures degree of ptosis, with patient at your eye level, ask him/her to look straight ahead at a distance target, shine the penlight at the patient's eye
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    Levator function (LF): block action of the brow with your thumb and don't allow the head to tip up with eye elevation
    Skin crease height: distance from upper lid margin to the skin crease (normal 8–10 mm in women and 6–8 mm in men)

- Measure VA:
  - Fixation should be steady and maintained
  - Check for amblyopia: if amblyopia, due to deprivation or astigmatism, is present, consider earlier surgery to correct ptosis
- External appearance of child:
  - Appearance should be normal for simple congenital ptosis
  - Most common abnormal facies are seen in blepharophimosis syndrome
  - Many other syndromes can have ptosis as one of the associated findings
- Measure the motility:
  - Normal motility is associated with simple congenital ptosis
  - Most common motility disturbance seen in children with ptosis is a localised weakness of the superior rectus muscle (occurs in 5% of patients born with ptosis)
  - Any bizarre movement of the upper lid associated with eye movement should suggest aberrant regeneration of CN III
- Ask the child to open and close the mouth and move the jaw around:
  - No movement of the eyelid should occur with simple congenital ptosis
  - Any lid movement will diagnose a Marcus Gunn jaw winking ptosis
- Look for risk factors that increase the chance of corneal exposure (rare in children): facial nerve palsy, poor Bell's phenomenon, lagophthalmos (previous ptosis surgery), poor tear film, corneal exposure

3.16.4 Investigations

- Bloods: anti-Ach receptor/muscle-specific receptor tyrosine kinase (MuSK) antibodies if myasthenia gravis suspected
- Genetic testing: oculopharyngeal dystrophy, myotonic dystrophy
- CT angiography: indicated if partial CN III palsy (rule out a posterior communicating artery aneurysm) or a painful Horner's syndrome (rule out ICA dissection) is identified
- Skeletal muscle biopsy: look for red ragged fibers in CPEO

3.16.5 Treatment

- Adult patients
  - Indications for surgical correction of eyelid ptosis:
    - Symptoms: decreased central or peripheral vision, heaviness of the lids, brow ache or headache, difficulty reading, and neck ache (from chronic lifting of the chin)
    - Examination findings: elevated or arched eyebrows, prominent forehead furrows, and a chin up position
  - Preoperative considerations:
    - Stop aspirin or clopidogrel (7–10 days before operation), NSAIDS (24–72 h before operation), warfarin (5 days before operation), rivaroxaban (at least 24 h before operation), apixaban (at least 48 h before operation)
  - Choice of surgical procedure:
    - For simple congenital ptosis with levator function greater than 4 mm, a levator aponeurosis advancement is the correct treatment
    - For simple congenital ptosis with levator function less than 3 mm, a frontalis sling is appropriate
    - For simple ptosis with levator function between 3 and 4 mm, a generous advancement is usual, with the resection extending high above Whitnall's ligament into the muscle itself
    - For involutional ptosis with a normal levator function, a levator aponeurosis advancement is the procedure of choice
    - Decide if additional procedures such as a blepharoplasty or browplasty are necessary. Older patients often have dermatochalasis and brow ptosis accompanying involutional ptosis
- Paediatric patients

Table 3.15 Levator advancement procedure

- Procedure of choice for adults with involutional ptosis
- Tightening the levator muscle doesn't improve the levator function or movement of the eyelid; it essentially only resets the lid height
- Operation most easily done using a local anaesthetic under the skin (allows operation on aponeurosis but does not paralyse the deeper levator muscle — makes intraoperative adjustment of lid height and contour possible)
- Operation includes:
  - Patient preparation: mark upper lid skin crease, inject local anaesthetic with epinephrine
  - Skin incision: open orbicularis muscle
  - Identification of the levator aponeurosis: dissect orbicularis off orbital septum, open septum, dissect septum off preaponeurotic fat, dissect preaponeurotic fat off aponeurosis
  - Dissection of the levator aponeurosis off Muller's muscle: disinsert levator aponeurosis from anterior surface of tarsus, dissect aponeurosis free from Muller's muscle
  - Levator aponeurosis advancement
  - Intraoperative adjustment to height and contour: aim for 1 mm overcorrection
  - Closure: reform skin crease, running suture to close skin)

Table 3.16 Frontalis sling procedure

- Procedure of choice for any type of ptosis with poor levator function
- Eyelid is surgically "connected" to the brow with the action of the frontalis muscle lifting the upper eyelid
- Operation includes:
  - Patient preparation
  - Skin incisions
  - Suturing of the fascia to tarsus
  - Passing the fascia to the brow
  - Skin crease closure
  - Adjustment of height and contour
  - Closure of forehead incisions

  - Indications for surgical correction of eyelid ptosis:
  - Choice of surgical procedure:
    Ptosis with poor levator function (1–3 mm) requires a frontalis sling operation
    Ptosis with medium to good levator function (>4 mm: lowest amount of levator function that will allow eyelid to lift without creating corneal exposure) can be corrected with a levator aponeurosis advancement operation (Tables 3.15 and 3.16)

3.17 Approach to the Patient with Vertical Diplopia

3.17.1 Diagnoses to Consider for Monocular Vertical Diplopia

- Tear film abnormalities
- Uncorrected refractive error
- Corneal irregularity (e.g. keratoconus, refraction surgery) or scar
- Cataract
- Polycoria
- Dislocated lens
- Macular distortion (e.g. ERM)
- Non-organic

3.17.2 Diagnoses to Consider for Binocular Vertical Diplopia

- Neurogenic:
  - CN III palsy
  - CN IV palsy
- Mechanical:
  - TED
  - Myasthenia gravis
  - Orbital floor fracture
  - Congenital and acquired Brown's syndrome
  - Orbital inflammatory disease (myositis)
- Other:
  - Skew deviation
  - Ocular surgery, e.g. scleral buckling surgery
  - Decompensated hyperphoria
  - Superior oblique myokymia

3.17.3 History

- "Does the double vision resolve when either eye is covered?": In binocular diplopia, one of the images disappear when one eye is covered. In contrast, monocular diplopia ceases when covering the affected eye but persists when occluding the unaffected eye

- Patients with binocular diplopia should be asked the following questions:
  - "Is the double vision intermittent, constant, or variable?"
    Double vision that is worse in the mornings may suggest TED
    Double vision that is worse in the evenings or with fatigue could indicate myasthenia gravis or a decompensated phoria
  - "Does the double vision depend upon direction of gaze (left, down, distance, near)?"
  - Ask for old photographs to look for an anomalous head posture: suggests a chronic ocular misalignment
  - If patient 50 years or older, ask about headaches, jaw claudication, scalp tenderness and weight loss to rule out giant cell arteritis (GCA)
  - Ask about dysphagia, dyspnea, dysarthria, or proximal muscle weakness: suggests myasthenia gravis
  - Ask about oscillopsia: suggests a nystagmus or superior oblique myokymia
  - Ask about eyelid malpositions (retraction or ptosis): suggests myasthenia gravis, CN III palsy, or TED
  - Past medical and ocular history should include the following questions:
    Head or ocular trauma
    Thyroid disease
    Vasculopathic risk factors
    Childhood strabismus or amblyopia
    Previous eye muscle surgery

3.17.4 Examination

- Monocular vertical diplopia:
  - Examine anterior segment for any tear film abnormalities (early tear-film break up time, abnormal Schirmer test), areas of corneal thinning or cataract
  - Examine posterior segment for macular pathologies such as an ERM
  - Full ocular motility
- Binocular vertical diplopia:
  - Examine for an abnormal head posture: head tilt (e.g. CN IV palsy), chin-up position (e.g. TED)
  - Examine eyelid position
  - Perform exophthalmometry
  - Examine pupils
  - Examine ocular motility:
    Examine pursuits and saccades of the eyes individually (ductions) and together (versions):
    - Ophthalmoplegia secondary to a myopathy, neuropathy, or neuromuscular junction disorder reveals slowed saccades ± abnormal pursuits
    - Restrictive ophthalmoplegia demonstrates normal saccadic velocity

    Ocular alignment should be evaluated in primary position, upgaze, downgaze, and horizontal gaze positions, including distance and near:
- Cover-uncover test: distinguish phorias from tropias
- Alternate cover test: reveals full deviation of tropia plus latent phoria

3.17.5 Investigations

- Monocular vertical diplopia:
  - Refraction: reveal any unidentified or irregular astigmatism from corneal or lenticular causes
  - Corneal topography: detect an irregular corneal surface or contour
  - OCT: detect macular pathology
- Binocular vertical diplopia:
  - Bloods tests: anti-Ach receptor/ MuSK antibodies (myasthenia gravis), TSH/T3/T4 levels (TED), glucose levels (vasculopathic CN palsies), FBC/CRP/ESR (if patient 50 years or older to rule out GCA)
  - Blood pressure: vasculopathic CN palsies
  - ICE pack test/Tensilon test: myasthenia gravis
  - Repetitive stimulation electromyography (EMG): myasthenia gravis
  - Hess chart: for incomitant strabismus

  - CT scan: if orbital fracture is suspected, sight threatening TED is suspected, partial CN III palsy (rule out a posterior communicating artery aneurysm) is identified or multiple cranial nerves are involved
  - Forced duction testing: verify a restrictive process

3.17.6 Restriction of Extraocular Motility in Orbital Fractures

3.17.6.1 Differential Diagnosis of Enophthalmos

- Bony defects: orbital fractures, congenital orbital wall defects
- Small globe: microphthalmos, nanophthalmos, phthisis bulbi, orbital implant
- Soft tissue atrophy: post-irradiation, scleroderma, cicatrizing tumours

3.17.6.2 Classification of Blow Out Fractures

- Orbital rim remains intact: fracture affects the floor (antral blowout), medial wall (ethmoidal blow out), combined antral and ethmoidal blow out
- Orbital rim fractured in addition to an antral, ethmoidal, or combined blow out

3.17.6.3 Classification of Orbital Floor Blow Out Fractures

- Type I: limited elevation of affected eye from mechanical restriction
- Type II: limited depression of affected eye from IR muscle palsy
- Type III: combined limited elevation and depression from mechanical restriction and IR muscle palsy, respectively

3.17.6.4 Examination

- Orbital floor fracture: vertical diplopia with limitation of both upgaze and downgaze (upgaze is commonly more affected than downgaze resulting in downward displacement of the small field of BSV)
- Type I orbital floor blow out fracture:
  - Limitation of ocular movement on up gaze
  - Positive FDT for mechanical restriction with the greatest limitation in elevation and abduction
  - Field of BSV is reduced in upgaze
- Type II orbital floor blow out fracture:
  - Limitation of ocular movement on down-gaze
  - Negative FDT for mechanical restriction on depression
- Type III orbital floor blow out fracture:
  - Limitation of ocular movement on up-gaze with positive FDT for mechanical restriction, with the greatest restriction in elevation and abduction
  - Limitation of ocular movement on downgaze with negative FDT for mechanical restriction on depression
  - Patient often has small central island of BSV, but is considerably handicapped by diplopia on downgaze
- Medial wall fracture (most often seen in association with a blowout fracture of the orbital floor): horizontal diplopia with restriction of abduction (mechanical restriction) and adduction (either mechanical restriction or to a neurogenic palsy of the MR)
- Backwards (enophthalmos) ± downward displacement (herniation of fat from the inferior part of the orbit into the antrum) of the globe
- Retraction of the globe (on elevation in a floor blow out fracture and on abduction in medial wall blow out fracture): occurs when the eye moves away from the site of entrapment
- Infraorbital anaesthesia (damage to infraorbital nerve): loss of sensation to ipsilateral cheek and upper teeth
- >5 mm difference in IOP in primary position and in position of gaze in which movement is restricted

3.17.6.5 Investigations

- CT scan: tear drop sign (small clump of soft tissue lying outside the orbit), missing rectus sign (absence of IR above orbital floor), muscle rounding sign (rounding of IR muscle)
- Hess chart: mechanical restriction
- Field of binocular single vision (BSV)
- Forced duction testing (FDT)

3.17.6.6 Treatment

- Advise patients to refrain from nose blowing
- Antibiotic prophylaxis
- Type I orbital floor blow out fracture:
  - Conservative treatment: prisms, occlusion
  - Surgical treatment (avoid if it puts the field of BSV in the primary position and down-gaze at risk): recession of contralateral IO muscle ± contralateral SR muscle
- Type II orbital floor blow out fracture:
  - Conservative treatment (continued for at least 9–12 months from the time of injury to allow spontaneous recovery of IR muscle function): prisms, occlusion
  - Surgical treatment: recession of contralateral SR ± inverse Knapp procedure
- Type III orbital floor blow out fracture:
  - Conservative treatment: occlusion
  - Surgical treatment: IR and SR recessions of the unaffected eye
- Medial wall blow-out fracture:
  - Conservative (continued for at least 9–12 months from the time of injury to allow spontaneous recovery of IR muscle function): prisms, occlusion
  - Surgical treatment: limitation of adduction due to MR muscle palsy is corrected by an ipsilateral MR resection/LR recession if palsy is partial and by a transposition of the SR and IR to the MR + LR weakening by Botox if palsy is complete

3.17.6.7 Indications for Surgical Intervention in Orbital Floor Fractures

- Immediate:
  - Persistent oculocardiac reflex
  - Young patient with "white eyed" trapdoor fracture
  - Significant facial asymmetry
- Early (<2 weeks):
  - Persistent symptomatic diplopia (diplopia within 30° of fixation)
  - Significant enophthalmos (>2 mm)
  - Hypoglobus
  - Progressive infraorbital anesthesia
  - Fracture involving >50% of the orbital floor
- Observation:
  - Minimal diplopia (e.g. just in upgaze)
  - Minimal restriction
  - Minimal enophthalmos

3.17.7 Restriction of Extraocular Motility in TED

3.17.7.1 Examination

See Sect. 3.15.4.2.

3.17.7.2 Investigation

See Sect. 3.15.4.2.

3.17.7.3 Treatment

- Conservative:
  (a) Treatment of diplopia: prisms, Botox, occlusion (last resort)
- Surgical:
  (a) Aims of extraocular muscle surgery are to improve the patient's appearance and to establish a field of binocular single vision in the primary position and on down-gaze, extending the area into other fields of gaze if possible
  (b) Patient should be euthyroid and the ocular muscle imbalance should have remained stable for at least 3 months before considering surgery
  (c) Categorise the ocular motility disturbances into recognisable patterns:
    1. Unilateral or grossly asymmetrical bilateral restriction of elevation
       - Incomitant (increase in vertical deviation on upgaze and a reduction on downgaze, usually with an intact inferior field of BSV): mechanical restriction of ipsilateral IR — treat with ipsilateral IR recession
       - Concomitant (vertical deviation that is the same on upgaze and which decreases minimally or not at all on downgaze, usually with no field of BSV): mechanical restriction of ipsilateral IR + contralateral SR — treat with IR recession ± SR recession

2. Unilateral or grossly asymmetric bilateral restriction of abduction
   - Incomitant (ET which increases in the direction of mechanical restriction and reduces in the opposite field of gaze + face turn away from the side with the mechanical restriction + intact field of BSV): mechanical restriction of ipsilateral MR — treat with ipsilateral MR recession
   - Concomitant (ET in all positions of gaze): bilateral mechanical restriction of both MR — treat with unilateral or bilateral MR recession
3. Unilateral or grossly asymmetric bilateral restriction of both elevation and abduction: management is the same as for pattern (1) and (2)
4. Bilateral symmetric restriction of elevation
   - Neither eye is able to maintain fixation in primary position
   - Asymmetrical mechanical restriction of elevation, with a − 2 to −3 restriction in the more mobile eye
   - A pattern ET is present on upgaze, with a convergence retraction movement as the eyes attempt to move into the field of maximum restriction
   - Contraction of the SR, if present, will restrict movement on down-gaze
   - Treat with bilateral IR recession
5. Bilateral restriction of both elevation and abduction
6. Mechanical restriction of the superior rectus muscles resulting in limited down-gaze
   - Limitation of depression that is greatest in abduction
   - Treat with SR recession

3.18 Angle Closure (Table 3.17)

3.18.1 Risk Factors for Angle Closure

- Inuit/South East Asians/Chinese
- Hyperopia with short axial length

Table 3.17 Angle closure terminology

- Angle closure is characterised by apposition of the peripheral iris against the trabecular meshwork, resulting in obstruction of aqueous outflow
- Primary angle closure suspect (PACS)/Occludable angle: ≥2 quadrants (180°) of iridotrabecular contact (ITC), normal IOP, no PAS, normal optic nerve (ZAP trial - see Table 3.20)
- Primary angle closure (PAC): ≥2 quadrants (180°) of ITC, raised IOP (>21 mmHg) and/or PAS, normal optic nerve (EAGLE study - see Table 3.19) — 30% in 5 years develop PACG
- Primary angle-closure glaucoma (PACG): PAC with disc or reproducible field defects consistent with glaucoma (EAGLE - see Table 3.19)

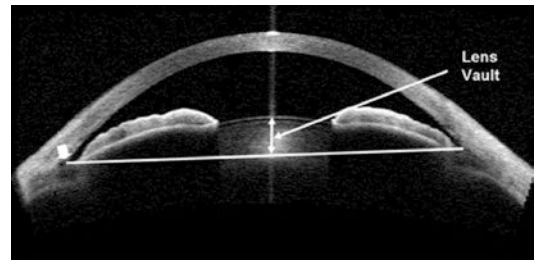

Fig. 3.28 Anterior lens vault

- Older age: reduced depth and volume of the AC
- Anterior lens vault (see Fig. 3.28): perpendicular distance between the anterior pole of the lens and the horizontal line joining the two scleral spurs on horizontal anterior segment OCT — eyes with angle closure have greater lens vault compared with normal eyes

3.18.2 Mechanisms of Angle Closure

- Pupil-block (most common mechanism): strong apposition of iris sphincter to anterior lens capsule (mid-dilated pupil), increased fluid pressure in PC causes a forward shift of the iris, anterior movement of iris results in closure of AC angle
  - Acute angle closure ± glaucoma
  - Sub-acute angle closure ± glaucoma: symptoms intermittent (colour halos around lights from corneal epithelial oedema — blue-green central halo and yellow-red peripheral halo) or absent

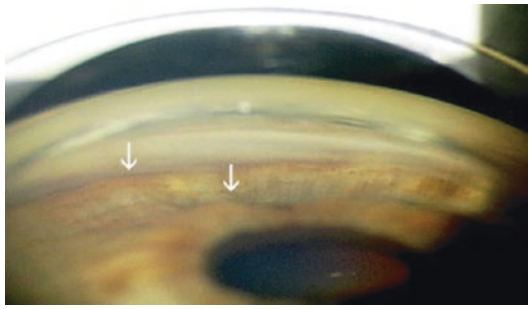

Fig. 3.29 Gonioscopic view of a patient with a plateau iris configuration showing the double hump sign (white arrows) on indentation gonioscopy

  - Chronic angle closure ± glaucoma: IOP chronically elevated with varying degree of PAS (usually broad based and starts in the superior quadrant — narrowest)
  - Combined mechanisms glaucoma: angle initially closed, PI performed, angle open but IOP remains high
- Plateau iris:
  - Plateau iris configuration (see Fig. 3.29): pre-iridotomy anatomic appearance, anterior position of ciliary body and processes, flat iris plane, closed AC angle, normal central AC depth, gonioscopy (double-hump sign on indentation gonioscopy — central iris moves posteriorly, peripheral hump created from anterior ciliary body pushing iris root forward, central hump created by iris sitting on anterior lens capsule)
  - Plateau iris syndrome: angle closure in eye with plateau iris configuration despite presence of a patent PI
  - Secondary angle closure

3.18.3 History

- Ask about risk factors for angle closure (see Sect. 3.18.1)

3.18.4 Examination

- Bilateral (PAC) or unilateral (secondary angle closure, e.g. phacomorphic) shallow peripheral AC: Van Herick's method — direct a narrow-slit beam at 60° onto the cornea just anterior to the limbus, AC considered narrow if distance between the anterior iris and posterior cornea is <1/4 of the corneal thickness
- Normal Central AC depth
- Fixed semi-dilated pupil with diffuse iris atrophy/transillumination defects: suggestive of previous acute angle closure attack
- Glaucomflecken: small anterior subcapsular opacities (lens epithelial necrosis) suggestive of previous acute angle closure attack
- Check IOP
- Perform gonioscopy: open or closed angle, PAS
- Examine the optic disc for signs of glaucoma:
  - Generalised signs: CDR 0.7 or more, asymmetry of CDR of 0.2 or more, progressive enlargement of cup
  - Focal signs: rim thinning/notching (ISNT rule), regional pallor, NFL haemorrhage, NFL loss

3.18.5 Investigations

- HVF: early: paracentral defect, nasal step (IT or ST rim thinning), temporal wedge (nasal disc thinning) / late: arcuate defect, double arcuate defect, central vision only

3.18.6 Treatment

- If IOP raised:
  - Immediate IOP reduction with IV acetazolamide (Diamox), topical β blockers, PGAs, α2 agonists ± IV mannitol
  - Instillation of miotic once IOP reduced to break the pupil block
- PACS: prophylactic Yag PI's (see Table 3.18)
- PAC: Yag PI (see Table 3.18), lens extraction ± goniosynechialysis, trabeculectomy
- PACG: Yag PI (see Table 3.18), lens extraction ± goniosynechialysis, trabeculectomy
- Plateau iris syndrome: iridoplasty, lens extraction

Table 3.18 Yag PI procedure

- Indications: therapeutic — angle closure with pupil block, prophylactic — PACS, fellow eye in AACG (approximately 50–75% of patients who develop acute angle closure in one eye will have an attack in the fellow, unoperated eye within 5–10 years)
- Consent: risks — bleeding, inflammation, pressure spike, monocular diplopia, failure/need for retreatment, corneal burns (if shallow AC)
- Pre-procedure: instill topical pilocarpine 2% (tightens the iris), topical Iopidine 1% (prevents IOP spike + reduce bleeding), topical anaesthetic, set up laser — two to three pulses of 3–6 mJ, angle the beam (beam should not be perpendicular), position the Abraham CL
- During procedure: identify suitable iridotomy site — superior (hidden by normal lid position), peripheral, and ideally in an iris crypt, focus and fire laser — success indicated by a forward gush of pigment loaded aqueous
- Post-procedure: check IOP at 30–60 min post PI, topical steroid, follow-up in outpatient's clinic in 2 weeks

3.18.7 Other Diagnoses to Consider

- Trauma (surgical or non-surgical): sectoral iris atrophy/transillumination defects, mydriasis

3.18.8 Management of Acute Angle Closure (AAC) Attack

- Lowering of IOP in affected eye:
  - Systemic: IV acetazolamide (Diamox) 500 mg STAT (then 250 mg PO QDS)
  - Topical:
    - β-blocker
    - α2 adrenergic agonists
    - Prostaglandin analogues
    - Topical steroids
  - Check IOP hourly until adequate control
  - If IOP not responding to above treatments: admit patient, systemic mannitol 20% IV 1 g/kg
  - If IOP still not responding: acute YAG PI (if corneal oedema not obscuring view)
  - If IOP still not responding: review diagnosis (? malignant glaucoma) ± repeat YAG PI ± AC paracentesis ± cyclodiode ± surgical PI ± laser iridoplasty ± emergency cataract extraction
- Break the pupillary block and open the AC angle in affected eye (once IOP reduced):
  - Pilocarpine 2%
  - Yag PI
- Prevention of AAC attack in contralateral non-affected eye (50% to 75% of patients who develop acute angle closure in one eye will have an attack in the fellow eye):
  - Pilocarpine 2% followed by Yag PI

3.19 Normal Tension Glaucoma (NTG) (Table 3.21)

3.19.1 History

- History of Raynaud's disease
- History of migraines

3.19.2 Examination

- Check VA, colour vision, RAPD
- Check IOP: <21 mmHg
- Perform gonioscopy: open angle
- Examine the optic nerve for signs of glaucoma:
  - Generalised signs: CDR 0.7 or more, asymmetry of CDR of 0.2 or more, progressive enlargement of cup
  - Focal signs: rim thinning/notching (ISNT rule), regional pallor, NFL haemorrhage, NFL loss

3.19.3 Investigations

- HVF: early: paracentral defect, nasal step (IT or ST rim thinning), temporal wedge (nasal disc thinning) / late: arcuate defect, double arcuate defect, central vision only
- Phasing: look for IOP spikes (diurnal fluctuations in IOP)

Table 3.19 Summary of the effectiveness of early lens extraction for the treatment of primary angle-closure glaucoma (EAGLE) study (Azuara-Blanco et al. 2016)

- Primary outcome: a multicentre RCT to assess the efficacy, safety, and cost-effectiveness of clear-lens extraction (CLE) compared with standard care (SC) with laser PI plus topical medications as first line treatment in people with newly diagnosed PACG or PAC with IOP ≥30 mmHg
- Methods:
  - Inclusion criteria: phakic, age ≥50, newly diagnosed PAC with IOP ≥30 mmHg or PACG
  - Exclusion criteria: symptomatic cataract, advanced glaucoma (MD >−15 dB or CDR ≥0.9), previous AAC attack or who has undergone previous laser or ocular surgery
  - Groups: SC group — PI, laser trabeculoplasty if angle closure persisted, escalation of medical treatment, trabeculectomy / CLE group — phaco + IOL, escalation of medical treatment, trabeculectomy (target IOP 15–20 mmHg for both groups)
  - Primary endpoints: European QOL 5-dimension (EQ5D) questionnaire, IOP, incremental cost-effectiveness ratio (ICER — cost to NHS/QALY)
  - Secondary endpoints: trabeculectomy rate. Field loss
  - Follow up: 3 years
- Results: 419 patients
  - Primary endpoints: EQ-5D questionnaire scores and IOP (16.6 CLE vs 17.9 SC) at 36 months was statistically significantly better in the CLE group, at 3 years 61% of the CLE group and 21% of the SC group were on no glaucoma medications and the mean number of drops was 0.4 in the CLE group and 1.3 in the SC group
  - Secondary endpoints: VF severity at 3 years was similar in the two treatment groups, there was six trabeculectomies in the SC group but only one in the CLE group
  - Safety/complications: 3% (6 patients with one having irreversible loss of two lines) had intraoperative complications from the CLE group, 8% (16 patients) had minor bleeding from PI
- Conclusion of study: In the context of newly diagnosed PAC with IOP ≥30 mmHg or PACG with no visually significant cataract, CLE results in greater overall QOL, lower IOP, and fewer drops when compared to standard care (PI and topical medications). Immediate CLE would seem likely to be cost effective, particularly in the longer term

Table 3.20 Summary of the Zhongshan Angle Closure Prevention (ZAP) trial (He et al. 2019)

- Primary outcome: Assess the efficacy of laser PI in preventing the development of primary angle-closure or acute angle closure in Chinese people with primary angle closure suspects (PACS)
- Methods:
  - Inclusion criteria: age 50–70 years old; bilateral PACS (defined as six or more clock hours of angle circumference in which the posterior trabecular meshwork was not visible under non-indentation gonioscopy) in the absence of primary angle-closure or primary angle-closure glaucoma; IOP 21 mmHg or less; vertical CDR less than 0.7; cup to disc asymmetry was no greater than 0.2; borderline or normal glaucoma hemifield test
  - Exclusion criteria: PAS observed on gonioscopy; severe health problems resulting in life expectancy of less than 1 year; previous intraocular surgery or penetrating eye injury; media opacity preventing laser PI; BCVA worse than 20/40; IOP greater than 15 mmHg after dilation or after a 15-min dark room prone provocative testing
  - Groups: Laser PI in one randomly selected eye, with the contralateral eye serving as an untreated control
  - Primary endpoint: Incidence of primary angle closure (IOP above 24 mmHg on two separate occasions, development of at least 1 clock hour of PAS in any quadrant, or an episode of acute angle closure) by eyes by 72 months
  - Secondary endpoint: presenting VA, IOP, total angle width on gonioscopy, limbal AC depth, adverse events during laser PI or at any follow up visits
  - Follow up: 72 months
- Results: 889 patients
  - Primary endpoint: incidence of PAC in 4.19 per 1000 eye-years in treated eyes compared with 7.97 per 1000 eye-years in untreated eyes ($p = 0.024$). Eyes that underwent laser PI had a 47% reduction in the risk of developing PAC or an acute attack compared to untreated eyes. One in 20 untreated eyes developed PAC at 72 months. NNT was 44 to prevent one case of new PAC disease over 72 months. Rate of developing any angle closure endpoint in PACS eyes was less than 1% per year.
  - Secondary endpoint: similar presenting VA and IOP measurements between the two arms; laser PI itself was safe and no long-term adverse events were identified; angles were significantly larger after laser PI than in untreated eyes
- Conclusions of study: Benefit of prophylactic laser PI is limited; therefore, widespread prophylactic laser PI for PACS is not recommended

Table 3.21 Definition of NTG

• Open normal appearing angles who have glaucomatous optic nerve head and VF damage despite pressures that have never been documented above 21 mmHg

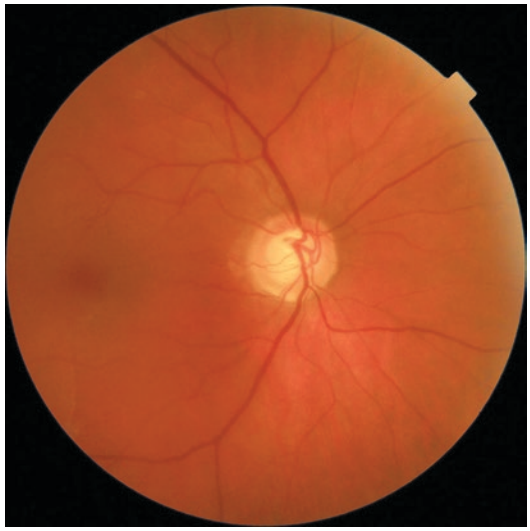

Fig. 3.30 Colour fundus image of a patient with NTG showing increased optic disc cupping and prominent inferior notching with loss of normal sheen of NFL radiating temporally from notch

- 24-hour BP monitoring: nocturnal hypotension
- Ensure correlation between optic nerve head findings and VF defects (see Figs. 3.30 and 3.31)
- Neuro-imaging (see Table 3.22 for indications)

3.19.4 Treatment

- Reduce IOP by 30% (see Table 3.23): medical treatment initially and surgical treatment (laser trabeculoplasty, trabeculectomy, GDI) after failure of maximal tolerated medical therapy (MTMT)
- Avoid drug induced nocturnal systemic hypotension: liaise with GP/physicians

3.19.5 Risk Factors for Progression of NTG

- Female sex
- History of migraines
- Disc haemorrhages at diagnosis

3.19.6 Other Diagnoses to Consider

- POAG
- Secondary open angle glaucomas: steroid induced, PDS, PXF
- PACG
- Ischaemic optic neuropathy
- Compressive lesions of the optic nerve and tract
- Optic neuritis
- Trauma

3.20 Chronic Open Angle Glaucoma (COAG) (Table 3.24)

3.20.1 Risk Factors for COAG

- Age
- African-Caribbean: more frequent, younger onset, more severe
- Positive Family History
- High myopia: scleral canal morphology making disc more vulnerable
- Raised IOP

3.20.2 History

- Ask about family history of glaucoma

3.20.3 Examination

- NICE Guidance [NG81]:
  - IOP measurement using Goldmann applanation tonometry (slit-lamp mounted)

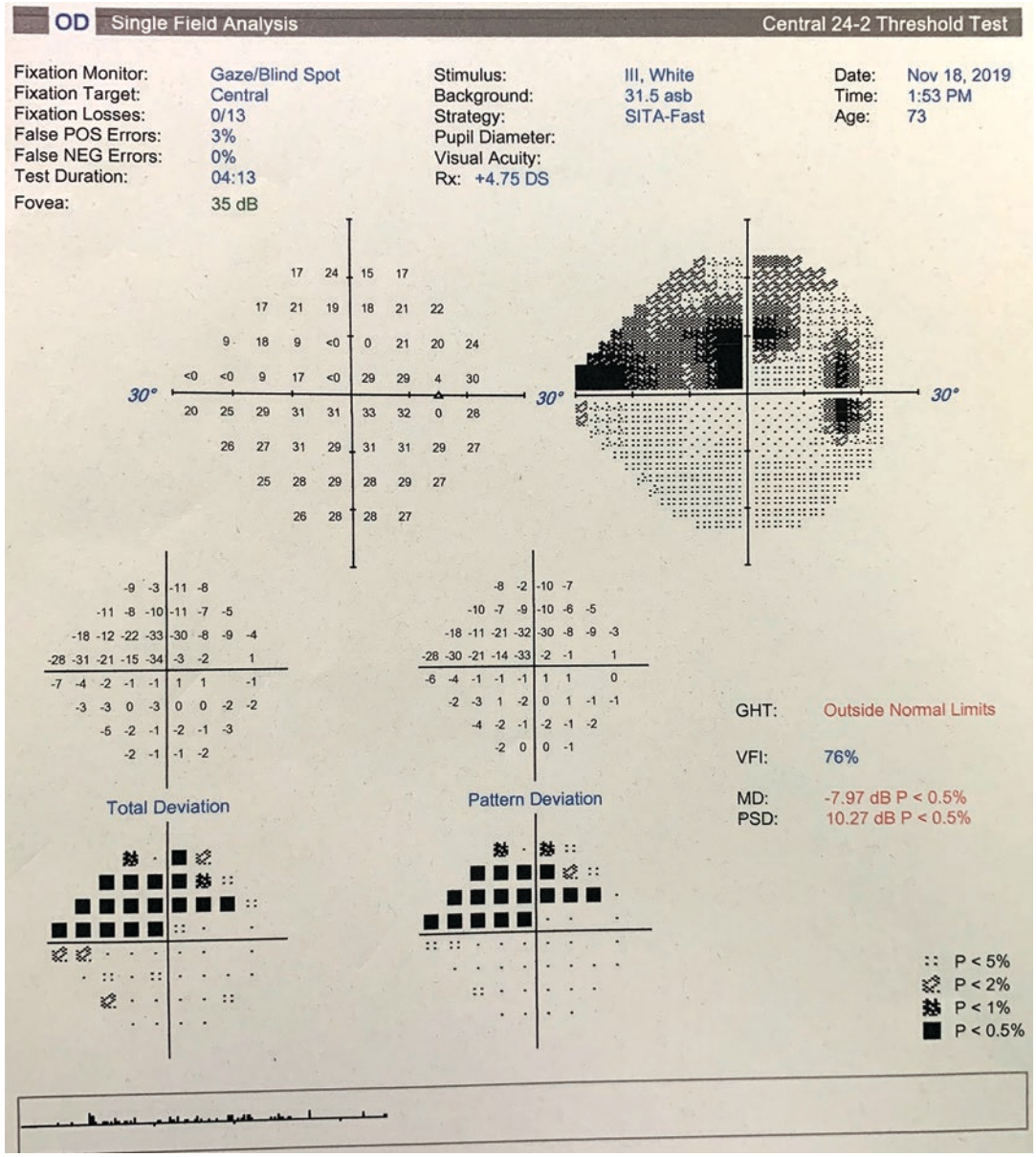

Fig. 3.31 30-2 HVF of the same patient as in Fig. 3.30 showing a superior arcuate scotoma which correlates to the prominent inferior optic disc notching as shown in Fig. 3.30

Table 3.22 Indications for neuro-imaging

- General factors: age <50, new onset or increased severity of headaches, localising neurologic symptoms other than migraines
- Ocular factors: positive visual symptoms, colour vision abnormalities, lack of disc and VF correlation, VF defect respecting the vertical midline, optic disc pallor, unexplained VA reduction, RAPD

– Central corneal thickness (CCT) measurement
– Peripheral anterior chamber configuration and depth assessments using gonioscopy: open angle
– Optic nerve assessment and fundus examination using stereoscopic slit lamp biomicroscopy, with pupil dilatation.

Table 3.23 Summary of the Collaborative Normal Tension Glaucoma Study (Collaborative Normal-Tension Glaucoma Study Group 1998)

- Primary outcome: An RCT conducted to determine whether IOP played a part in the pathogenic process of NTG
- Methods:
  - Inclusion criteria: unilateral or bilateral NTG with optic disc abnormalities and VF defects characteristic of glaucoma, no single IOP reading of >24 mmHg with median IOP reading (from ten baseline IOP readings) of ≤20 mmHg, age >20 years and <90 years, pupil diameter ≥2.5 mm
  - Exclusion criteria: patients taking systemic β-blockers or clonidine, eyes with previous laser treatment, previous ocular surgery, or cyclodestructive procedures, non-glaucomatous conditions that might later affect the visual field, narrow angles or advanced field loss, BCVA <20/30
  - Groups: One eye of each patient was randomised to either the untreated control arm or to the 30% IOP reduction (from the mean of the last three pre-randomisation pressure readings) arm by medical (pilocarpine) or surgical (ALT or trabeculectomy) intervention. Randomisation began if eye had VF defect that threatened fixation, VF progression was demonstrated, a change in the optic nerve head appearance was confirmed, or a disc haemorrhage was noted.
  - Primary end points: VF progression, change in degree of glaucomatous optic disc damage, or both
  - Follow up: 5 years (initial report)
- Results: 145 eyes of 145 patients
  - Lowering of IOP by 30% reduces the rate of VF progression from 35% to 12%
  - 12% of eyes showed VF progression despite an IOP reduction of 30%
  - 65% of patients showed no progression during follow up of 5 years or more
  - 30% IOP reduction could be achieved and maintained in 57% of patients with topical medications, ALT, or both
  - Females, especially those with a hx of migraine and patients with disc haemorrhages at diagnosis were all more likely to progress
- Conclusions: IOP is part of the pathogenic process of NTG. Therapy that is effective in lowering IOP and free of adverse effects would be expected to be beneficial in patients who are at risk of disease progression

Table 3.24 Useful information about COAG

- Adult onset optic neuropathy with glaucomatous optic disc and/or VF changes, open angles, IOP >21 mmHg and no other underlying disease
- Prevalence (proportion of a population with the disease at a given time point) of 1% >40 years old/ prevalence of 10% >75 years old + Caucasian

- Optic disc signs in glaucoma:
  - Generalised signs: CDR 0.7 or more, asymmetry of CDR of 0.2 or more, progressive enlargement of cup
  - Focal signs: rim thinning/notching (ISNT rule not obeyed), regional pallor, NFL haemorrhage, NFL loss

3.20.4 Investigations

- NICE Guidance [NG81]:
  - Visual field assessment using standard automated perimetry (central threshold testing)
  - Optic nerve head (ONH) image for baseline documentation
- HVF signs in glaucoma:
  - Early: paracentral defect, nasal step (IT or ST rim thinning), temporal wedge (nasal disc thinning)
  - Late: arcuate defect, double arcuate defect, central vision only
  - Ensure correlation between optic nerve head findings and VF defects

3.20.5 Diagnosis

- NICE Guidance [NG81]
  - COAG: any IOP, ONH damage, normal/ uncertain/defects on VF
  - Suspected COAG: any IOP, suspicious of possible glaucoma on ONH, normal or uncertain VF

3.20.6 Treatment (see Tables 3.25, 3.26 and 3.27)

- Suspected COAG pathway (NICE Guidance [NG81])
  - If IOP less than 24 mmHg:
    Do not offer treatment initially and reassess
    - If conversion to COAG is present at reassessment: manage patient according to COAG pathway (see below)
    - If uncertain of conversion to COAG and IOP controlled at reassessment: further reassess at 6–12 months.
    - If IOP not controlled and conversion to COAG uncertain or not detected at reassessment: offer generic prostaglandins as first line treatment if IOP is 24 mmHg or more. Review at 1–4 months after starting treatment. Further reassess at 6–12 months if IOP controlled and COAG uncertain or 12–18 months If IOP controlled with treatment and conversion to COAG not detected
    - If conversion to COAG not detected and IOP controlled at reassessment: further reassess at 12–18 months — patient can subsequently be discharged if patient is not on any treatment, IOP remains controlled and results no longer suggest COAG
  - If IOP 24 mmHg or more:
    Offer generic prostaglandins and reassess at 1–4 months after starting treatment:
    - If conversion to COAG is present at reassessment: manage patient according to COAG pathway (see below)
    - If IOP is not controlled and conversion to COAG is uncertain at reassessment: review management plan (use alternative second line treatments) and further reassess at 1–4 months
    - If IOP is controlled and conversion to COAG is uncertain at reassessment: reassess at 6–12 months
    - If IOP is controlled and conversion to COAG not detected at reassessment: reassess at 12–18 months
- COAG pathway (NICE Guidance [NG81])
  - For patients with early or moderate COAG: offer a generic prostaglandin.
  - For patients with advanced COAG: offer surgery with augmentation and interim pharmacological treatment. Offer a generic prostaglandin if patient is not keen for surgical intervention
  - Check treatment is effective and tolerated at 1–4 months for people starting or changing treatment. If prostaglandins have not been effective then offer alternative second line treatments
  - Follow up regime:
    If IOP controlled:
    - Reassess at 2–6 months if progression or uncertain progression. If progression of COAG is subsequently detected then offer patient surgery with augmentation
    - Reassess at 6–12 months if progression not detected and high clinical risk
    - Reassess at 12–18 months if progression not detected and low clinical risk

    If IOP not controlled:
    - Reassess at 1–2 months if uncertain progression or progression. If progression of COAG or IOP remains uncontrolled then offer patient surgery with augmentation
    - Reassess at 1–4 months if progression not detected
- Other options to consider:
  - Selective laser trabeculoplasty (see Table 3.28)
  - Glaucoma drainage implants
  - Cyclodiode

Table 3.25 Summary of the Early Manifest Glaucoma Trial (Heijl et al. 2002)

- Primary outcome: Compare the effect of immediate therapy to lower the IOP, vs no treatment or later treatment, on the progression of newly detected open-angle glaucoma (OAG) as measured by increasing VF loss or optic disc changes
- Methods:
  - Inclusion criteria: diagnosis of early manifest open angle glaucoma (POAG, NTG, PXF glaucoma), age between 50 and 80 years, reproducible glaucomatous VF defects in at least one eye
  - Exclusion criteria: advanced VF loss (MD > −16 dB) or a threat to fixation, VA <20/40, mean IOP >30 mmHg or any IOP >35 mmHg in at least one eye, any condition precluding reliable results of perimetry or optic disc photography, the use of study interventions, or 4 years of follow up, cataractous lens changes exceeding gradings of N1, C2, or P1 according to the lens opacification classification system (LOCS) II
  - Groups: Treatment group — 360° ALT + betaxolol 0.5% BD (reduced mean IOP by 25%, a reduction maintained throughout follow up — IOP reduction was larger in eyes with a baseline IOP of ≥21 mmHg [29%] than in eyes with a baseline IOP of <21 mmHg [18%])/ non-treatment group
  - Primary endpoints: Progression of either glaucomatous VF defects or optic disc cupping
  - Follow up: median 6 years (initial report)
- Results: 255 patients
  - Primary endpoints: After a median of 6 years of follow-up, progression was less frequent in the treatment group (45%) than in controls (62%) and occurred significantly later in treated patients (median time to progression was 18 months longer in the treatment group than the control group). Each 1 mmHg of decreased IOP was related to an approximately 10% lowering of risk.
  - Safety/complications: Nuclear cataract developed faster in the treated group and six had surgery (compared to two controls)
  - Risk factors for progression (in decreasing order of risk): PXF, bilateral glaucoma, higher baseline IOP (≥21 mmHg), worse baseline MD (more than −4 dB), older age, frequent disc haemorrhages post treatment (not associated with IOP or treatment)
- Conclusion of study: Clear beneficial effects of lowering IOP on delaying the onset of progression, with lower rates of progression in the treatment group than the control group

3.21 Aqueous Misdirection (Fig. 3.32)

3.21.1 Definition

- Posterior misdirection of aqueous into the vitreous causing anterior displacement of vitreous, ciliary processes, and lens/IOL with secondary angle closure

3.21.2 Risk Factors

- Short axial length
- Nanophthalmos
- Uveal effusion syndrome
- History of angle closure: previous acute angle closure, chronic angle closure
- Post procedures: trabeculectomy, GDI, cataract extraction, surgical iridectomy, Yag PI

3.21.3 History

- Ask about history of angle closure
- Ask about previous ocular surgeries including trabeculectomy, GDI, cataract extraction, surgical iridectomy, Yag PI

3.21.4 Examination

- Raised IOP
- Shallow/flat central and peripheral AC — significant myopic shift
- Patent PI — no iris bombe
- No suprachoroidal haemorrhage or detachments on fundus examination

3.21.5 Treatment

- Ensure patent PI before commencing treatment
- Medical:
  - Atropine
  - Reduction of IOP with systemic and topical medications

Table 3.26 Summary of the Advanced Glaucoma Intervention Study (The AGIS Investigators 1998, 2001)

- Primary outcome: Assess the effects of two surgical intervention sequences in patients with advanced POAG after the failure of medical therapy.
- Methods:
  - Inclusion criteria: eyes with either advanced (glaucoma not controlled adequately despite MTMT in the presence of glaucomatous VF defect) POAG without previous surgery or advanced POAG in a phakic eye 4 weeks or more after PI, phakic VA better than 20/80 [6/24]), age 35–80 years old, reproducible glaucomatous VF defects in at least one eye, a table of specific combinations of elevated IOP and VF defect was used to define uncontrolled glaucoma and was used to determine if a second or third operation was required
  - Exclusion criteria: secondary glaucoma or congenital angle anomalies, other active eye diseases that cause field loss or previous surgery
  - Groups: A-T-T group: ALT followed if necessary by trabeculectomy, followed if necessary by repeat trabeculectomy/T-A-T group: trabeculectomy followed if necessary by ALT, followed if necessary by repeat trabeculectomy
  - Primary endpoints: VA and/or VF (score 0 normal to-20 blind)
  - Follow up: 7 years (initial report)
- Results: 332 black patients, 249 white patients, 10 patients of other races
  - Low post intervention IOP is associated with reduced progression of VF defect

    Predictive analysis (IOP averaged over the first three 6-month visits: designed to assess whether IOP during early follow up is predictive of subsequent change from baseline in VF defect score): Initial mean IOP <14 mmHg over the first 18 months after surgery had a mean VF score deterioration of less than one point from baseline and those with an initial IOP ≥18 mmHg had a mean score deterioration of three points over 7 years

    Associative analysis (% of visits over the first 6 years of follow up for which an eye presented with IOP <18 mmHg): IOP <18 mmHg on 100% of follow up visits over 6 years resulted in a mean score deterioration of close to zero, but those achieving IOP <18 mmHg on <100% of visits had a mean deterioration of two to three points
  - After 7 years of follow-up, overall (both races) the mean decrease in IOP from baseline is greater in eyes assigned to T-A-T than in those assigned to A-T-T
  - In white patient's VF was better preserved by T-A-T only after the first year of follow-up and thereafter favour the A-T-T sequence, and acuity was better preserved by A-T-T throughout follow up.
  - For black patients, VF and acuity loss were less for eyes in the A-T-T sequence
  - Complications of trabeculectomy: relative risk of cataract in the 5 years after trabeculectomy was 1.78 compared to those participants who avoided trabeculectomy. Youth and high IOP were key risk factors for failure of either ALT or trabeculectomy. Diabetes mellitus or persistent postop inflammation were also significant risk factors for trabeculectomy failure
- Conclusion of study: Low IOP reduces risk of VF progression. Data supports the use of the A-T-T sequence for all black patients. For white patients the data supports the use of the T-A-T sequence

- Laser:
  - Yag disruption of posterior capsule (if pseudophakic) + anterior vitreous face
  - Trans-scleral cyclodiode photocoagulation of the ciliary body in one quadrant
- Surgical:
  - If pseudophakic: pars plana vitrectomy + posterior capsulotomy
  - If phakic: cataract extraction + posterior capsulotomy + pars plana vitrectomy

3.22 Vernal Keratoconjunctivitis (VKC) (Fig. 3.33 and Table 3.29)

3.22.1 Associated Diseases

- HSV keratitis
- Keratoconus
- Anterior capsular cataract

Table 3.27 Summary of the Collaborative Initial Glaucoma Treatment Study (Lichter et al. 2001)

- Primary outcome: Determine whether patients with newly diagnosed OAG are best treated by initial treatment with topical medications or by immediate trabeculectomy
- Methods:
  - Inclusion criteria: newly diagnosed OAG (POAG, PXF glaucoma, pigmentary glaucoma); one of three combinations of qualifying IOP (IOP ≥20 mmHg), VF changes, and optic disc findings; BCVA of 20/40 or better in both eyes; age 25–75 years; no prior ocular surgery; little (≤14 cumulative days of topical therapy) or no prior treatment of glaucoma
  - Exclusion criteria: use of glaucoma medication >14 cumulative days; CIGST VF score >16 in either eye; ocular disease that might affect measurement of IOP, VA, or VF; undergone ophthalmic laser, refractive, conjunctival, or intraocular surgery in either eye; PDR, DMO, or NPDR with >10 MA's by clinical count; current or expected chronic use of corticosteroids; likely require cataract surgery within 1 year of randomisation
  - Groups: topical medication group — escalating drops, if further treatment was required start with ALT, then trabeculectomy ± 5-FU drops, then trabeculectomy + anti-fibrotic agent, then medication/trabeculectomy group — trabeculectomy ± 5-FU, if further treatment was required start with ALT, then escalating drops, then repeat trabeculectomy + anti-fibrotic agent, then medication
  - Primary endpoint: increasing CIGST VF score reflecting increased VF loss
  - Secondary endpoints: change in VA, change in IOP, occurrence of cataract extraction, QOL (questionnaire)
  - Follow up: 5 years (initial report)
- Results: 607 patients
  - Primary endpoint: no significant difference in VF scores at 5 years in both groups
  - Secondary endpoints: initial VA decrease in the trabeculectomy group that was not observed in the topical medication group, resulted in lower mean VA in the trabeculectomy group that persisted through 3.5 years after surgery. After that time, mean VA levels were comparable in the two treatment groups up to 5 years of follow up (VA less in trabeculectomy group compared to topical medications group); there were no significant differences in the QOL between the two groups; both groups had significantly decreased mean IOP after treatment initiation (3 mmHg better reduction with trabeculectomy) although the amount of decrease was greater in the trabeculectomy group (48% in trabeculectomy group vs 35% in the topical medication group), and the difference was maintained over 5 years of observation; the trabeculectomy group had a higher cataract extraction probability over time; risk factors for VF progression: older age, non-white race, DM, development of cataract, maximal IOP, IOP fluctuation between visits
- Conclusion of study: CIGTS clinical outcomes do not suggest a change in the way ophthalmologists currently manage their patients with newly diagnosed OAG

3.22.2 History

- History of atopy: eczema, hayfever, asthma

3.22.3 Examination

- Skin of the lids may be eczematous with excoriation at the canthi ± reactive ptosis
- Palpebral VKC: giant papillae (>1 mm diameter) giving a cobblestone appearance ± mucus accumulation between the papillae
- Limbal VKC: white Horner-Trantas dots (aggregates of degenerated eosinophils and epithelial cells) on the apices of papillae at the limbus
- Cornea:
  - Punctate epithelial erosions on the superior and central cornea with adherent mucus
  - Macroerosion: confluent area of epithelium breakdown
  - Vernal plaque (shield ulcer): deposition of calcium and mucus deposited on Bowman's layer — prevent re-epithelialisation

3.22.4 Treatment

- Inflammation:
  - Topical mast cell stabilisers (e.g. cromolyn sodium)/topical anti-histamines (e.g. emedastine)/topical mast cell stabilisers + anti-histamines (e.g. olopatadine, lodoxamide)
  - Topical corticosteroids: risk of glaucoma, ocular herpetic infection, cataract
  - Topical acetylcysteine: reduces mucus adherence to the cornea during exacerbations

Table 3.28 Summary of the selective laser trabeculoplasty versus eye drops for first-line treatment of ocular hypertension and glaucoma (LiGHT) trial (Guzzard et al. 2019)

- Primary outcome: To compare eye drops versus selective laser trabeculoplasty (SLT) as first line treatment for OAG or OHT
- Methods:
  - Inclusion criteria: newly diagnosed untreated OAG or OHT in one or both eyes; qualified for treatment according to NICE guidelines; VF loss with MD not worse than −12 dB in the better eye or −15 dB in the worse eye with corresponding damage to the optic nerve for those with OAG; VA 6/36 or better in eyes to be treated; no previous intraocular surgery except uncomplicated phacoemulsification at least 1 year prior to randomisation
  - Exclusion criteria: patients with contraindications to SLT (history of uveitis, unable to sit at slit-lamp, poor view of trabecular meshwork); patients unable to use eye drops; patients who had a symptomatic cataract; patients who were under active treatment for another ophthalmic condition
  - Groups: eye drops group, SLT group
  - Primary endpoint: health-related quality of life measured using the EuroQol EQ-5D 5 levels utility scores
  - Secondary endpoint(s): glaucoma-specific treatment related quality of life assessed with the Glaucoma Utility Index (GUI); patient-reported disease and treatment-related symptoms assessed using the Glaucoma Symptom Scale (GSS); patient-reported visual function assessed using the Glaucoma Quality of Life-15 questionnaire (GQL-15); clinical effectiveness (proportion of visits at target IOP, number of treatment escalations); visual function (VA, VF); safety
  - Follow up: 36 months
- Results: 652 patients
  - Primary endpoint: no significant difference in EQ-5D scores at 36 months
  - Secondary endpoints: mean GUI score, mean GQL-15 and mean GSS scores were similar between the two groups at 36 months; two groups had similar endpoint VA, IOP, and VF loss MD; 74.2% of eyes in the SLT group remained drop free at 36 months; SLT was more cost effective; 11 eyes (1.8%) required trabeculectomy in the eye drops group compared with none in the SLT group
- Conclusions of study: SLT should be offered as first line treatment for OAG and OHT

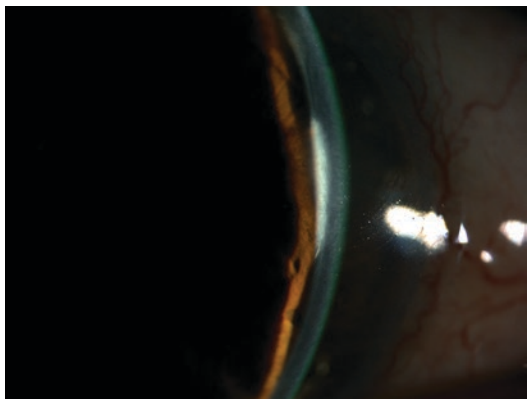

Fig. 3.32 Anterior segment image of a patient with aqueous misdirection showing a shallow central AC

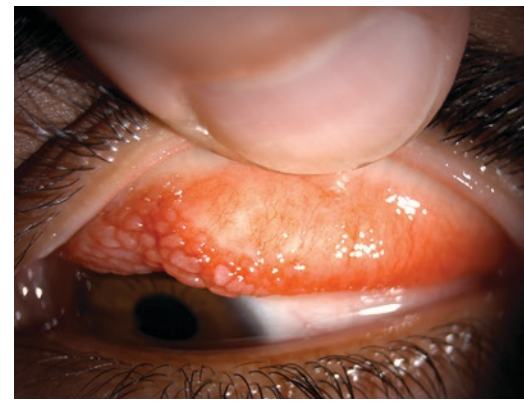

Fig. 3.33 Anterior segment image of a patient with VKC showing giant papillae

  - Steroid (e.g. triamcinolone 40 mg/mL) injected into the supratarsal space after lid eversion: reserved for severe disease not responding to topical treatment or given following surgery for a vernal plaque
  - Topical cyclosporin A: alternative to topical corticosteroid
  - Oral steroid: reserved for severe unremitting disease with corneal complications
- Vernal plaque:
  - Debridement of plaque
  - Superficial keratectomy after the local allergic inflammatory disease has been medically controlled

Table 3.29 Key facts about VKC

- Atopic disease in which an allergic response is mounted to common environmental allergens, dust, or pollen
- Usually develops in the first decade of life (82% by age 10 years with a mean age of 7 years)
- More common in males
- Seasonal propensity

Table 3.30 Key facts of AKC

- Bilateral, chronic inflammation of the conjunctiva and lids associated with atopic dermatitis
- Onset of disease usually in the second through fifth decade
- Male:Female ratio as 2.4:1
- Consists of type I and type IV hypersensitivity reactions

3.23 Atopic Keratoconjunctivitis (AKC) (Table 3.30)

3.23.1 History

- Periocular itching associated with dermatitis
- History of seasonal or exposure-related exacerbations is usually present
- Family History of atopic disease in one or both parents
- History of atopy: asthma, eczema, hayfever
- History of CL wear: lack of CL wear aids in differentiating AKC from GPC

3.23.2 Examination

- Periocular and lid dermatitis — scaling, flaking skin with reddened base
- Loss of cilia, meibomianitis, keratinization, and punctal ectropion.
- The conjunctiva of the tarsal surfaces has a papillary reaction and possibly a pale white oedema ± subepithelial fibrosis
- Inferior fornix shortening with symblepharon
- Perilimbal gelatinous hypertrophy ± Horner-Trantas dots
- Punctate epithelial keratopathy, persistent epithelial defects, scarring, microbial ulceration, and neovascularisation
- Anterior or posterior subcapsular cataract.
- Signs of KC (see Sect. 8.21)

3.23.3 Investigations

- Skin testing to determine nature of the irritants
- Corneal topography if clinical signs of KC is present

3.23.4 Treatment

- Environmental control: removal of environmental irritants in both the home and the employment or school setting
- Correction of trichiasis or lid position abnormalities if contributing in any way to corneal compromise, correction of blepharitis, lubricants for dry eye
- Topical medications: anti-histamines, topical steroids (for 7–10 days) — potential for cataract or glaucoma, mast-cell stabilisers — recommended for patients with perennial symptoms, mast cell stabilisers + anti-histamines (olopatadine, azelastine, epinastine, ketotifen), ciclosporin A, tacrolimus
- Systemic medications: oral prednisolone in cases of uncontrolled dermatitis with vision threatening complications

3.23.5 Other Diagnoses to Consider

- Vernal keratoconjunctivitis (VKC) — AKC patients are usually older and have major lid involvement compared to patients with VKC
- Giant papillary conjunctivitis (GPC) — history of CL wear
- Seasonal allergic conjunctivitis (SAC) — no or markedly diminished symptoms out of their season and show no evidence of chronic inflammation in the conjunctiva
- Perennial allergic conjunctivitis

3.24 Bacterial Keratitis (Fig. 3.34)

3.24.1 Risk Factors

- Ocular
  - Contact lens wear (gram negative pseudomonas is the most common cause of bacterial keratitis in CL wearers)
  - Trauma causing a corneal abrasion or epithelial defect: chemical and thermal injuries, foreign bodies, local irradiation
  - Corneal surgery: LASIK, RK, PK ± loose sutures
  - Ocular surface disease: dry eye, bullous keratopathy, chronic keratitis (e.g. HSV), neurotrophic keratitis (e.g. HSV, HZV, tumours of the cerebellopontine angle with CN VII palsy), OCP, SJS, atopic keratoconjunctivitis
  - Lid abnormalities: entropion, lagophthalmos, trichiasis
- Systemic
  - Immunosuppression: diabetes, drugs
  - Vitamin A deficiency
- Other
  - Male sex

3.24.2 History

- Ask about risk factors for bacterial keratitis (see Sect. 3.24.1)

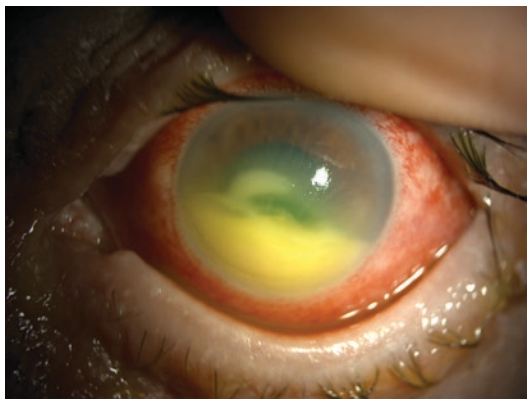

Fig. 3.34 Anterior segment image of a patient with a bacterial keratitis

- For contact lens wearers, enquire about the following
  - Type of contact lens worn
  - Duration of contact lens wear
  - Hygiene of contact lenses
  - Does the patient sleep, swim or shower with contact lens in their eyes?
  - Lifestyle: wearing of contact lenses for sports or at work
  - Purchasing of contact lenses: over the internet, from opticians

3.24.3 Examination

- Features suggestive of bacterial keratitis
  - Suppurative stromal infiltrate (particularly those greater than 1 mm in size) with indistinct edges, oedema, and white cell infiltration in surrounding stroma
  - Epithelial defect is typically present
  - An AC reaction is often seen ± hypopyon
- Pseudomonas: stromal necrosis exhibiting a shaggy surface and adherent mucopurulent exudate

3.24.4 Investigation

- Corneal scrapes
  - Stain: gram stain, giemsa stain, Ziehl-Neelson stain
  - Culture: blood agar, chocolate agar, Lowenstein-Jensen
- If patient wears CL's — send lenses, solutions, cases for culture

3.24.5 Treatment

- Admit and daily review if
  - Severe infection: >1.5 mm diameter infiltrate, central corneal ulcer, hypopyon
  - Poor compliance likely: either with administering drops or returning for daily review
  - Only eye
  - Failing to improve

- Stop CL wear if patient wears CL
- Medications
  - Intensive topical broad-spectrum antibiotics
  - Cycloplegia
  - Topical corticosteroids: no difference in BCVA at 3 months (Srinivasan et al. 2012) but corticosteroid use was associated with a mean one-line improvement in BCVA at 12 months among patients with non-Nocardia ulcers (Srinivasan et al. 2014)
- If an initial scrape result in no growth and current regimen proves clinically ineffective, consider withholding treatment for 12–24 h before re-scraping or performing a formal corneal biopsy
- Surgery
  - Cyanoacrylate tissue adhesive: progressive corneal thinning, corneal perforation
  - Therapeutic PK: impending or overt perforation
  - Optical PK: can be used after complete resolution of the corneal infection to remove corneal scarring and to rehabilitate vision
  - Conjunctival flap: non healing corneal ulcer

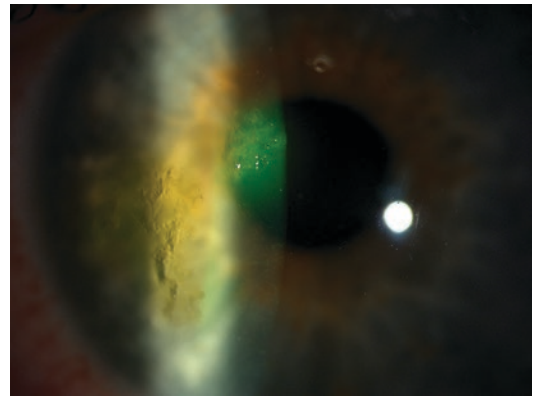

Fig. 3.35 Anterior segment image of a patient with a dendritic ulcer

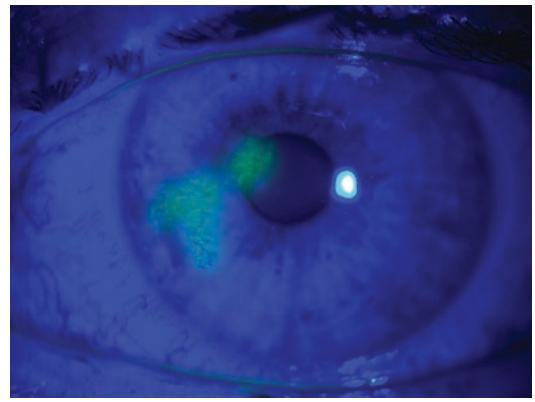

Fig. 3.36 Anterior segment image of the same patient in Fig. 3.35 showing fluorescein staining of the dendritic lesion

3.25 Herpes Simplex Virus (HSV) Keratitis

3.25.1 History

- History of cold sores
- History of previous attacks of HSV keratitis

3.25.2 Examination

- Epithelial keratitis (see Figs. 3.35 and 3.36)
  - Dendritic ulcer: branching linear lesion with terminal bulbs (stain with fluorescein) and raised swollen epithelial borders (negative staining with fluorescein + stain with rose bengal), lesion extends through basement membrane (true ulcer) — pseudodendrites are raised rather than ulcerated and do not stain with fluorescein
  - Geographic ulcer: non-linear enlarged dendritic ulcer, scalloped borders of swollen epithelial cells
  - Marginal ulcer: anterior stromal infiltrate with overlying ED, limbal injection with neovascularisation of the infiltrate, progresses centrally
  - Corneal vesicles: small raised clear vesicles in the epithelium
- Stromal keratitis (see Fig. 3.37)
  - Necrotising stromal keratitis: stromal infiltration with overlying epithelial defect
  - Interstitial keratitis: stromal infiltration with intact overlying epithelium, stromal oedema, stromal neovascularisation ± ghost vessels ± lipid exudation

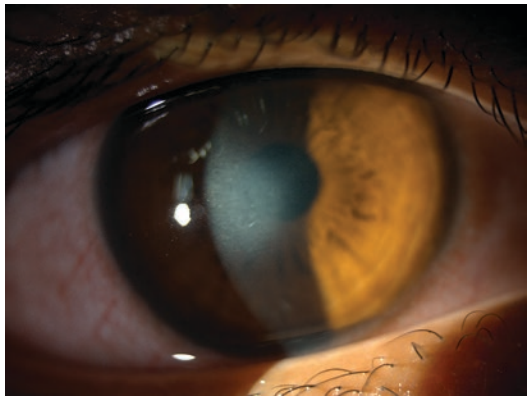

Fig. 3.37 Anterior segment image of a patient with HSV stromal keratitis

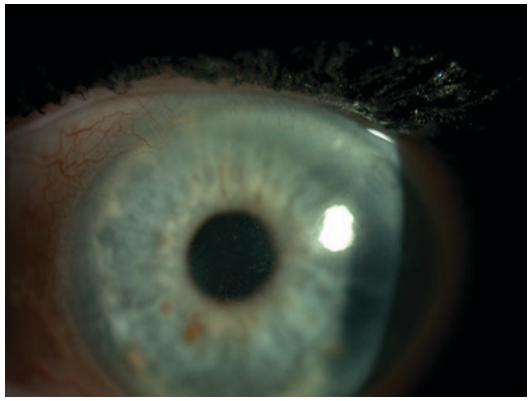

Fig. 3.38 Anterior segment image of a patient with HSV endotheliitis

- Endotheliitis (see Fig. 3.38)
  - Disciform endotheliitis: round area of stromal ± epithelial oedema without stromal infiltrate overlying KP's, iritis
  - Diffuse endotheliitis: diffuse stromal oedema with diffusely scattered KP's
  - Linear endotheliitis: line of KP's accompanied by stromal + epithelial oedema between the KP's and the limbus
- Iridocyclitis
  - Sectoral iris atrophy
  - Raised IOP

3.25.3 Treatment

- Epithelial keratitis
  - Topical aciclovir 3% 5×/day for 10–14 days
  - Cycloplegia
- Stromal keratitis
  - Topical corticosteroids (defer where possible until epithelium intact)
  - Topical aciclovir 3% 5×/day to prevent outbreak of epithelial keratitis
  - Cycloplegia
  - Monitor IOP and treat if necessary
- Endotheliitis
  - Topical corticosteroids (defer where possible until epithelium intact)
  - Topical aciclovir 3% 5×/day to prevent outbreak of epithelial keratitis
  - Oral aciclovir 400 mg 5×/day for 7 days then 400 mg BD
  - Cycloplegia
  - Monitor IOP and treat if necessary
- Iridocyclitis
  - Topical corticosteroids
  - Oral aciclovir 400 mg 5×/day for 7 days
  - Cycloplegia
  - Monitor IOP and treat if necessary

3.25.4 Herpetic Eye Disease Study (HEDS)

- A set of multicentre RCT's designed to address six HSV-associated clinical questions:
  - Topical corticosteroids in treating stromal keratitis already on a topical antiviral (Wilhelmus et al. 1994)

    Time to failure (new focal stromal inflammation, increase in area of inflammed cornea) comparison was highly in favour of the treatment group at 10 weeks (73% vs 26%)

    Delaying steroid initiation does not affect visual outcome at 6 months

- Oral aciclovir in treating stromal keratitis already on a topical steroid and antiviral (Barron et al. 1994)
  Time to treatment failure at 16 weeks was not delayed significantly in the treatment group
  No benefit of adding oral aciclovir (400 mg 5×/day) in patient on topical antiviral and topical corticosteroids
- Oral aciclovir in treating iridocyclitis already on topical steroid (The Herpetic Eye Disease Study Group 1996)
  The rate ratio for the protective effect of aciclovir on time to failure at 10 weeks bordered on significant
- Oral aciclovir in preventing recurrence of epithelial and stromal keratitis (The Herpetic Eye Disease Study Group 1998)
  Aciclovir prophylaxis (400 mg BD) reduced recurrence of ocular HSV from 32% (placebo group) to 19% (aciclovir group) at 12 months
  Effect applied to both epithelial (14% to 9%) and stromal keratitis (28% to 14%) — greatest for stromal keratitis patients with at least one prior episode
- Demographic and disease-specific predictors of recurrent HSV keratitis (Herpetic Eye Disease Study Group 2001)
  History of epithelial keratitis was not a risk factor for recurrent epithelial keratitis
  The more prior episodes of stromal keratitis, the higher the likelihood of recurrence
- Risk factors for recurrence of ocular HSV (Herpetic Eye Disease Study Group 2000)
  Stress, systemic infection, sunlight exposure, menstruation, CL wear, and eye injury were not deemed significant

3.26 Acanthamoeba Keratitis (Fig. 3.39)

3.26.1 Risk Factors

- Contact lens wear: poor CL hygiene (e.g. rinsing in tap water), extended wear CL (soft — 90% or rigid CL), swimming with CL insitu (ponds, hot tubs, swimming pools)
- Trauma: agricultural or rural setting

3.26.2 History

- Disproportionate incapacitating ocular pain to clinical findings
- Ask about risk factors (see Sect. 3.26.1)

3.26.3 Examination

- Radial keratoneuritis: represents amoebic migration along the corneal nerves (can also be seen in pseudomonas keratitis)
- Epitheliitis (flat diffuse microcystic form with perilimbal sparing) ± epithelial ridges ± pseudodendrites
- Anterior stromal infiltrate ± overlying ED that progresses circumferentially to form a

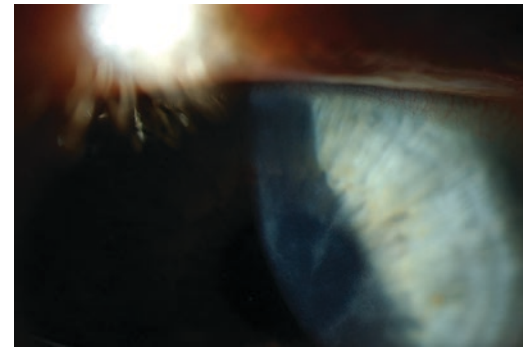

Fig. 3.39 Anterior segment image of a patient with acanthamoeba keratitis showing radial keratoneuritis

stromal ring infiltrate with subsequent stromal scarring
- Scleritis
- Uveitis

3.26.4 Investigations

- Corneal scrape:
  - Culture on non-nutrient agar with E. coli overlay
  - Stain with Calcofluor white (stains cysts visualised under UV light) or gram stain (stains organisms)
  - DNA detection using PCR
- If patient wears CL's — send lenses, solutions, cases for culture
- Invivo confocal microscopy (IVCM):
  - Direct visualisation of cysts (high contrast round bodies — see Fig. 3.40)
- Corneal biopsy for culture if other tests negative but there is a strong suspicion of acanthamoeba keratitis

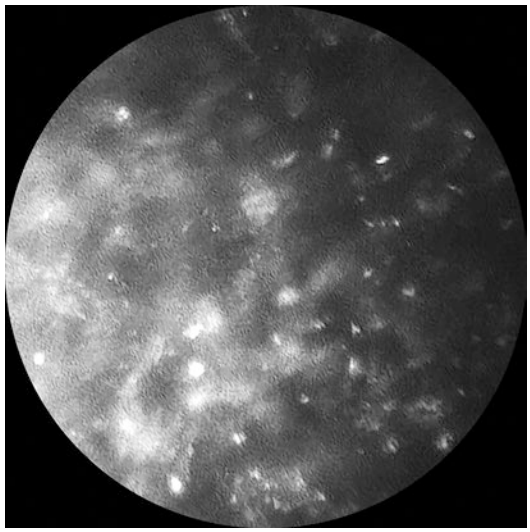

Fig. 3.40 IVCM of a patient with acanthamoeba keratitis showing high contrast round bodies suggestive of acanthamoeba cysts

3.26.5 Treatment

- Admit and daily review
- Stop CL wear if patient wears CL
- Educate patient about CL wear and hygiene
- Medical:
  - Intensive topical anti-amoebic agents:
    Biguanides: PHMB 0.02% or chlorhexidine 0.02%
    Diamidine: propamidine 0.1% or hexamidine 0.1%
  - Cyclopentolate
  - Scleritis: systemic steroids ± steroid sparing agent
- Surgical:
  - Severe stromal scarring: PK an option once free of infection — 3 months after discontinuation of anti-acanthamoebal medications
  - Extensive stromal necrosis and impending or overt perforation: emergency PK — high risk of persistent or recurrent disease in grafted tissue
  - Severe intractable pain: enucleation

3.27 Fungal Keratitis (Fig. 3.41)

3.27.1 Risk Factors

- Trauma involving plant matter
- Contact lens wear
- Immunosuppression: topical corticosteroids, alcoholism, diabetes, HIV positive, systemic immunosuppression
- Corneal surgery: PK, LASIK, RK
- Chronic keratitis: neurotrophic cornea (HSV, HZV, topical anaesthetic abuse), dry eye

3.27.2 History

- Ask about risk factors (see Sect. 3.27.1)

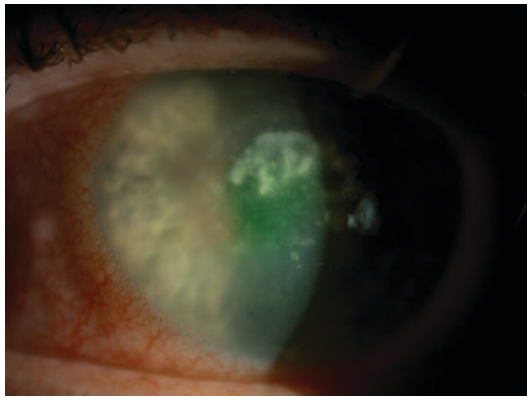

Fig. 3.41 Anterior segment image of a patient with a fungal keratitis

3.27.3 Examination

- Non-specific: conjunctival injection, epithelial defect, stromal infiltration, AC reaction or hypopyon
- Filamentous fungi: stromal infiltrates with irregular feathery margins, elevated edges, dry rough texture, satellite lesions
- Yeast: localised with "button" appearance, expanding stromal infiltrate, relatively small epithelial ulceration
- It is not always possible to differentiate clinically between bacterial and fungal keratitis, especially in cases where yeasts are the infecting fungi

3.27.4 Investigations

- Corneal scrapes
  - Stains: gram stain, giemsa stain, Grocott's methenamine silver (GMS) stain
  - Culture: Sabouraud's dextrose agar (for most fungi), sheep blood agar (for fusarium)
- In vivo confocal microscopy (IVCM): look for filaments (see Fig. 3.42)
- Corneal biopsy if corneal scrapings for culture are negative and there is a strong suspicion of fungal keratitis

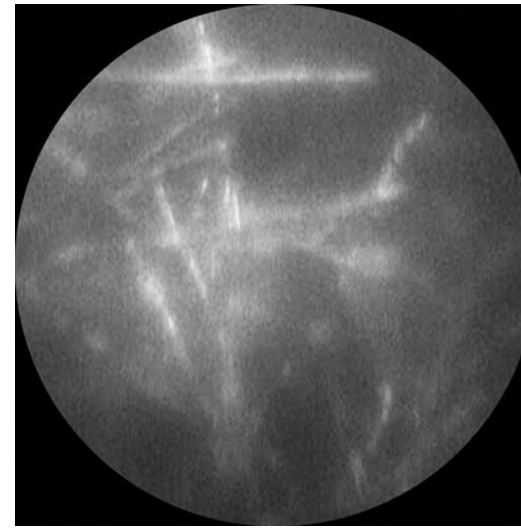

Fig. 3.42 IVCM of a patient with a fungal keratitis secondary to a filamentous fungus

3.27.5 Treatment

- Admit and daily review, stop CL wear if patient wears CL
- Medical treatment:
  - Topical:
    Intensive topical broad spectrum anti-fungal agents: natamycin 5% (fusarium infection), voriconazole 1% (candidal infection), amphotericin 0.15% (candida, aspergillus): natamycin treatment is associated with significantly better clinical and microbiological outcomes than voriconazole treatment for filamentous fungal keratitis (Prajna et al. 2013)
    Cyclopentolate
  - Systemic:
    Oral fluconazole (candida and aspergillus)
    Oral voriconazole
- Visual rehabilitation after a treated fungal infection begins with spectacle correction and hard contact lenses. If these modalities fail to improve vision sufficiently — surgery
- Surgical treatment: PK in a quiet but visually compromised eye or therapeutic PK or for

impending or overt perforation, conjunctival flap for a non-healing ulcer

3.28 Ectopia Lentis (Fig. 3.43)

3.28.1 Differential Diagnosis

- Systemic
  - Marfan syndrome (AD — fibrillin gene on chromosome 15, clinical diagnosis):
    Ocular: bilateral superotemporal lens subluxation, accommodation intact, RD, glaucoma, keratoconus, high myopia, blue sclera
    Musculoskeletal: arachnodactyly, disproportionately long limbed, joint laxity, high-arched palate
    Cardiovascular: mitral valve prolapse, aortic dilatation, aortic regurgitation, aortic dissection
  - Weill-Marchesani syndrome (AR):
    Ocular: bilateral inferonasal lens subluxation, microspherophakia, RD, high myopia
    Musculoskeletal: brachydacytyly, short stature
    Neurological: reduced IQ
  - Homocystinuria (AR):
    Ocular: bilateral inferonasal lens subluxation, myopia, glaucoma
    Musculoskeletal: marfanoid habitus
    Haematological: thromboses, especially associated with GA
    Neurological: reduced IQ3.28.2
  - Hyperlysemia (AR)
  - Sulfite oxidase deficiency (AR)
  - Ehlers-Danlos syndrome (AR)
- Ocular
  - Trauma
  - PXF
  - High myopia
  - Hypermature cataract
  - Buphthalmos
  - Ciliary body tumour
  - Aniridia
  - Hereditary ectopia lentis
  - Ectopia lentis et pupillae: lens subluxation with pupil displacement in opposite direction

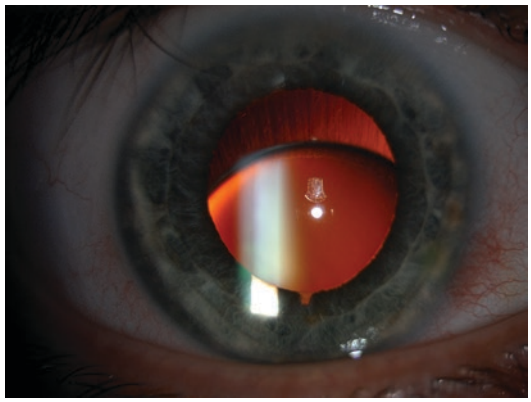

Fig. 3.43 Anterior segment image of a patient with ectopic lentis

3.28.2 History

- History of trauma
- Positive family history
- Cardiovascular or musculoskeletal abnormalities in patient or family

3.28.3 Examination

- Ectopia lentis ± uveitis ± corneal decompensation ± pupil block
- Check IOP
- Perform gonioscopy to look for angle closure
- Perform a dilated fundus examination to look for RD, signs of glaucoma
- Systemic examination

3.28.4 Investigations

- Refraction
- Cardiac evaluation (echocardiography) in Marfan's syndrome
- Plasma homocysteine level in homocystinaemia

3.28.5 Treatment

- Genetic counselling
- Vision
  - Correction of refractive error: spectacles, CL
  - Surgical: Lensectomy ± vitrectomy with post-op aphakia correction or secondary artisan IOL, or scleral sutured PCIOL
- Ectopia lentis
  - Migration of lens into AC: mydriatics + lie patient on their back to permit posterior migration of lens behind the iris
  - Pupil block glaucoma: Yag PI and topical medications to reduce IOP
  - Lensectomy ± vitrectomy ± artisan IOL ± scleral sutured PCIOL:
  - Indications:
    Lens induced glaucoma/uveitis
    Lens in AC with corneal decompensation
    Lens opacity is mature or hypermature
    Inadequate VA not correctable by refraction
    RD

3.29 High Myopia and Cataract Surgery

3.29.1 Preoperative Considerations

- Assess visual potential: myopic degeneration, macular holes, myopic foveoschisis, previous RD repair with silicone oil
- Discuss refractive outcome: anisometropia — less need for second eye operation if patient already wears CL
- Biometry
  - Use of IOL master rather than A-scan to measure the axial length (AL) of the eye (posterior staphyloma can generate an erroneously long axial length when measured with the A scan giving rise to a postoperative hypermetropic refractive surprise)
  - Convert speed of sound through vitreous to 987 m/s on IOL master to measure true AL in a silicone oil (viscosity 1000 cSt) filled eye/true AL of a silicone oil filled (viscosity 1300 cSt) eye can be estimated from the measured AL (MAL) obtained on A/B scan US by multiplying MAL by a conversion factor of 0.71
  - Formula choice: SRK/T if axial length >26.5 (NICE Guidance [NG77])
  - IOL power choice: A constant increases as IOL power is lower, which leads to selection of a higher dioptric power implant to lessen the odds of a postoperative hyperopic surprise — select a power of IOL which leaves some residual of postoperative myopia
  - IOL material selection: avoid silicone lenses

3.29.2 Intraoperative Considerations

- Anaesthesia: retrobulbar and peribulbar anaesthesia carry the risk of perforation of the globe in a long, myopic eye
- Deeper AC: break reverse pupillary block by using the chopper to slightly tent up the iris at the pupillary margin to establish a channel for anterior-posterior fluid flow (equalise anterior and posterior chamber pressures), decrease infusion pressure by lowering bottle height (increase risk of surge)
- Increased risk of post-op RD (0.9–3.8% risk if AL >26.0 mm): prevent collapse of the AC when removing the phaco probe or I&A probe from the eye to avoid traction or tension on the vitreous during surgery (once AC collapses, the vitreous has a tendency to move anteriorly) — inject viscoelastic via the paracentesis prior to removing the phaco probe or IA probe from the eye
- Zonular weakness: minimise nuclear manipulation to protect damaged zonules from a previously vitrectomised eye

3.29.3 Postoperative Considerations

- Floppy large bag: postop refraction can take time to stabilise due to the variation in effective

lens position as the capsular bag shrinks and wraps around the IOL
- Repeat fundus exam to search for retinal breaks that may have been created during the surgery
- Timely surgery on the fellow eye (within 6 weeks) will minimise the imbalance caused by the large degree of anisometropia

3.30 Pseudoexfoliation and Cataract Surgery

3.30.1 Preoperative Considerations

- Risk of wipe out (progression of VF) to a vulnerable nerve
- Control of high IOP: risk for suprachoroidal haemorrhage
- Phacodonesis: when there is severe zonular instability, the surgeon may consider pars plana lensectomy with an ACIOL or sutured PCIOL
- Zonular dialysis: quantified by the number of clock hours involved — a capsular tension ring (CTR) can be used if 4 clock hours or less of zonule loss
- AC depth: AC depth <2.5 mm centrally may indicate anterior displacement of the lens-iris diaphragm from zonular weakness
- Poor mydriasis: look for iris atrophy and transillumination defects

3.30.2 Intraoperative Considerations

- Pupil size: ensure adequate pupil dilation by use of intracameral injection of phenylephrine, iris stretching or iris hooks
- Avoid overinflating AC with viscoelastic causing posterior pressure on the lens can further weakening the zonules
- Capsulorrhexis: large capsulorrhexis (risk of post-op anterior capsular phimosis), provide counter traction via the non-dominant hand using a second instrument via the paracentesis (if wrinkling of the anterior capsule when piercing the anterior capsule)
- Hydrodissection: avoid overfilling of the AC causing excessive zonular stress
- Nucleus removal: for soft nuclei consider prolapsing the nucleus anteriorly, for denser nuclei consider chopping techniques
- Cortex removal: lower flow rate and maximum vacuum settings, perform circumferential removal of cortex rather than radial stripping (less stress on zonules)
- Consider insertion of CTR if up to 4 clock hours of zonular dehiscence present
- IOL insertion: IOL placed in the capsular bag — orientation of haptics towards the area of zonular loss to bolster support at the equator / IOL placed in the ciliary sulcus — orientation of haptics 90° away from the area of zonular loss

3.30.3 Postoperative Considerations

- IOP spike: diamox for 3 days postoperatively

3.31 Intraoperative Floppy Iris Syndrome (IFIS)

3.31.1 Features

- Syndrome characterised by a triad of occurrences
  - Fluttering and billowing of the iris stroma in response to normal irrigation currents
  - A propensity for the floppy iris stroma to prolapse towards the phaco and side incisions
  - Progressive pupillary constriction that occurs during the surgical procedure

3.31.2 Preoperative Considerations

- Past or present use of α1-antagonists (tamsulosin, alfuzosin, doxazosin) in the treatment of BPH and HTN

3.31.3 Intraoperative Considerations

- Pupil size: intracameral injection of phenylephrine (0.25 mL 2.5% phenylephrine mixed with 1 mL BSS — 1:200 solution), iris hooks
- Wound construction: longer incision within the clear cornea and move incisions more anteriorly into the cornea to help with flow dynamics and iris prolapse

3.32 Corneal Endothelium in Cataract Surgery

3.32.1 Endothelial Cell Counts

- 4000 cells/mm^2 at birth
- 2500 cells/mm^2 in middle age
- 2000 cells/mm^2 in old age

3.32.2 Ophthalmic Viscosurgical Devices (OVDs)

- OVDs are solutions of long chain polymers
- Dispersive OVDs:
  - Lower viscosity + cause less IOP spikes (more difficult to remove from the eye)
  - Uses: isolate part of surgical field, e.g. protect cornea or keeping the iris or vitreous out of the way
  - Examples: Viscoat (sodium chondroitin sulfate + sodium hyaluronate with molecular weight of 100–500 kDa)
- Cohesive OVDs:
  - Higher viscosity + cause higher IOP spikes (easier to remove from the eye)
  - Uses: deep AC creation, opening the bag prior to IOL implantation
  - Examples: Healon (sodium hyaluronate with molecular weight of 1000–2000 kDa), Provisc (sodium hyaluronate with molecular weight of 1000–2000 kDa), Healon GV (sodium hyaluronate with molecular weight of 4000–8000 kDa)
- Viscoadaptive OVDs:
  - Has components of both cohesive and dispersive OVDs
  - At high flow rates (e.g. phacoemulsification) it acts like a dispersive OVD and stays within the eye to protect the corneal endothelium
  - At low flow rates (e.g. I/A) it acts like a cohesive OVD for easier removal
  - Example: Healon 5 (sodium hyaluronate with molecular weight of 4000–8000 kDa)

3.32.3 Soft-Shell Technique

- Dispersive OVD to protect the corneal endothelium
- Cohesive OVD to maintain the AC space

3.32.4 Ultimate Soft-Shell Technique

- Viscoadaptive OVD + Basic Salt Solution

3.32.5 Irrigating Solutions

- Basic Salt Solution
  - Composition per 1 mL: sodium and potassium chloride, calcium chloride dehydrate, magnesium chloride hexahydrate, sodium acetate trihydrate, sodium citrate dehydrate, sodium hydroxide, hydrochloric acid
- Basic Salt Solution Plus
  - Has been shown to minimise endothelial pleomorphism and polymegathism though Invivo studies
  - Part I: 480 mL solution in a 500 mL single dose bag to which the part II concentrate is added. Each mL of part I contains (five salts and a buffer): sodium and potassium chloride, dibasic sodium phosphate, sodium bicarbonate, hydrochloric acid, sodium hydroxide
  - Part II: sterile concentrate in a 20 mL single dose vial for addition to part I. Each mL of part II contains: calcium chloride dehydrate, magnesium chloride hexahydrate, dextrose (energy source), glutathione disulfide (antioxidant)

3.33 Endophthalmitis (Table 3.31)

3.33.1 Other Diagnoses to Consider

- Toxic anterior segment syndrome (TASS)
  - Acute post-operative non-infectious inflammatory reaction due to inadvertent entry of toxic substances in the AC
  - Rapid onset: 12–24 h post-surgery
  - Mild/moderate or no pain
  - Corneal oedema (limbus to limbus) with moderate-to-severe AC inflammation ± fibrin/hypopyon, raised IOP
  - Vitritis is rare
  - Highly sensitive to topical steroids
- Occult retention of lens cortex or nucleus
- Hypopyon uveitis (e.g. Behcet's)
- Inflammatory reaction to intravitreal drug

3.33.2 Investigations

- B-scan
  - Indication: significant media opacification prevents adequate view of the fundus
  - Findings: dispersed vitreous opacities with vitritis, chorioretinal thickening
  - Rule out RD or choroidals, dislocated lens material, retained foreign bodies

Table 3.31 Key facts about endophthalmitis

- National rate of post cataract surgery endophthalmitis was 0.14% in the BOSU study (Kamalarajah et al. 2004) and 0.055% in the Bolton study (Kelly et al. 2007)
- Acute post-operative endophthalmitis: usually 3–5 days after ocular surgery
- Chronic post-operative endophthalmitis: usually 6 weeks after ocular surgery
- White plaque on posterior capsule suggest Propionobacterium acnes infection
- Current advice is to continue with the local arrangements for preventative treatment of endophthalmitis if audited figures reveal a rate similar to the Bolton study. If figures are higher, the use of intracameral cefuroxime should be considered

3.33.3 Treatment of Acute Endophthalmitis

- Admit
- If VA hand motion (HM) or better
  - Perform a vitreous needle tap (27G needle attached to a TB syringe) ± AC tap (30G needle attached to a TB syringe) with simultaneous injection of intravitreal antibiotics (vancomycin 1 mg/0.1 mL + amikacin 0.4 mg/0.1 mL or ceftazidime 1 mg/0.1 mL)
  - Oral ciprofloxacin 750 mg BD: no evidence of clinical benefit
  - Corticosteroids: topical (e.g. dexamethasone 0.1% hourly), systemic (e.g. oral prednisolone 1 mg/kg OD rapidly reducing to zero over 7–10 days): no evidence it improves VA and should be avoided in fungal infections
  - If failure to respond at 48–72 h consider repeating needle vitreous tap ± AC tap with simultaneous injection of intravitreal antibiotics (repeat intravitreal antibiotics may increase the risk of retinal toxicity)
- If VA light perception (LP) of worse
  - Pars plana vitrectomy (PPV) with intravitreal injection of antibiotics:

    In the Endopthalmitis Vitrectomy Study (Endophthalmitis Vitrectomy Study Group 1995), patients with postop endophthalmitis within 6 weeks of cataract surgery who presented with LP only VA had a significant threefold improved chance of obtaining 6/12 vision after immediate vitrectomy compared to tap and inject
  - Oral ciprofloxacin 750 mg BD: no evidence of clinical benefit. Potential resistance from pseudomonas and gram-positive cocci organisms
  - Corticosteroids: topical (e.g. dexamethasone 0.1% hourly), systemic (e.g. oral prednisolone 1 mg/kg OD rapidly reducing to zero over 7–10 days): no evidence it improves VA and should be avoided in fungal infections

  - If failure to respond at 48–72 h consider repeating needle vitreous tap ± AC tap with simultaneous injection of intravitreal antibiotics (repeat intravitreal antibiotics may increase the risk of retinal toxicity)

3.33.4 Prevention

- Pre-operative
  - Identification and treatment of blepharitis, conjunctivitis, mucocele or chronic dacryocystitis before elective surgery is performed
  - Avoidance of intraocular procedures in patients with significant active non-ocular infections
- Intra-operative
  - Skin and conjunctival preparation with 5% povidone iodine 5 min before op
  - Eyelid speculum and careful draping to eliminate eyelashes from surgical field
  - Suturing of any leaking wounds at the completion of the operation
  - Avoidance of serious intraoperative complications such as PCR and vitreous loss and avoidance of overly prolonged surgery
  - Intracameral cefuroxime (1 mg in 0.1 mL) at the completion of cataract surgery:
    ESCRS study (ESCRS Endophthalmitis Study Group 2007): five-fold decrease in incidence of postoperative endophthalmitis with intracameral cefuroxime compared with topical levofloxacin
    NICE Guidance [NG77]: recommends use of intracameral cefuroxime during cataract surgery to prevent endophthalmitis
- Post-operative
  - Topical antibiotics

3.33.5 Prognosis

- Prognosis depends on organism (e.g. poor prognosis with pseudomonas, staphylococcus aureus and streptococcus pneumoniae), patient factors (e.g. diabetes, advanced age, post complicated cataract surgery), time to intravitreal injection

3.34 The RCOphth Ophthalmic Services Guidance on Managing an Outbreak of Post-Operative Endophthalmitis 2016

3.34.1 Outbreak Definition

- More than one case in a short time frame, e.g. days to weeks

3.34.2 Determine If There Is an Outbreak

- Incident report all cases
- Review cases for risk and causes with particular concern if
  - Analysis of the cases demonstrate a common organism especially an unusual organism
  - Analysis of the cases demonstrates the same apparent underlying cause of concern
  - Analysis of the cases demonstrates the cases related clearly to only one team member, one surgeon, one theatre/site, one session in the week, a particular instrument or consumables batch number
  - Two or more cases have arisen during the same theatre list
  - Cluster occurring over a very short time frame, e.g. days to weeks
- Regularly assess incidence
- Use agreed system as cut off for action

3.34.3 Notification

- Notify/involve colleagues: ophthalmology, risk team, microbiology, infection control, management (clinical and medical director)

- Make patients aware of symptoms and provide easy emergency postop access
- Consider resuming early follow up

3.34.4 Immediate Measures

- Consider cessation of all surgery/procedures
- Cease bilateral simultaneous cataract surgery if performed
- Ensure all know and follow current prophylaxis regime

3.34.5 Investigation

- Review cases and check all aspects for risks and common factors:
  - Patient factors — blepharitis, diabetes, concurrent systemic illness, vitreous loss, postop wound leak, duration of surgery, non-compliance with prescribed drops
  - Surgeon factors: surgical and draping technique
- Check theatre environment, cleanliness, airflow/ventilation system
- Microbiological sampling of intraocular tap samples (looking for a common organism or subtype), equipment, theatre, drugs, irrigating and viscoelastic solutions
- Review and obey theatre discipline and correct operating practices
- Ensure equipment/devices up to date, used properly, maintained well
- Check instrument cleaning and sterilisation procedures
- Keep detailed records of investigations and actions
- Eliminate specific cause if found
- If specific cause not found:
  - Revise and improve current prophylaxis protocol
  - Introduce intracameral antibiotics
  - Consider external review from other unit or College

3.35 Idiopathic Intracranial Hypertension (IIH) (Fig. 3.44 and Table 3.32)

3.35.1 Differential Diagnosis of Disc Swelling

- Pseudopapilloedema
  - Features:

No disc hyperaemia, no dilation of surface microvasculature, no blurring of retinal vessels at the disc margin

  - Causes:

    Optic disc drusen

    Myelinated peripapillary nerve fibers: dense white opacity

    Tilted discs

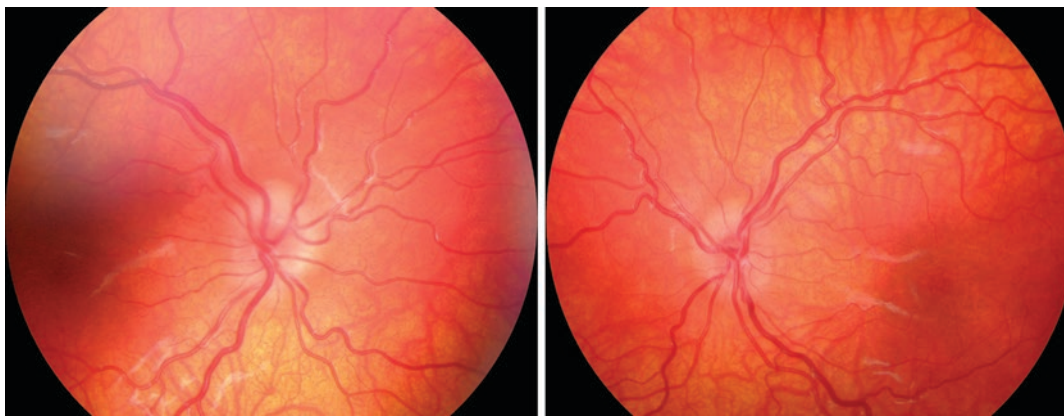

Fig. 3.44 Colour fundus image of a patient with IIH showing bilateral disc swelling

Table 3.32 Key facts about IIH

- The syndrome of increased ICP without ventriculomegaly or mass lesion, and with normal CSF composition
- Diagnosis of exclusion
- Obesity is the major risk factor

Hypermetropic discs
Myopic discs

- Papilloedema
  - Features:
    Patients retain good visual function (VA, VF, colour vision) until late in disease course regardless of how swollen the nerve appears
    Bilateral disc swelling
  - Causes:

Raised intracranial pressure (ICP)

- Local disc swelling
  - Causes:
    Inflammatory: optic neuritis, uveitis, scleritis
    Vascular: AION, CRVO, diabetic papillitis
    Granulomatous: TB, sarcoid
    Infiltrative: leukaemia, lymphoma
    Trauma causing hypotony
    Tumours of optic nerve: optic nerve sheath meningioma, glioma
    Hereditary: LHON
    Iatrogenic: surgery causing hypotony

3.35.2 Causes of Raised ICP

- Mass effect: tumours, haemorrhage, trauma — oedema, haematoma
- Increased CSF production: choroid plexus tumour
- Reduced CSF drainage: IIH
- Drugs ("I LOVE PTC"): isotretinoin, lithium, OCP, vitamin A derivatives, endocrine (synthetic growth hormone), prednisolone withdrawal, tetracyclines, cyclophosphamide
- Haematological: cerebral venous sinus thrombosis
- Endocrine: Addison's disease, hypoparathyroidism, obesity

3.35.3 Terminology

- Primary pseudotumor cerebri
  - IIH: includes patients with obesity, recent weight gain, polycystic ovarian syndrome, and thin children
- Secondary pseudotumor cerebri
  - Cerebral venous abnormalities:
    Cerebral venous sinus thrombosis
    Bilateral jugular vein thrombosis or surgical ligation
    Middle ear or mastoid infection
    Increased right heart pressure
    Superior vena cava syndrome
    Arteriovenous fistula
    Decreased CSF absorption from previous intracranial infection or subarachnoid hemorrhage
    Hypercoagulable states
  - Medications and exposures
    Antibiotics: tetracycline, minocycline, doxycycline, nalidixic acid, sulfa drugs
    Vitamin A and retinoids: hypervitaminosis A, isotretinoin, all-trans retinoic acid for promyelocytic leukaemia, excessive liver ingestion
    Hormones: human growth hormone, thyroxine (in children), leuprorelin acetate, levonorgestrel, anabolic steroids
    Withdrawal from chronic corticosteroids
    Lithium
    Chlordecone
  - Medical conditions
    Endocrine disorders: Addison disease, Hypoparathyroidism
    Hypercapnia: sleep apnoea, Pickwickian syndrome
    Anaemia
    Renal failure
    Turner syndrome
    Down syndrome

3.35.4 Criteria for Diagnosis of IIH

- Revised diagnostic criteria for the pseudotumor cerebri syndrome in adults and children (Friedman et al. 2013)

1. Required for diagnosis of pseudotumor cerebri syndrome:
   - A diagnosis of pseudotumor cerebri syndrome is definite if the patient fulfils criteria A–E. The diagnosis is considered probable if criteria A–D are met but the measure CSF pressure is lower than specified for a definite diagnosis
     A. Papilledema
     B. Normal neurologic examination except for cranial nerve abnormalities
     C. Neuroimaging: normal brain parenchyma without evidence of hydrocephalus, mass, or structural lesion and no abnormal meningeal enhancement on MRI, with or without gadolinium, for typical patients (female and obese), and MRI, with and without gadolinium, and magnetic resonance venography for others; if MRI is unavailable or contraindicated, contrast-enhanced CT may be used
     D. Normal CSF composition
     E. Elevated lumbar puncture opening pressure (at least 250 mm CSF in adults and at least 280 mm CSF in children [250 mm CSF if the child is not sedated and not obese]) in a properly performed lumbar puncture
2. Diagnosis of pseudotumour cerebri without papilledema:
   - In the absence of papilledema, a diagnosis of pseudotumor cerebri syndrome can be made if B–E from above are satisfied, and in addition the patient has a unilateral or bilateral sixth nerve palsy
   - In the absence of papilledema or sixth nerve palsy, a diagnosis of pseudotumor cerebri syndrome can be suggested but not made if B–E from above are satisfied, and in addition at least three of the following neuroimaging criteria are satisfied:
     I. Empty sella
     II. Flattening of the posterior aspect of the globe
     III. Distension of the perioptic subarachnoid space with or without a tortuous optic nerve
     IV. Transverse venous sinus stenosis

- IIH: consensus guidelines on management (Mollan et al. 2018)
  A. Papilloedema
  B. Normal neurological examination (except CN VI palsy)
  C. Neuroimaging: normal brain parenchyma (no hydrocephalus, mass, structural lesion or meningeal enhancement). Venous thrombosis excluded in all
  D. Normal CSF constituents
  E. Elevated lumbar puncture pressure of at least 25 cmCS
  - IIH without papilloedema (IIHWOP) diagnostic criteria:
    Presence of criteria B–E for IIH plus unilateral or bilateral CN VI palsy
    Suggestion of possible IIHWOP if presence of criteria B–E plus three neuroimaging finding (empty sella, flattening of posterior aspect of the globe, distension of the perioptic subarachnoid space ± a tortuous optic nerve, transverse venous sinus stasis) suggestive of raised ICP

3.35.5 History

- Symptoms (Mollan et al. 2018)
  - Headache worse lying down (76–96%)
  - Transient visual obscurations lasting 1–30 s precipitated by posture/straining (68–72%)
  - Pulsatile tinnitus (52–61%)
  - Back pain (53%)
  - Dizziness (52%)
  - Neck pain (42%)
  - Blurred vision (32%)
  - Cognitive disturbance (20%)
  - Radicular pain (19%)
  - Diplopia from CN VI palsy (18%)
  - Nausea or vomiting

3.35.6 Examination

- CN VI palsy
- True disc swelling
  - Elevated appearance of optic nerve head
  - Blurring of disc margins
  - Peripapillary NFL oedema with obscuration of retinal vessels
  - Hyperaemia and dilation of the disc surface capillary net
  - Peripapillary haemorrhages (acute) and exudates (chronic)
  - Retinal venous dilatation and tortuosity
- Optociliary shunt vessels in chronic papilloedema
- Enlarged blind spot

3.35.7 Investigations

- MRI head: rule out tumour, hydrocephalus, meningeal lesion
- MRV/CTV: rule out cerebral venous thrombosis
- LP (normal opening pressure <20 cmH_2O or <25 cmH_2O in the obese): confirm raised ICP and normal CSF composition to rule out a meningeal process
- VF: enlarged blind spot

3.35.8 Treatment

- Weight loss with sodium reduction
- Medical:
  - Diamox
  - Topiramate
  - Furosemide
- Surgical:
  - Optic nerve sheath fenestration: for progressive visual loss despite maximally tolerated medical therapy
  - CSF diversion procedure (lumboperitoneal or ventriculoperitoneal shunt): for intractable headache despite maximally tolerated medical therapy

3.36 Septo-Optic Dysplasia (De Morsier Syndrome) (Fig. 3.45)

3.36.1 Risk Factors for Optic Nerve Hypoplasia

- Young maternal age
- Maternal drug (LSD) and alcohol abuse (fetal alcohol syndrome) during pregnancy
- Exposure to sodium valproate or phenytoin during pregnancy
- Maternal diabetes: superior segmental optic nerve hypoplasia (topless disc syndrome — superior entrance of central retinal vessels, superior disc pallor)

3.36.2 Examination

- Optic nerve hypoplasia (subnormal number of optic nerve axons with normal mesodermal elements and glial supporting tissue): small optic nerves with crowded vessels and a pale ring around the nerve (double ring

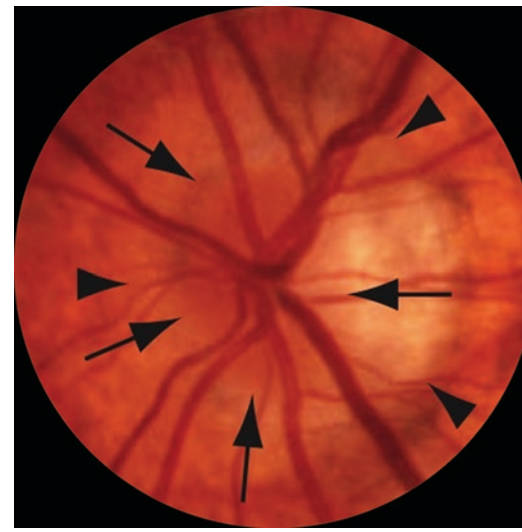

Fig. 3.45 Colour fundus image of a patient with optic nerve hypoplasia showing the double ring sign. Black arrows show the inner ring and the black arrowheads show the outer ring

sign — inner ring is the abnormal extension of the retina and RPE over the outer portion of the lamina cribrosa, outer ring is the consists of the normal junction between sclera and lamina cribrosa)

3.36.3 Investigations

- Bloods: hypopituitarism (GH, TSH, ACTH, ADH deficiency)
- MRI head and orbit: midline abnormalities — absent septum pellucidum and agenesis or thinning of corpus callosum

3.36.4 Treatment

- Refer to endocrinologists for hormonal supplementation
- Visual impairment registration

3.37 Tobacco-Alcohol Amblyopia

3.37.1 Pathophysiology

- Both smoking and alcohol can cause B12 deficiency. B12 and B9 (folate) deficiencies lead to increased formic acid production, which impairs the electron transport chain (mitochondrial oxidative phosphorylation). This leads to ATP deficiency, thus causing optic neuropathy
- Abuse of tobacco can lead to increased levels of cyanide in the body, which can impair the electron transport chain similarly to that of formic acid. Tobacco can also be toxic by causing disturbances in the metabolism of the vitamin B complex and by impairing vitamin B12 absorption
- Tobacco and alcohol act synergistically to cause optic nerve damage via a disease referred to as "tobacco-alcohol amblyopia". The theoretical mechanism of this disease is based on the decreased consumption of vitamin B12 from alcohol abuse combined with the decreased absorption of B12 from tobacco use leading to severely low levels of this vitamin in the body

3.37.2 Differential Diagnosis

- Toxic optic neuropathy
  - Drugs: vigabatrin, ethambutol, amiodarone, isoniazid, lead, methanol
- Inflammatory optic neuropathy
  - Typical/atypical optic neuritis
  - Sarcoidosis
  - Vasculitis, e.g. SLE, PAN
- Inherited
  - LHON: VA typically 6/60—HM
  - Kjer syndrome
  - Behr syndrome
  - Wolfram syndrome (DIDMOAD)
- Compressive/infiltrate optic neuropathy

3.37.3 History

- Symptoms:
  - Subacute, painless, bilateral progressive central vision loss
  - Colour desaturation (red desaturation)
  - Isolated numbness or paraesthesia
  - Gait abnormalities
  - Psychiatric or cognitive symptoms
- Alcohol abuse with malnourishment — caloric needs from alcohol. Which is lacking in the vitamin B complex — chronic alcohol abuse leads to systemic deficiencies in B1, B9, and B12
- Smoking
- FHx: inherited optic atrophy
- DHx: toxic optic neuropathy

3.37.4 Examination

- Bilateral decreased VA (typically 6/9–6/60) due to preferential damage to the papillomacular bundle3
- Reduced colour vision
- Sluggish pupil reactions; however, there may be no RAPD VF demonstrate bilateral central or cecocentral scotomas

- Optic discs may look normal initially or slight hyperaemic, progressing to temporal pallor over time
- Rule out any signs of intraocular inflammation

3.37.5 Investigations

- Bloods: vitamin B1 (thiamine), B2 (riboflavin), B3 (niacin or nicotinamide), B6 (pyridoxine), folate (B9), B12 (cobalamin)

3.37.6 Treatment

- Abstain from alcohol
- Abstain from tobacco
- Supplement deficient vitamins, specifically B12 (IM injections) and folate (oral)
- Pabrinex:
  - Indication: prophylaxis and treatment (to prevent irreversible Korsakoff's syndrome — reduced ability to acquire new memories) of Wernicke's encephalopathy (thiamine deficiency with triad of confusion, ataxia with wide spaced gait, ophthalmoplegia or nystagmus)
  - Contents: vitamins B and C (B1, B2, B3, B6, ascorbic acid)

3.38 Optic Atrophy in Infancy and Childhood

3.38.1 Causes

- Unilateral (other eye clinically normal with normal ERG/VEPs)
  - Tumour compression anterior to chiasm: optic nerve glioma — fusiform enlargement of optic nerve on MRI scan
  - Tumour infiltration anterior to chiasm: leukaemia
  - Trauma
  - Leber's hereditary optic neuropathy (LHON) before other eye affected (other eye usually affected within 2 months)
  - Glaucoma
- Bilateral ± nystagmus
  - Severe hypoxia
  - Hereditary optic neuropathies (LHON, ADOA — Kjer syndrome, AROA — Behr syndrome, Wolfram syndrome [AR] — DIDMOAD)
  - Tumour: glioma of the optic chiasm, craniopharyngioma
  - Increased ICP: congenital hydrocephalus, IIH
  - Optic neuritis
  - Toxic or nutritional optic neuropathy: drugs, avitaminosis
  - Neurometabolic

3.38.2 History

- History of birth (prematurity with IVH) or perinatal problems (whether child had to be in an incubator, have added oxygen, be ventilated, or had any difficulty in breathing, episodes of bradycardia or apnoea, resuscitation): perinatal asphyxia
- Family History of poor vision: hereditary optic neuropathy (LHON, ADOA, optic nerve gliomas in NF-1) or retinal dystrophies
- History of diabetes and hearing loss
- Headaches, vomiting: raised ICP
- History of trauma: traumatic optic neuropathy
- Sudden visual loss:
  - With pain: optic neuritis, infiltrations (leukaemia)
  - Without pain: LHON — peripapillary telangiectasia, NMO
- History of toxic drugs (anti-TB agents, e.g. ethambutol, systemic antibiotics, e.g. linezolid, immunomodulatory agents, e.g. infliximab), malnutrition (anorexia nervosa): toxic/nutritional optic neuropathy
- History of seizures: hereditary degenerative diseases

- History of other systemic disorders: syndromic optic neuropathy
- Any photophobia, blepharospasm, buphthalmos: congenital glaucoma

3.38.3 Examination

- Optic nerve function: VA, RAPD, colour vision (blue-yellow tritanopia of ADOA)
- Check for proptosis (axial for optic nerve glioma)
- Check IOP and measure the horizontal corneal diameter: glaucoma
- Examine parents and siblings: hereditary optic neuropathy (LHON, ADOA)
- Full systemic examination including dermatological (NF-1) and neurological

3.38.4 Investigations

- VF (age ≥5 years old): central or cecocentral scotomas for LHON or toxic/nutritional optic neuropathies
- MRI head/orbits: exclude tumours
- ERG: exclude a primary retinal disease (even if the retina appears normal)
- VEP: delayed with abnormal amplitude and waveform in the acute stage of optic neuritis
- Bloods: glucose, vitamin B1 (thiamine), B2 (riboflavin), B6 (pyridoxine), B12, folic acid levels
- Raised ICP: LP
- LHON: Mitochondrial DNA analysis for mutations (11,778, 14,484, 3460)

3.38.5 Treatment

- Treat the underlying cause
  - Nutritional optic neuropathy: Oral vitamin supplementation
  - Toxic optic neuropathy: stop drugs
  - Optic nerve glioma:
    Observation: isolated optic nerve involvement distant from the chiasm, good vision, non-disfiguring proptosis
    Surgical excision: reduced vision, pain, severe proptosis, posterior spread threatening the chiasm
    Chemotherapy/radiotherapy: chiasmal or midbrain involvement
- Visual impairment registration

3.39 Giant Cell Arteritis (GCA)

3.39.1 History

- Symptoms: abrupt onset headaches (usually unilateral in the temporal area), scalp tenderness, jaw claudication, visual symptoms (diplopia, reduced VA), constitutional symptoms (fever, weight loss, loss of appetite), vascular claudication of the limbs
- Osteoporotic risk factors and fractures

3.39.2 Examinations

- Abnormal superficial temporal artery: tender, thickened with reduced or absent pulsation
- RAPD suggesting AION or CRAO
- CN III, IV, VI palsy

3.39.3 Investigations

- Bloods: FBC (anaemia, thrombocytosis), raised CRP, raised ESR
- Temporal artery duplex US: hypoechoic halo due to vessel wall oedema in temporal arteries, positive for over 2 weeks post-steroid initiation
- Temporal artery biopsy: samples should be at least 2 cm in length, aim for within 1 week but sample can remain positive for 2–6 weeks after the commencement of treatment
  - Consent: risks — visible scarring, haematoma, wound infection, scalp or skin necrosis, facial nerve injury, cerebral infarction
  - Procedure:
    Map the artery by palpation or US doppler (mark skin overlying the artery)
    Hair removal for good surgical exposure

Clean the skin and inject local anaesthetic
Skin incision
Blunt dissection to artery — artery lies superficially in the superficial temporalis fascia
Tie the proximal and distal end of the artery with 4/0 silk or Vicryl before cutting
Close subcutaneous tissue with 5/0 interrupted Vicryl and skin closure with a running 6/0 Vicryl subcuticular suture
Compression bandage for 24 h

- MRI: in patients with suspected large vessel GCA, e.g. limb claudication or persistently high-inflammatory markers despite adequate glucocorticoid therapy
- CXR: every 2 years in patients with large vessel GCA

3.39.4 Interpretation of Investigations

- Bloods
  - ESR (upper limit in women: age + 10/2, upper limit in men: age/2): can be raised in patients with anaemia
- TAB
  - Length of specimen biopsied should be documented and known in order to be able to interpret findings correctly
  - TAB may be negative in some patients. Patients should be regarded as having GCA if there is a typical clinical picture and response to glucocorticosteroids. If features considered atypical or alternative explanations are available and TAB is negative, rapid glucocorticosteroid tapering (within 2 weeks).

3.39.5 Treatment

- British Society for Rheumatology guideline on diagnosis and treatment of giant cell arteritis (Mackie et al. 2020)
  - High dose glucocorticosteroid therapy should be initiated immediately when GCA is strongly suspected. 'Strongly suspected' GCA means that in the assessing clinician's judgement, GCA is a more likely explanation for the patient's symptoms that any other condition
  - Glucocorticoid starting dosages:
    The standard initial glucocorticoid dose for GCA is 40–60 mg oral prednisolone per day. The vast majority of patients with GCA symptomatically within 1–7 days to a 40–60 mg daily dose of prednisolone, apart from irreversible sequelae such as established visual loss, stroke or tissue necrosis. Failure to respond to this dose should prompt re-evaluation of the diagnosis
    GCA patients with acute or intermittent visual loss may initially be given 500 mg–1 g intravenous methylprednisolone daily for up to 3 consecutive days before commencing oral prednisolone therapy. If intravenous therapy is not immediately possible, this should not delay initiation of oral prednisolone (60–100 mg may be given for up to 3 consecutive days)
  - Glucocorticoid tapering regime:
    Glucocorticoid dose should be tapered to zero over 12–18 months, providing there is no return of GCA symptoms, signs or laboratory markers of inflammation. A more rapid dose reduction is appropriate for patients at high risk of glucocorticoid toxicity and/or those receiving concomitant glucocorticoid sparing therapy
    Initial dose of prednisolone continued until GCA symptoms and acute phase markers resolve (induction of clinical remission)
    Reduce daily dose by 10 mg every 2 weeks to 20 mg (aim to reach 20 mg prednisolone once the patient has been in remission for 4–8 weeks)

Reduce daily dose by 2.5 mg every 2–4 weeks to 10 mg
Reduce daily dose by 1 mg every 1–2 months
One week after any change in dose, review the person to exclude any relapse of symptoms (it may be possible to do this by telephone)
Return to previous higher prednisolone dose if headache symptoms return (and judged to be due to GCA relapse) during glucocorticoid taper
Consider high-dose oral prednisolone (40–60 mg) with or without glucocorticoid-sparing agent if jaw or tongue claudication occurs (and judged to be due to GCA relapse) during glucocorticoid taper
Investigate with vascular imaging (MRI, CT or FDG-PET/CT) and consider increasing oral prednisolone and/or adding glucocorticoid-sparing agent if weight loss, fever, night sweats, anaemia, persistent acute phase response, new/recurrent polymyalgia rheumatica symptoms, limb claudication, abdominal pain or back pain occurs (and judged to be due to GCA relapse) during glucocorticoid taper

- Methotrexate (MTX)
  MTX might be considered for GCA, in combination with a glucocorticoid taper, in patients at high risk of glucocorticoid toxicity or who relapse
- Proton pump inhibitors (recommended for GI protection — risk of GI bleed from corticosteroids)
- Osteoporosis prophylaxis
- The routine use of antiplatelet or anticoagulant agents for GCA is not recommended
- The routine use of cholesterol-lowering agents such as statins for GCA is not recommended
- Follow up:
  Weeks 0, 1, 3, 6, then months 3, 6, 9, 12 in the first year
  Arrange routine reviews a week after any change in dose
  After the first year, the person should be seen every 3–6 months (with extra visits for relapses or adverse events)

- Tocilizumab
  - Giant-Cell Arteritis Actemra (GiACTA) trial (Stone et al. 2017): tocilizumab with a tapering course of glucocorticosteroids was more effective than glucocorticosteroids alone at increasing the proportion of patients sustaining remission and time to first flare up at 52 weeks
  - NICE Guidance [TA518]: when used with a tapering course of glucocorticosteroids (and when used alone after glucocorticosteroids), is recommended as an option for treating GCA in adults only if:
    They have relapsing or refractory disease
    They have not already had tocilizumab
    Tocilizumab is stopped after 1 year of uninterrupted treatment at most

3.39.6 Complications

- Second eye involvement is 10% if treated and 95% if untreated
- Vascular: thoracic aortic aneurysms, TIA/CVA, MI
- Death

3.40 Comitant Esotropia (ET)

3.40.1 Other Diagnoses to Consider

- Type 1 Duane's syndrome: limitation of abduction, globe retraction in adduction
- Congenital CN VI palsy: limitation of abduction
- Convergence spasm: intermittent spasm of convergence, of miosis, and of accommodation, high myopia on dry retinoscopy accompanying the failure of abduction — treatment options include cycloplegia and bifocals

3.40.2 Classification of Comitant ET

- Primary ET
  - Accommodative ET:
    Refractive fully accommodative ET
    Refractive partially accommodative ET
    Non-refractive convergence excess ET with high AC/A ratio
  - Non-accommodative ET:
    Constant:
    - Starting <6 months: infantile ET
    - Starting >6 months: basic ET — muscle surgery

    Variable with distance:
    - Distance fixation only: distance ET (divergence insufficiency) — orthoptic exercises initially
    - Near fixation only: non-accommodative convergence excess — muscle surgery
    - Secondary sensory ET
    - Consecutive ET

3.40.3 Infantile ET

3.40.3.1 Definition

- Infantile esotropia is a constant non-accommodative ET with onset before 6 months of age in a neurologically normal child

3.40.3.2 Examination

- The angle is >30 PD with mild or no amblyopia (alternate fixation) and mild hyperopia
- Full extraocular motility: can elicit by monocular occlusion or performing a doll's head manoeuvre
- Dissociated vertical deviation (DVD): eye elevates and extorts and is not associated with a corresponding downwards movement of the other eye when fixation is resumed — can occur spontaneously or when the eye is occluded
- Inferior oblique overaction (IOOA): visible in adduction only and is associated with fundus excyclotorsion, if the eye elevates in adduction and there is a corresponding hypodeviation in the opposite eye the deviation is due to IOOA
- Latent nystagmus: horizontal jerk nystagmus that occurs on monocular occlusion, fast phase toward the uncovered eye (fixing eye), nystagmus lessened in adduction and worsened in abduction
- Optokinetic asymmetry: greater sensitivity to objects moving from temporal to nasal than from nasal to temporal
- Normal anterior/posterior segment examination

3.40.3.3 Investigations

- Cycloplegic refraction

3.40.3.4 Treatment

- Full hypermetropic correction if hyperopia ≥2.5 D
- Treat any amblyopia present: atropine penalisation or patching
- Muscle surgery (before age 2 — better stereopsis outcomes): bilateral MR recession, unilateral MR recession and LR resection, IO recession or myectomy for IOOA

3.40.4 Accommodative ET

3.40.4.1 Definition

- Accommodative ET describes an ET caused in whole, or in part, by the use of accommodation to clear vision in the presence of uncorrected hypermetropia

3.40.4.2 Classification

- Refractive fully accommodative ET
  - Equal distance and near deviation
  - ET resolves with full hypermetropic correction
- Refractive partially accommodative ET
  - Equal distance and near deviation
  - ET partially resolves with full hypermetropic correction
- Non-refractive accommodative convergence excess ET
  - Near ET
  - Little or no ET at distance
  - Deviation at least 10 PD more at near than at distance

3.40.4.3 Examination

- Full extraocular motility ± IOOA
- Normal anterior/posterior segment examination
- Determine AC/A ratio based on near-distance discrepancy (≥10 PD)

3.40.4.4 Investigations

- Cycloplegic refraction: hypermetropia ≥2.5 D

3.40.4.5 Treatment

- Refractive error correction
  - Full hypermetropic correction
  - Myopic correction if > −3.0 D
  - Executive bifocals (+3.00 near add) + full hypermetropic correction for non-refractive accommodative convergence excess ET
- Miotics: phospholine iodide — non-refractive accommodative convergence excess ET
- Treat any amblyopia present: atropine penalisation or patching
- Muscle surgery (for potential BSV or cosmesis when eyes not aligned adequately with glasses): bilateral MR recession

3.41 Comitant Exotropia (XT)

3.41.1 Other Diagnoses to Consider

- Sensory XT: abnormal anterior/posterior segment
- Type 2 Duane's syndrome: limitation of adduction, globe retraction in adduction
- Convergence insufficiency: near point of convergence greater than age for normal, no manifest deviation but may be exophoric for near — treatment options include full myopic correction, convergence exercises (e.g. pencil push ups), prisms, Botox, surgery

3.41.2 Classification of Comitant XT

- Primary XT:
  - Constant:
    Starting <6 months: Infantile XT
    Starting >6 months: Basic XT
  - Intermittent:
    Distance fixation only:
    - True divergence excess XT (normal AC/A ratio)
    - Simulated divergence excess XT (high AC/A ratio)

    Near fixation only: Near XT
- Secondary sensory XT
- Consecutive XT

3.41.3 Intermittent XT

3.41.3.1 Definition

- Intermittent XT is a strabismus condition with outward drifting of either eye interspersed with periods of good alignment or orthotropia
- Onset usually before 18 months of age
- XT at distance fixation with eyes remaining aligned for near fixation

3.41.3.2 Classification

- True divergence excess XT

Deviation ≥10 PD larger when measured at distance fixation than at near

- Simulated divergence excess XT

  Initial deviation ≥10 PD larger when measured at distance fixation than at near

  Misalignment at near fixation increases to <10 PD of the angle at distance following disruption of near binocular vision by 1 h of monocular occlusion or with +3.0 D lenses or pharmacological cycloplegia

3.41.3.3 Newcastle Control Score (NCS) for Intermittent XT

- A scoring system for grading the severity of intermittent distance XT (Haggerty et al. 2004). The components of the NCS are
  - Home control (subjective criteria):

    Score 0: XT or monocular eye closure never noticed

    Score 1: XT or monocular eye closure seen <50% of time child observed for distance fixation

    Score 2: XT or monocular eye closure seen >50% of time child observed for distance fixation

Score 3: XT or monocular eye closure seen for distance and near fixation
- Clinic control near (objective criteria):
  Score 0: Manifest only after cover test (CT) and resumes fusion without need for blink or refixation
  Score 1: Blink or refixate to control after CT
  Score 2: Manifest spontaneously or with any form of fusion disruption without recovery
- Clinic control distance (objective criteria):
  Score 0: Manifest only after cover test (CT) and resumes fusion without need for blink or refixation
  Score 1: Blink or refixate to control after CT
  Score 2: Manifest spontaneously or with any form of fusion disruption without recovery

- Total score 0–7
- Surgical intervention indicated for NCS ≥3 to achieve a cure (NCS 0 or 1)

3.41.3.4 Examination
- Full extraocular motility: can elicit by monocular occlusion or performing a doll's head manoeuvre
- Normal anterior/posterior segment examination

3.41.3.5 Investigations
- Cycloplegic refraction

3.41.3.6 Treatment
- Refractive error correction:
  - Full myopic correction in children
  - Hypermetropia correction if > +4.00 D
- Muscle surgery (NCS ≥3):
  - Simulated distance XT: unilateral MR resection and LR recession
  - True distance XT: bilateral LR recession

3.42 Amblyopia Management (Table 3.33)

3.42.1 Classification

- Strabismic amblyopia
- Refractive amblyopia
- Stimulus deprivation amblyopia

3.42.2 Methods of Detection

- Reduced BCVA in the absence of an organic cause
- Crowding phenomenon: scores better with single optotypes
- Tolerance of a neutral density filter: classically in amblyopia VA is reduced less by the addition of neutral density filters than in other causes of reduced VA

3.42.3 Methods of Treatment

- Refractive error correction alone first-spectacle adaptation phase of 18 weeks:
  - Correct anisometropia > 1.00 D and correct astigmatism > 1.50 D
  - Full myopic correction in children > 3.5 years old if VA <6/9 and myopia > −0.75 D
- Occlusion therapy (if reduced VA remains after 18 weeks of refractive error correction):

Table 3.33 Key facts about amblyopia

- Amblyopia is the decrease of best corrected visual acuity (BCVA) by one line or more caused by pattern vision deprivation or abnormal binocular interaction for which no causes can be detected by the physical examination of the eye
- Development of amblyopia occurs during the critical period of visual development (the first 7–8 years of life)

  - Moderate amblyopia (6/12 to 6/24): 2 h per day of total occlusion is as effective as 6 h per day of total occlusion for improving visual acuity in children aged 3–7 years (The Pediatric Eye Disease Investigator Group 2003a)
  - Severe amblyopia (6/30 to 6/120): 6 h per day of total occlusion is as effective as all-day full-time occlusion for improving visual acuity in children aged 3 to less than 7 years of age (The Pediatric Eye Disease Investigator Group 2003b)
  - Teenagers (13–17 years old) who have never before received amblyopia treatment may improve visual acuity from a trial of occlusion therapy for 2–6 h per day (The Paediatric Eye Disease Investigator Group 2005)
- Penalisation therapy:
  - Moderate amblyopia (6/12 to 6/24): atropine is as effective as 6 h per day of total occlusion for improving visual acuity in children aged 3 to less than 7 years (The Pediatric Eye Disease Investigator Group 2002)

3.43 Retinopathy of Prematurity (ROP)

3.43.1 Classification of ROP

The International Classification of ROP (An International Committee for the Classification of Retinopathy of Prematurity 2005):

- Plus disease
  - Retinal arterial tortuosity ± venous dilatation in the posterior pole in at least two quadrants
  - Pre-plus disease is the presence of retinal arterial tortuosity ± venous dilatation in the posterior pole in one quadrant only
- Zones
  - Zone I:
    Area in a circle twice the radius of the distance from the optic disc to the foveola
    Approximate temporal extent of Zone I can be determined by using a 25- or 28-D lens:
    - Place nasal edge of optic disc at one edge of the field of view
    - Limit of Zone I is at the temporal field of view
  - Zone II:
    Area in a circle centred on the optic disc with a radius of the distance from the optic disc to the nasal ora serrata
  - Zone III:
    Includes remainder of the fundus outside zones I and II
- Staging
  - Stage 1 (see Fig. 3.46):
    Flat demarcation line separating vascular and avascular retina
  - Stage 2 (see Fig. 3.47):
    Border thickens and appears elevated (ridge); small tufts of vessels may be present at border
  - Stage 3 (see Fig. 3.48):
    Presence of a ridge with extraretinal fibrovascular proliferations
    Blood vessels grow through the ILM of the retina at the ridge into the vitreous
  - Stage 4:
    4a - Macula on partial tractional RD
    4b - Macula off partial tractional RD
  - Stage 5:
    5a - Open funnel total tractional RD
    5b - Closed funnel total tractional RD

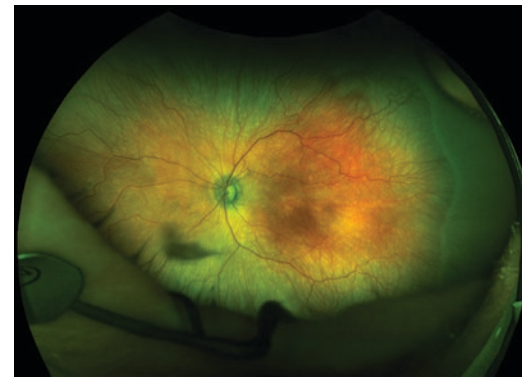

Fig. 3.46 Optos pseudocolour fundus image of a patient with stage I ROP with no plus disease

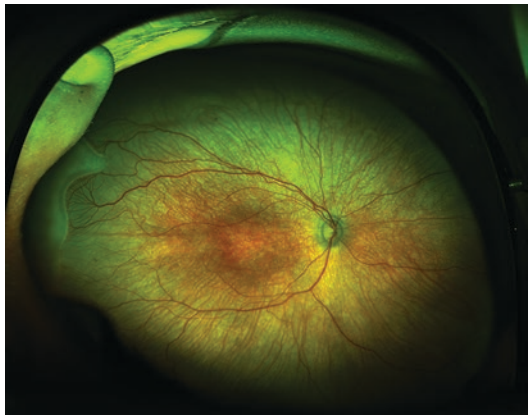

Fig. 3.47 Optos pseudocolour fundus image of a patient with stage II ROP with pre-plus disease

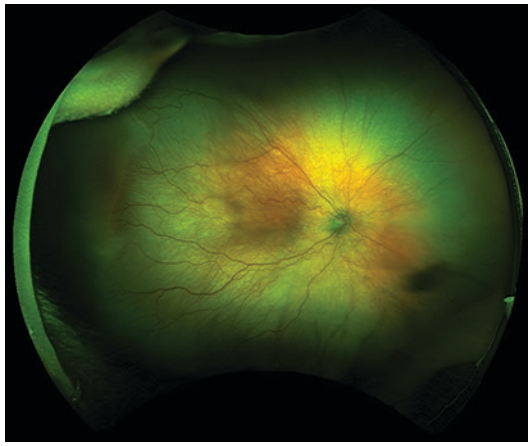

Fig. 3.48 Optos pseudocolour fundus image of a patient with stage III ROP with plus disease

3.43.2 UK ROP Guideline 2008

3.43.2.1 Screening Inclusion Criteria

- Must be screened: birth weight <1251 g and/or gestational age <31 weeks
- Should be screened: birth weight <1501 g and/or gestational age <32 weeks

3.43.2.2 First Screening Examination

- Gestational age <27 weeks: 30–31 weeks post-menstrual age
- Gestational age 27–32 weeks: 4–5 weeks postnatal age
- Gestational age >32 weeks: 4–5 weeks postnatal age

3.43.2.3 Frequency of Screening

- Weekly: vessels end in zone I or posterior zone II or any plus or pre-plus disease or any stage 3 disease (any zone)
- Fortnightly: all other circumstances where termination criteria not reached

3.43.2.4 Termination of Screening

- Babies with ROP that have two successive examinations showing any of
  - Lack of increase in intensity
  - Partial resolution progressing towards complete resolution
  - Change in colour in the ridge from salmon-pink to white
  - Transgression of vessels through the demarcation line
  - Commencement of the process of replacement of active ROP lesions by scar tissue
- Babies without ROP
  - Vascularisation has extended into zone 3

3.43.2.5 Treatment Criteria

- Stage 3 Zone 2 with plus disease
- Stage 3 Zone 1 without plus disease
- Any Stage Zone 1 with plus disease
- Stage 2 Zone 2 with plus disease (consider treatment)

3.43.2.6 Timing of Treatment

- Aggressive ROP: treat ASAP (<48 h)
- All other ROP requiring treatment: treat within 48–72 h

3.43.2.7 Treatment Technique

- Transpupillary diode laser to give near confluent (0.5–1 burn width) laser burn spacing to the entire avascular retina

3.43.2.8 Post-Treatment Follow Up

- First examination: 5–7 days post treatment
- Subsequent examination: Initially at least weekly, then as clinically indicated until at least 5 years of age

3.43.2.9 Re-Treatment

- Failure of ROP to regress: 10–14 days post-initial treatment

3.44 Penetrating Eye Injury

3.44.1 History

- Mechanism of injury
- Tetanus status

3.44.2 Examination

- IOP: may be reduced
- Lids: lid lacerations with or without involvement of the lid margin or canaliculus
- Conjunctiva: conjunctival lacerations, subconjunctival haemorrhage
- Cornea: penetrating corneal injury — perform a seidel test
- Sclera: penetrating scleral injury
- AC: formed or flat, hypopyon, hyphaema
- Iris: iris hole (transillumination), peaked pupil
- Perform gonioscopy to look for angle recession and occult intraocular foreign body (IOFB) in angle
- Lens: traumatic cataract (focal) ± disruption of anterior/posterior lens capsule ± zonular dehiscence ± subluxation/dislocation, IOFB
- Fundus: vitreous/retinal haemorrhage, retinal tear(s), RD, commotio retinae, choroidal rupture, IOFB (see Fig. 3.49)

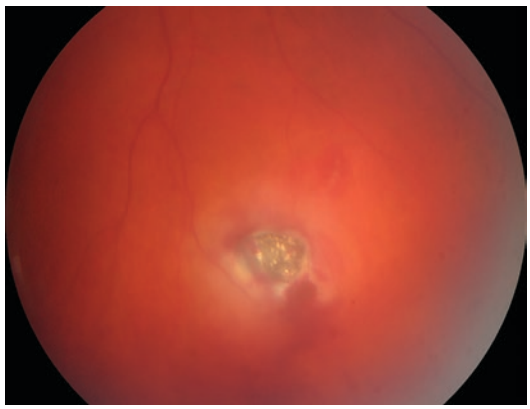

Fig. 3.49 Colour fundus image of a patient with a metallic IOFB dislodged in the retina

3.44.3 Investigations

- B-scan (if poor view of fundus): IOFB (highly reflective mobile appearing opacity), RD or choroidal haemorrhage
- CT orbit with 2 mm slices: orbital fractures, IOFB
- Full field ERG: siderosis causes a progressive reduction in the B-wave with eventual total extinguishing

3.44.4 Treatment

- Pre-operative
  - Admit and prepare for GA (NBM, determine last meal/drink, liaise with anaesthetist, ECG/bloods if indicated)
  - Protect globe with clear plastic shield
  - Systemic antibiotics, e.g. ciprofloxacin 750 mg BD ± topical antibiotics
  - Administer tetanus vaccine/toxoid if indicated
- Intraoperative
  - Primary globe repair:

    Limbus is repaired first typically with 9/0 nylon sutures

    Any corneal laceration is then repaired typically with 10/0 nylon sutures (longer compression suture throws are used in the peripheral cornea and shorter suture throws used in the central cornea) — rotate sutures to bury knots; return exposed viable iris tissue through perforation; abscise exposed tissue if non-viable

    Any scleral laceration is then repaired (following a conjunctival peritomy) in an anterior to posterior direction with 8/0 nylon sutures; return exposed viable uveal tissue through perforation; cut prolapsed vitreous flush to wound taking care not to induce vitreous traction
  - IOFB removal

    AC IOFB: corneal approach, removal with fine forceps

    Angle IOFB: scleral trapdoor approach

Lenticular IOFB: consider leaving in situ or remove with lens at cautious cataract surgery

Posterior segment IOFB: intraocular magnet or vitrectomy forceps

– Lid laceration repair
– Secondary procedures

Traditionally performed 4–10 days after initial injury, in part, to allow for the formation of a PVD

PPV + tamponade (C3F8 or silicone oil) ± membrane dissection (if PVR) ± encircling buckle (if breaks) ± lensectomy (if cataract; IOL commonly deferred) ± intravitreal antibiotics (if endophthalmitis)

3.44.5 Tetanus Prophylaxis

- Tetanus vaccine treatment (3 doses of 0.5 mL IM Td/IPD, separated by 4 weeks, with a booster after 10 years) if
  – Patient non-immune and wound is clean or tetanus prone
  – Patient is uncertain of vaccination status and wound is clean or tetanus prone
- Tetanus immunoglobulin treatment if
  – Patient non-immune and wound is tetanus prone
  – Patient is uncertain of vaccination status and wound is tetanus prone

3.45 Atypical Optic Neuritis (Table 3.34)

Table 3.34 Key facts about atypical optic neuritis

- Atypical optic neuritis is a heterogeneous collection of disorders whose presenting features suggest inflammation of the optic nerve
- Inflammation of the optic nerve may be divided into papillitis (disc is swollen), retrobulbar neuritis (disc is spared), and neuroretinitis (retinal involvement, macular star)
- If an acute optic neuropathy does not fulfil the criteria for typical optic neuritis (see Sect. 3.45.1) then it must be investigated further as an atypical optic neuritis to exclude a compressive lesion or other serious pathology

3.45.1 Features of Typical Optic Neuritis (Acute Demyelinating Optic Neuritis)

- Age 20–50
- Unilateral
- Worsens over hours/days
- Recovery starts within 2 weeks
- Retrobulbar pain (may be worse on eye movements) — present in 92% of cases
- Reduced colour vision
- RAPD — disc swelling only present in 1/3 of cases

3.45.2 Features of Atypical Optic Neuritis

- Absence of pain
- Grossly swollen optic disc with peripapillary haemorrhages
- Bilateral
- Severe loss of vision over several weeks
- Recurrence on cessation of steroids

3.45.3 Causes of Atypical Optic Neuritis

- Infection: syphilis, TB, lyme, HIV
- Lymphoproliferative (directly or indirectly related to the haematological disease): lymphoma, leukaemia, neurotoxic treatments post bone-marrow transplant
- Systemic immune mediated disorders: neurosarcoidosis, IBD, systemic vasculitis, connective tissue disease
- Antibody mediated neurological illness: NMO spectrum disorder (NMOSD), MOG antibody mediated demyelinating disease

3.45.4 History

- Course of optic nerve dysfunction both current and in the past: persistent visual loss, negligible spontaneous improvement
- Presence of paraesthesia, weakness of limbs — clumsiness with dropping things frequently, bowel and bladder incontinence — NMOSD
- Any recent infections or vaccinations — vaccinations induced optic neuritis

- History of lymphoproliferative diseases, IBD, connective tissue disorders
- History of autoimmunity (e.g. MG, hypothyroidism): NMOSD frequently associated with systemic autoimmune disorders
- Concurrent or recent treatments, e.g. bone marrow transplant, new biologic agents such as monoclonal antibodies

3.45.5 Examination

- Optic nerve function: VA, RAPD, colour vision, confrontational VF
- Cranial nerve: CN VII involvement in Sarcoidosis — Heerfordt's syndrome (CN VII palsy, uveitis, parotid/submandibular gland enlargement)
- Uveitis (anterior, intermediate or posterior): sarcoidosis, infective causes, lymphoproliferative causes
- Skin: erythema nodosum (red tender elevated lesions on the shins)

3.45.6 Investigations

- HVF
- MRI brain with gadolinium contrast ± spinal cord (transverse myelitis — lesion extending continuously over ≥3 vertebral segments)
- Bloods:
  - VDRL: syphilis
  - FBC, ESR: lymphoproliferative
  - ACE: sarcoidosis
  - Aquaporin-4 antibodies: NMOSD
  - Myelin oligodendrocyte glycoprotein (MOG) antibodies
- CXR: sarcoidosis (hilar lymphadenopathy, pulmonary fibrosis), TB

3.45.7 Treatment

- High dose oral/IV corticosteroids, followed by a reducing dose oral steroid programme
- Refer to respiratory team for bronchoscopy
- Refer to neurologists for full neurological examination

3.46 Carotid Artery Dissection (Table 3.35)

3.46.1 History

- Symptoms: headache, ocular pain, neck pain, Horner's syndrome (caused by compression of the ascending sympathetic supply within the carotid sheath), symptoms of TIA/CVA (over 50% of patients with a spontaneous ICA dissection present initially as a stroke or TIA with hemiplegia, dysarthria, dysphagia, or amaurosis fugax)
- History of neck trauma (e.g. from car accident with seat belt injury to neck)
- History of hereditary connective tissue disorders

3.46.2 Examination

- Horner's syndrome
- Deviation of tongue to affected side: compression of hypoglossal nerve (CN XII)
- Neurological examination

3.46.3 Investigation

- CTA or MRA

Table 3.35 Key facts about carotid artery dissection

- Dissection occurs when a tear forms within the inner wall of an artery
- Bloods enters tunica media of the vessel and forms an intramural haematoma along plane of the vessel wall — may cause vessel wall to bulge toward the lumen, leading to stenosis, or it may cause outward pseudoaneurysmal bulging of the vessel wall
- Cervical artery dissection accounts for only 1–2% of all ischaemic strokes, but in young and middle-aged people it accounts for 10–25% of strokes (Debette and Leys 2009)
- May occur spontaneously or secondary to trauma, hereditary connective tissue disorders (Marfan syndrome, Ehlers-Danlos syndrome, osteogenesis imperfecta)

3.46.4 Treatment

- Patients are treated empirically with either antiplatelet (aspirin, clopidogrel, dipyridamole) or anticoagulation (warfarin, heparin) therapy to prevent formation of a thrombus at the site of dissection and subsequent embolisation. However, there is no difference in efficacy of antiplatelet and anticoagulant drugs at preventing stroke and death in patients with symptomatic carotid and vertebral artery dissection (The CADISS Trial Investigators 2015; Markus et al. 2019)

3.46.5 Prognosis

- The risk of stroke is zero for patients who present with anything other than an initial stroke (The CADISS Trial Investigators 2015)
- For patients who present initially with symptoms of a stroke, only 2% will have a stroke recurrence (The CADISS Trial Investigators 2015)
- All stroke events occur in the first 10 days (The CADISS Trial Investigators 2015)

3.47 Transient Ischaemic Attack (TIA) and Stroke: NICE Guidance [TA128]

3.47.1 Prompt Recognition of Symptoms of Stroke and TIA

- FAST (Face Arm Speech Test):
  - Validated tool used outside of hospital to screen for a diagnosis of stroke or TIA in people with sudden onset of neurological symptoms:
  - Face: ask the person to smile
    Arm: ask the person to raise both arms
    Speech: ask the person to repeat a simple phrase

3.47.2 Assessment of People Who Have Had a Suspected TIA, and Identifying Those at High Risk of Stroke

- $ABCD^2$ score (0–9): A validated scoring system for assessing the risk of a subsequent stroke for people who have had a suspected TIA (that is, they have no neurological symptoms at the time of assessment and neurological symptoms lasted <24 h)
- Age ≥60 years old (1 point)
- BP ≥140/90 (1 point)
- Clinical features
  - Unilateral weakness (1 point)
  - Speech disturbance without weakness (1 point)
- Diabetes (1 point)
- Duration of symptoms
  - Symptoms lasting ≥1 h (2 points)
  - Symptoms lasting 10–59 min (1 point)
- People who have had a suspected TIA who are at high risk of stroke ($ABCD^2$ score ≥4) should have
  - Aspirin 300 mg OD started immediately
  - Specialist assessment and investigation within 24 h of onset of symptoms
  - Measures for secondary prevention introduced as soon as the diagnosis is confirmed, including discussion of individual risk factors
- People with crescendo TIA (two or more TIAs in a week) should be treated as being at high risk of stroke, even though they may have an $ABCD^2$ score of 3 or below
- People who have had a suspected TIA who are at lower risk of stroke (ABCD2 score ≤3) should have
  - Aspirin 300 mg OD started immediately
  - Specialist assessment and investigation ASAP, but definitely within 1 week of onset of symptoms
  - Measures for secondary prevention introduced as soon as the diagnosis is confirmed, including discussion of individual risk factors

- People who have had a TIA but who present late (more than 1 week after their last symptom has resolved) should be treated as though they are at a lower risk of stroke

3.47.3 Urgent Carotid Endarterectomy and Carotid Stenting

- People with stable neurological symptoms from acute non-disabling stroke or TIA who have symptomatic carotid stenosis of 50–99% according to the North American Symptomatic Carotid Endarterectomy (NASCET) Trial criteria (Ferguson et al. 1999), or 70–99% according to the European Carotid Surgery Trial (ECST) criteria (European Carotid Surgery Trialists Collaborative Group 1991) should
  - Be assessed and referred for carotid endarterectomy within 1 week of onset of stroke or TIA symptoms
  - Undergo surgery within a maximum of 2 weeks of onset of stroke or TIA symptoms
  - Receive best medical treatment (control of BP, antiplatelet agents, cholesterol lowering through diet and drugs, lifestyle advice)
- People with stable neurological symptoms from acute non-disabling stroke or TIA who have symptomatic carotid stenosis of less than 50% according to the NASCET criteria, or less than 70% according to the ECST criteria should
  - Not undergo surgery
  - Receive best medical treatment (control of BP, antiplatelet agents, cholesterol lowering through diet and drugs, lifestyle advice)

3.47.4 Pharmacological Treatments for People with Acute Stroke

- Thrombolysis with alteplase:
  - Recommended for treating acute ischaemic stroke in adults if:

    Treatment is started as early as possible within 4.5 h of onset of stroke symptoms and Intracranial haemorrhage has been excluded by appropriate imaging techniques
- Aspirin and anticoagulant treatment
  - People with acute ischaemic stroke:

    All people presenting with acute stroke who have had a diagnosis of primary intracerebral haemorrhage excluded by brain imaging should, ASAP but certainly within 24 h, be given:
    - Aspirin 300 mg PO if they are not dysphagic
    - Aspirin 300 mg PR or by enteral tube if they are dysphagic

    Thereafter aspirin should be continued until 2 weeks after the onset of stroke symptoms, at which time definitive long-term antithrombotic treatment should be initiated
  - People with stroke associated with acute arterial dissection:

    Treat with either anticoagulants or antiplatelet agents
  - People with acute venous stroke:

    People diagnosed with cerebral venous sinus thrombosis should be given full-dose anticoagulant treatment (initially full dose heparin and then warfarin INR 2–3) unless there are comorbidities that preclude its use

3.48 Amaurosis Fugax (Table 3.36)

3.48.1 Causes

- Embolic
  - Carotid artery disease:

    Atherosclerosis

    Dissection

    Aneurysms
  - Cardiac disease:

    Valvular heart disease

    Mural thrombi, e.g. lesions associated with AF or MI

    Intracardiac tumour, e.g. atrial myxoma

Table 3.36 Key facts about amaurosis fugax

- Defined as transient monocular visual loss attributed to ischaemia or vascular insufficiency
- Typically, patients describe diminished or absent vision in one eye that progresses over a few seconds and lasts for seconds to a few minutes followed by complete recovery

  - Drug abuse:
    Talc retinopathy
- Haemodynamic
  - Inflammatory arteritis:
    Takayasu's disease
  - Hypoperfusion:
    Heart failure
    Acute hypovolaemia
- Ocular
  - AION
  - CRAO/BRAO
  - CRVO
- Neurologic
  - Optic neuritis, optic nerve or chiasm compression
  - Papilloedema
  - MS
  - Migraine
- Idiopathic

3.48.2 History

- Ask about symptoms of GCA: headache, jaw claudication, scalp tenderness, weight loss, fever
- Ask about cardiovascular risk factors: HTN, DM, hypercholesterolaemia, smoking
- Ask about use of recreational drug use: talc
- Ask about symptoms of migraine: unilateral headache, photophobia/phonophobia, nausea/vomiting, aura that usually precedes the headache (visual — starts paracentrally and expands temporally with advancing edge forms a positive scotoma, motor — hemiparesis, speech — dysphasia, somatosensory — hemianaesthesia/paraesthesia)
- Ask about symptoms of MS
  - Ocular symptoms: pain on eye movements, rapid decrease of vision over hours/days with recovery starting at 2 weeks
  - Systemic symptoms: limb weakness, paraesthesia, urine retention, incontinence

3.48.3 Examination

- Ophthalmic examination to exclude
  - Retinal vascular diseases
  - Optic neuropathy

3.48.4 Investigations

- Bloods: FBC, CRP, ESR
- TAB
- Carotid doppler
- Cardiac echocardiography
- MRI head

3.48.5 Treatment

- Treat underlying cause
- Refer to TIA clinic with ABCD^2 score

3.49 Juvenile Idiopathic Arthritis (JIA) (Table 3.37)

3.49.1 International League of Associations of Rheumatologists Classification

- Systemic disease
- Polyarticular rheumatoid factor positive: five or more joints affected during the first 6 months of disease
- Polyarticular rheumatoid factor negative: five or more joints affected during the first 6 months of disease

Table 3.37 Key facts about JIA

- Chronic rheumatic disease of childhood characterised by chronic inflammatory arthritis (swelling within a joint or limitation in range of movement with joint pain or tenderness which persists for a minimum of 6 weeks)
- Onset prior to age 16 years old
- More common in girls but boys get higher rates of visual loss and complications
- Annual incidence in the UK is 1:10,000 with a prevalence of 1:1000 (The BSPAR and RCOphth guidelines for screening for uveitis in JIA 2006)
- Type of arthritis and the age at onset dictates the risk of developing uveitis
- Uveitis in JIA is asymptomatic until visual complications arise and therefore screening by slit-lamp is essential for diagnosis
- Visual impairment arises mainly from complications of the uveitis including cataract, glaucoma, macular oedema, hypotony

- Oligoarticular persistent: one to four joints affected throughout the first 6 months of disease
- Oligoarticular extended: one to four joints affected throughout and after the first 6 months of disease
- Psoriatic arthritis
- Enthesitis-related arthritis
- Undifferentiated arthritis

3.49.2 Risk Factors for Developing Uveitis in JIA

- Oligoarticular group
- ANA positive
- Female
- <7 years old at age of onset

3.49.3 Examination

- Articular
- Ocular
  - Chronic recurrent anterior uveitis with a white eye, usually bilateral
  - Complications of uveitis:
    Band keratopathy
    Macular oedema
    Cataract
    Glaucoma
    Hypotony that may lead to phthisis bulbi

3.49.4 Investigations

- Bloods: ANA
- OCT: macular oedema

3.49.5 Treatment

- Arthritis
  - Physiotherapy
  - Occupational therapy
  - Joint inflammation:
    NSAIDs
    Oral corticosteroids
    Immunosuppresants
    Biologics: adalimumab, etanercept, tocilizumab are recommended for treating polyarticular and extended oligoarticular JIA (NICE guidance)
- Anterior uveitis and macular oedema
  - Topical steroids + mydriatics
  - Subtenon injection of steroids/orbital floor injections
  - Oral corticosteroids
  - Immunosuppresants: methotrexate (MTX)
  - Biologics: infliximab, adalimumab
- Complications of ocular inflammation
  - Glaucoma:
    Topical medications
    Trabeculectomy
    GDI
  - Cataract:
    Cataract extraction once uveitis quiescent for at least 3 months

Preoperative considerations:
- Determine visual potential
- Concurrent surgery: co-existing ERM, vitreous opacity
- Frequent topical ± oral steroid 1–2 week before surgery

Intraoperative considerations:
- Maximise pupil size: synechialysis, intracameral phenylephrine, iris hooks
- Large capsulorrhexis to prevent post-operative capsular phimosis
- Meticulous removal of all nuclear matter and cortical matter

Postoperative considerations:
- Frequent topical ± oral steroids (if started preoperatively) that are tapered slowly to zero or maintenance dose
- Close follow up: 1 day post-op, 1 week post-op, 6 weeks post-op

– Band keratopathy:
  Chelation with ETDA
  PTK

3.49.6 BSPAR and the RCOphth Guidelines for Screening for Uveitis in JIA 2006

3.49.6.1 Principles
- Initial screening examination within 6 weeks of referral
- Symptomatic patients or patient suspected of cataracts or synechiae should be seen within 1 week of referral
- EUA should be considered if the patient is uncooperative at initial screening or for an urgent symptomatic examination in a young child
- Screening should restart at 2 monthly intervals after stopping MTX or any other immunosuppressant therapy during the period of maximum risk for 6 months before reverting to the previous screening arrangements

3.49.6.2 Specific Screening Schedules
- First screening within 6 weeks of referral
- 2 monthly intervals from onset of arthritis for 6 months, then 3–4 monthly screening for time outlined below:
  – Oligoarticular JIA, Psoriatic arthritis onset and Enthesitis related arthritis irrespective of ANA status onset under 11 years:
    <3 years old at onset: screen for 8 years
    3–4 years old at onset: screen for 6 years
    5–8 years old at onset: screen for 3 years
    9–10 years old at onset: screen for 1 year
  – Polyarticular ANA + JIA onset under 10 years:
    <6 years old at onset: screen for 5 years
    6–9 years old at onset: screen for 2 years
  – Polyarticular ANA-JIA onset under 7 years:
    All children need 5 years of screening
- Alternative method is to screen all these groups until age 11–12 years
- Older patients presenting for the first time after the age of 11 should undergo 1 year of screening

3.50 Paediatric Cataract

3.50.1 History

- Any family history of childhood cataracts (parents, siblings)
- Exposure to corticosteroid or radiation therapy
- Ocular trauma: accidental or non-accidental
- Co-morbidities suggesting systemic disease:
  – Galactosaemia: failure to thrive
  – Lowe syndrome: hypotonia, problems with weight gain, delayed milestones, feeding difficulties
  – Dysmorphic features suggestive of a syndrome
- Intrauterine infections (TORCH): associated with severe intraocular disease

- Age child was first noted to squint or have leukocoria
- If bilateral cataracts, ask parents when they first noted abnormal visual behaviour or nystagmus

3.50.2 Examination

- Vision testing
  - Fix and following a target (CSM method: **C**entral — location of corneal light reflex under monocular conditions, **S**teady — steadiness of fixation as light is held motionless and slowly moved around under monocular conditions, **M**aintained — binocular conditions): 3 months onwards
  - Forced choice preferential looking tests (e.g, Teller acuity card): 0–1 year
  - Cardiff cards: 0–2 years
  - 3 m logMAR uncrowded Kay pictures: 18 months to 3 years
  - 3 m logMAR crowded Kay pictures: 2–4 years
  - 3 m logMAR crowded letters: Above 3 years
- Pupillary reflexes for an RAPD: suggests poor visual potential
- Look for nystagmus: suggests severe visual impairment and poor visual potential
- Slit lam exam
  - Evaluate cornea
  - Evaluate iris
  - Evaluate morphology of cataract:
    Anterior polar: AD inheritance, minimal visual deprivation, non-progressive
    Anterior subcapsular: atopic dermatitis
    Posterior subcapsular: radiation
    Lamellar: rubella, diabetes, galactosaemia
    Sutural: Fabry's disease, mannosidosis
    Posterior cortical with lenticonus: Alport's syndrome
    Nuclear: rubella, galactosaemia ("oil droplet" cataract)
- Dilated fundus examination
  - Optic nerve
  - Retina
- Examine parents and siblings: presence of asymptomatic cataracts may establish the heredity

3.50.3 Investigations

- B-scan: if density of cataract precludes an adequate view of the fundus
- Unilateral cataracts: no tests required as most are isolated ocular problems
- Bilateral cataracts
  - No tests required if positive family history and child has no other medical problems
  - If no family history — investigate for systemic associations:
    Paediatric systemic evaluation
    Galactosaemia: urinalysis for reducing substances, galactokinase levels
    Lowe syndrome: urine amino acids, serum electrolytes, enzyme assay on cultured skin fibroblasts, OCRL gene testing
    TORCH screen: serology for toxoplasma, syphilis, rubella, CMV, HSV
    Karyotyping and geneticist involvement if dysmorphic features are present in child

3.50.4 Treatment

- Non-surgical
  - Observation: cataracts that are not in the visual axis, <3 mm in diameter, partial density
  - Dilation
- Surgical
  - Indications: visually significant cataracts: cataracts that are dense, central/axial, posterior, >3 mm in diameter
  - Determining whether a cataract is visually significant in young children who can't use an eye chart:

Retinoscopy: blackening of the retinoscopic reflex in the visual axis (i.e. how much of the pupil has an absent red reflex) is suggestive of a visually significant cataract

Fixation behaviour of the cataractous eye

– Preoperative considerations:

Timing of cataract surgery:

- 6 weeks for a unilateral cataract
- 10 weeks for a bilateral cataract (1–2 week period between lensectomy for each eye)

IOL implantation:

- Infant Aphakia Treatment Study (Infant Aphakia Study Treatment Group 2010, 2014): IOL implantation vs CL for the correction of aphakia in infants aged 1–7 months with unilateral congenital cataracts. No significant difference in VA for infants with a unilateral congenital cataract who were corrected with a CL compared to an IOL after cataract surgery at 5 years. IOL may be better for families who have a developmentally delayed child or are expected to have difficulty caring for the contact lenses
- IoLunder2 study (Solebo et al. 2018): children aged 2 years or younger who had cataract surgery with IOL implantation versus cataract surgery with aphakic correction with contact lenses or glasses. IOL implantation does not confer better vision or protection against postoperative glaucoma. IOL implantation increases the risk of requiring early reoperation in children younger than 2 years with bilateral or unilateral cataract

Biometry: performed in the operating room with the child under anaesthesia, A-scan to determine axial length, handheld keratometer to determine K readings.

– Intraoperative considerations:

Suturing of corneal wound incisions (absorbable 10/0 sutures): corneal tissue is less likely to self-seal in children and children more prone to traumatising the eye

Posterior capsulotomy + anterior vitrectomy (up to age 6 or 7): secondary opacification of the posterior capsule is more frequent and thicker in children

Subconjunctival dexamethasone: IATS showed similar rates of pupillary membrane formation with or without subconjunctival dexamethasone

– Postoperative considerations:

Glaucoma: 28% risk in the IOL group and 35% risk in the contact lens group at 5 years in the Infant Aphakia Treatment Study (Infant Aphakia Treatment Study Group 2014), no significant difference in glaucoma incidence between the CL and IOL groups at 5 years in the Infant Aphakia Treatment Study (Infant Aphakia Treatment Study Group 2014)

Amblyopia: occlusion therapy of the preferred eye

Inflammation (due to increased tissue reactivity, inflammatory complications, e.g. AC cell and flare, cell deposits on IOL optic, PS) are more frequently observed in children: topical (6×/day for 1 month) ± oral steroids postoperatively

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4 Attitudes, Ethics and Responsibilities in Clinical Practice

Timothy H. M. Fung and Winfried M. K. Amoaku

4.1 GMC Guidance: Doctors Use of Social Media 2013

4.1.1 Facebook: Patient Asking to Add You As a Friend on Facebook

- It is important that doctors maintain a professional boundary between themselves and their patients, however minimal the professional contact may be. This professional boundary is important to maintain trust
- If the boundary is breached, whether the breach is deliberate or accidental, this can undermine a patient's trust in their doctor, and society's trust in the medical profession more widely
- Using social media also creates risks, particularly where social and professional boundaries become unclear
- If a patient contacts you about their care or other professional matters, through your private profile, you should indicate that you can't mix social and professional relationships and, where appropriate, direct them to your professional profile
- You must consider the potential risks involved in using social media and the impact that inappropriate use could have on your patients trust in you and society's trust in the medical profession.
- Social media can blur the boundaries between a doctor's personal and professional lives and may change the nature of the relationship between a doctor and a patient

4.1.2 Facebook: Posting Messages on a Groups Facebook Page

- Doctors must be careful not to share identifiable information about patients
- Although individual pieces of information may not breach confidentiality on their own, the sum of published information online could be enough to identify a patient or someone close to them. This would be in breach of the GMC's guidance on Confidentiality, Social Media and Good Medical Practice
- Doctors must also ensure that their tone online is in keeping with professional practice and that their comments don't risk damaging public trust in the profession
- The standards expected of doctors do not change because they are communicating

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through social media rather than face to face or through other traditional media
- You must make sure that your conduct justifies your patient's trust in you and the publics trust in the profession
- When communicating publicly, including speaking to or writing in the media, you must maintain patient confidentiality
- You should remember when using social media that communications intended for friends or family may become more widely available
- You must not use publicly accessible social media to discuss individual patients or their care, with those patients or anyone else
- Many doctors use professional social media sites that are not accessible to the public. However, you must still be careful not to share identifiable information about your patients. Although individual pieces of information may not breach confidentiality on their own, the sum of published information online could be enough to identify a patient or someone close to them.

4.1.3 Twitter: Doctor Tweeting Messages on Twitter

- You must make sure that your conduct justifies your patient's trust in you and the publics trust in the profession
- When communicating publicly, including speaking to or writing in the media, you must maintain patient confidentiality
- You should remember when using social media that communications intended for friends or family may become more widely available
- Using of social media has blurred the boundaries between public and private life, and online information can be easily accessed by others
- You should be aware of the limitations of privacy online and you should regularly review the privacy settings for each of your social media profiles. This is for the following reasons:
  - Social media sites cannot guarantee confidentiality whatever privacy settings are in place
  - Patients, your employer and potential employers, or any other organisation that you have a relationship with, may be able to access your personal information
  - Information about your location may be embedded within photographs and other content and available for others to see
  - Once information is published online it can be difficult to remove as other users may distribute it further or comment on it
- Using social media also creates risks, particularly where social and professional boundaries become unclear.
- You must not use publicly accessible social media to discuss individual patients or their care, with those patients or anyone else
- You must consider the potential risks involved in using social media and the impact that inappropriate use could have on your patients trust in you and society's trust in the medical profession.
- Social media can blur the boundaries between a doctor's personal and professional lives and may change the nature of the relationship between a doctor and a patient
- If doctors are using social media to comment on health or healthcare issues, it is good practice for them to say who they are.

4.2 GMC Guidance — Consent: Patients and Doctors Making Decisions Together 2008

- Assess capacity for patient to consent to investigation or treatment, starting from the presumption that the patient has capacity
- You must work on the presumption that every adult patient has the capacity to make decisions about their care, and to decide whether to agree to, or refuse, an examination, investigation or treatment.
- You must assess a patient's capacity to make a particular decision at the time it needs to be made. You must not assume that

because a patient lacks capacity to make a decision on a particular occasion, they lack capacity to make a decision at all, or will not be able to make similar decisions in the future

- You must give patients the information they want or need to know in a way they can understand. You should make sure that arrangements are made, wherever possible, to meet patient's language and communication needs.
- How you discuss a patient's diagnosis, prognosis and treatment options is often as important as the information itself. You should share information in a way that the patient can understand and, whenever possible, in a place and at a time when they are best able to understand and retain it
- You should check whether the patient needs any additional support to understand the information, to communicate their wishes, or to make a decision. You must make sure, wherever practical, that arrangements are made to give the patient any necessary support. This might include, for example: using an advocate or interpreter; asking those close to the patient about the patient's communication needs; or giving the patient a written or audio record of the discussion and any decisions that were made
- Ask the patient if there is anything that would help them remember information, or make it easier to make a decision; such as bringing a relative, partner, friend, carer or advocate to consultations, or having written or audio information about their condition or the proposed investigation or treatment
- If a patient is likely to have difficulty retaining information, you should offer them a written record of your discussions, detailing what decisions were made and why.
- You must only regard a patient as lacking capacity once it is clear that, having been given all appropriate help and support, they cannot understand, retain, use or weigh up the information needed to make that decision, or communicate their wishes by whatever means possible.
- If your assessment leaves you in doubt about the patients capacity to make a decision, you should seek advice from:
  - Nursing staff or others involved in the patients care, or those close to the patient, who may be aware of the patients usual ability to make decisions and their particular communication needs
  - Colleagues with relevant specialist experience, such as psychiatrists, neurologists, or speech and language therapists
- If you are still unsure about the patients capacity to make a decision, you must seek legal advice with a view to asking a court to determine capacity

4.2.1 Patients Who Lacks Capacity to Consent

- In England and Wales (under the Mental Capacity Act 2005) and in Northern Ireland (under the common law), decisions must be made in a patient's best interest
- Best interest can be assessed by evidence of patients previously expressed preferences (e.g. advance directive) and by consulting those who are familiar with the patient e.g. relatives or carers
- Independent mental capacity advocates (IMCA) must be instructed in relation to individuals who lack capacity and who have no family or friends whom it is appropriate to consult when:
  - An NHS body is proposing to provide, withhold or withdraw "serious medical treatment"; or
  - An NHS body or local authority is proposing to arrange accommodation, or a change in accommodation, in a hospital or care home, and the stay in hospital will be more than 28 days, or the stay in the care home more than 8 weeks

    The IMCA cannot make decisions, but represents the patient by bringing to the attention of decision makers the important factors that need to be considered, such as the patient's beliefs, feelings, and values

- In making decisions about the treatment and care of patients who lack capacity, you must:
  - Make the care of your patient your first concern
  - Treat patients as individuals and respect their dignity
  - Support and encourage patients to be involved, as far as they want to and are able, in decisions about their treatment and care
  - Treat patients with respect and not discriminate against them
- You must also consider:
  - Whether the patients lack of capacity is temporary or permanent
  - Which options for treatment would provide overall clinical benefit for the patient
  - Which option, including the option not to treat, would be least restrictive of the patient's future choices
  - Any evidence of patient's previously expressed preferences, such as an advance statement or decision (advance directive)
  - The views of anyone the patient asks you to consult, or who has legal authority to make a decision on their behalf, or has been appointed to represent them (lasting powers of attorney)
  - The views of people close to the patient on the patient's preferences, feelings, beliefs and values, and whether they consider the proposed treatment to be in the patients best interest
  - What you and the rest of the healthcare team know about the patients wishes, feelings, beliefs and values
- Unless the patient has signed an advance directive, the management decisions will rest with the doctor. Legally, relatives and others only have an advisory role.

4.2.2 Delegating Consent

- Clinical, legal and professional responsibility for ensuring that valid consent has been obtained before treatment is provided rests with the person carrying out the procedure
- The GMC's guidance states:
  - If you are the doctor undertaking an investigation or providing treatment, it is your responsibility to discuss it with the patient. If this is not practical, you can delegate the responsibility to someone else, provided you make sure that the person you delegate to:
    is suitably trained and qualified
    has sufficient knowledge of the proposed investigation or treatment, and understands the risk involved
    understands, and agrees to act in accordance with the GMC's guidance
  - If you delegate, you are still responsible for making sure that the patient has been given enough time and information to make an informed decision, and has given their consent, before you start any investigation or treatment

4.2.3 Capacity in Children

- All children aged 16 or above can be assumed to have the capacity to make decisions about their care, and to decide whether to agree to, or refuse, an examination, investigation or treatment (i.e. essentially they can be treated in exactly the same way as an adult)
- Children under the age of 16 can give consent to an examination, investigation or treatment if they are deemed to be Gillick competent
- A child is deemed Gillick competent if they can understand, retain, use and weigh the information given and their understanding of benefits, risks and consequences.
- Even if a child is competent enough to make a decision to consent to a given procedure or treatment, you should make every effort to encourage the child to involve their parents. Whatever their involvement, parents cannot override consent given by a competent child

4.2.4 Children Refusing Treatment

- Parents cannot override the competent consent of a young person to treatment that you

consider is in their best interests. You can rely on parental consent when a child lacks the capacity to consent.
- In Scotland, children can refuse treatment and the child's decision cannot be overridden by the parents
- In England, Wales and Northern Island, the law on parents overriding young people's competent refusal is complex. You should involve other members of the multidisciplinary team, an independent advocate, or a named or designated doctor for child protection or seek legal advice if you think treatment is in the best interests of a competent young person who refuses.

4.3 GMC Guidance — Confidentiality: Good Practice in Handling Patient Information 2017

- Not leaving computers with patient records unattended
- Not leaving patient details showing on screen where they can be viewed by others
- Not letting patient notes lie around and not taking notes home with you unless they have been anonymised
- Not leaving handover sheets where they can be seen by patients and their families
- Ensuring you check the identity of patients, particularly if you are discussing matters over the phone
- If the patient comes accompanied, asking the patient if they are comfortable with a third person sitting in on the consultation
- Not using the public as translators, even if they offer. There are a number of commercial interpreters available via telephone (e.g. LanguageLine)
- If an adult who has capacity to make the decision refuses to consent to information being disclosed that you consider necessary for their protection, you should explore their reasons for this. It may be appropriate to encourage the patient to consent to the disclosure and to warn them of the risks of refusing to consent.
- You should, however, normally abide by the patients refusal to consent to disclosure, even if their decision leaves them (but no one else) at risk of death or serious harm.
- You should do your best to give the patient the information and support they need to make decisions in their own interests e.g. by arranging contact with agencies to support people who experience domestic violence

4.3.1 Breaching Patient Confidentiality

- There are various legal requirements (e.g. court order) to disclose information about adults who are known or considered to be at risk or, or to have suffered, abuse or neglect. You must disclose information if it is required by law. You should:
  - Satisfy yourself that the disclosure is required by law
  - Only disclose information that is relevant to the request, and only in the way required by the law
  - Tell patients about such disclosures whenever practicable, unless it would undermine the purpose of the disclosure to do so
- You must not disclose personal information to a third party such as a solicitor, police officer or officer of a court without the patients explicit consent, unless it is required by law or can be justified in the public interest. You may disclose information without consent to your own legal advisors.
- In very exceptional circumstances, disclosure without consent may be justified in the public interest to prevent a serious crime such as murder, manslaughter or serious assault even where no other than the patient is at risk. This is only likely to be justifiable where there is clear evidence of an imminent risk of serious harm to the individual, and where there are no alternative (and less intrusive) methods of preventing that harm
- Disclosing information about serious communicable diseases:
  - You may disclose information to a known sexual contact of a patient with a sexually

transmitted serious communicable disease if you have reason to think that they are at risk of infection and that the patient has not informed them and cannot be persuaded to do so. This guidance applies, even if the sexual contact is not a patient
  - In such circumstances, you should tell the patient before you make the disclosure (and should consider any reason the patient gives for refusing to consent), if it is practicable and safe to do so.
  - You must be prepared to justify a decision to disclose personal information without consent

4.4 GMC Guidance: Financial and Commercial Arrangements and Conflicts of Interest 2013

- You must be honest in financial and commercial dealings with patients, employers, insurers and other organisations or individuals
- You must not allow any interests you have to affect the way you prescribe for, treat, refer or commission services for patients
- If you are faced with a conflict of interest, you must be open about the conflict, declaring your interest formally, and you should be prepared to exclude yourself from decision making
- You must not ask for or accept — from patients, colleagues or others — any inducement, gift or hospitality that may affect, or be seen to affect, the way you prescribe for, treat or refer patients or commission services for patients. You must not offer these inducements
- You should use your professional judgement to identify when conflicts of interest arise
- Avoid conflicts of interest wherever possible
- Declare any conflicts of interest to anyone affected, formally and as early as possible, in line with the policies of your employer or the organisation contracting your services
- Get advice about the implications of any potential conflict of interest
- Make sure that the conflict does not affect your decisions about patient care

4.5 GMC Guidance: Revalidation

- The process by which all licensed doctors are required to demonstrate on a regular basis that they are up to date and fit to practice in their chosen field and able to provide a good level of care. This means that holding a licence to practice is becoming an indicator that the doctor continues to meet the professional standards set by the GMC
- All doctors who wish to retain their licenses to practice are now legally required to be revalidated every 5 years as proof that they are up to date and fit to practice.
- Revalidation aims to protect patients from poorly performing doctors, promote good medical practice, and increase public confidence in doctors.
- Revalidation is based on annual whole practice appraisals, usually carried out by someone from the doctor's workplace.
- Each doctor needs to collect evidence and examples of his/her work throughout the year. At the appraisal, the doctor is expected to reflect on these and identify strengths and any areas that need development.
- There are three ways to get revalidated:
  - Responsible Officer:

    For the vast majority of doctors, this decision is based on a recommendation from a senior doctor in their organisation called a Responsible Officer (RO)

    The RO bases their recommendation on the doctor's appraisals and any relevant evidence such as clinical governance information
  - Suitable Person:

    For a small number of doctors who don't have a RO, another senior doctor is needed to take on their duties, known as a Suitable Person (SP)
  - Annual return:

    For doctors who do not have an RO or SP, the individual will need to send the GMC an annual return showing that he/she has annual appraisals and that there are no outstanding concerns about your practice

    In this case, the GMC may ask the doctor to sit a written knowledge test

4.6 GMC Guidance: Appraisal

- Definition of appraisal: A constructive discussion with a senior colleague during which doctors reflect on their performance over the last 12 months and consider their future development needs (PDP, CME, CPD)
- There are three stages in the appraisal process:
  - Inputs to appraisal, including a record of the doctors scope and nature of work and relevant supporting information
  - The confidential appraisal discussion
  - Outputs of appraisal, including the doctors PDP and a summary of the appraiser discussion and the appraiser's statements

4.7 UK Government Guidance: Parental Rights and Responsibilities

- Defined as "all the rights, duties, powers, responsibilities and authority which by law a parent of a child has in relation to the child and his property"
- This can include:
  - Consenting to a child's operation or certain medical treatment
  - Accessing a child's medical records
- Mothers automatically have parental responsibility and will not lose it if divorced
- Married fathers automatically have parental responsibility and will not lose it if divorced
- Unmarried fathers do not automatically have parental responsibility:
  - If an unmarried father has a child after 1st December 2003 and he is registered on the birth certificate, he will have parental responsibility
  - If a child's birth was registered before 1st December 2003 and the father was not named on the birth certificate, the birth can be re-registered to include the father's name — the father will then have parental responsibility
  - If a child's birth was registered before 1st December 2003 and includes the name of the unmarried father, the father will not have parental responsibility (unless obtained by other means)
- Step fathers and step mothers do not automatically have parental responsibility
- Grandparents do not automatically have parental responsibility

4.8 UK Government Guidance: Driving Eyesight Rules

- Group 1 drivers (car and light vehicles)
  - Vision requirements:

    BCVA of at least 6/12 with both eyes open (or in the only eye if monocular) AND

    Read a standard number plate at 20 m
  - Visual field requirements (Esterman programme on the Humphrey analyser — maximum of 20% false positives is allowed):

    At least 120° on the horizontal, with at least 50° left and right AND

    No significant defect on the binocular field encroaching within 20° of fixation above or below the horizontal meridian

    Significant defect:
    - A cluster of four adjoining points that is either wholly or partly within the central 20°
    - Loss consisting of both a single cluster of three adjoining missed points up to and including 20° from fixation AND any additional separate missed point within the central 20° area
    - Any central loss that is an extension of hemianopia or quadrantanopia of size greater than three missed points

    Where a driver has fully adapted to a static long-standing defect, the DVLA may consider them as an exceptional case and perform a practical driving assessment

- Group 2 drivers (large goods vehicles [LGV] and passenger-carrying vehicles [PSV])
  - Vision requirements:
    BCVA of at least 6/7.5 in the better eye
    AND
    BCVA of at least 6/60 in the worst eye
    AND
    Glasses, if required, should be up to +8 D in strength
  - Visual field requirements (Esterman programme on the Humphrey analyser — maximum of 20% false positives is allowed):
    At least 160° on the horizontal, with at least 70° left and right and 30° above and below AND
    No defects in the central 30°
- Monocularity
  - Group 1 drivers: do not need to tell DVLA if the other eye satisfies the usual vision and visual field requirements and may drive when clinically advised that they have adapted to the disability
  - Group 2 drivers: must not drive and must inform the DVLA
- Diplopia
  - Group 1 drivers: must inform the DVLA, driving may be resumed if diplopia controlled — patching is acceptable (must not drive if diplopia uncontrolled)
  - Group 2 drivers: must not drive and must inform the DVLA, patching not acceptable
- Blepharospasm
  - Patients with severe blepharospasm must not drive. Patients with mild treated blepharospasm may drive subject to consultant approval
  - Group 1 drivers: must inform DVLA
  - Group 2 drivers: must inform DVLA
- TIA
  - Group 1 drivers: must not drive for 1 month and only restart when the doctor tells the patient they are safe to resume driving; do not need to inform DVLA if patient had a TIA and have recovered
  - Group 2 drivers: must inform the DVLA and must not drive for 1 year following a TIA, and can only restart when the doctor tells the patient that he/she is safe to resume driving
- Glaucoma
  - Group 1 drivers: do not need to inform DVLA if glaucoma affects only one eye and your other eye has normal vision and visual field
  - Group 2 drivers: must inform DVLA if glaucoma affects one eye or both eyes
- Diabetic retinopathy
  - Group 1 drivers: must inform DVLA only when both eyes affected
  - Group 2 drivers: must inform DVLA if one or both eyes affected

4.9 UK Government Guidance: Registering Vision Impairment as a Disability

- Sight impaired
  - VA 3/60 to 6/60 with full field
  - VA 6/60 to 6/24 with moderate constriction of field (superior or patchy loss), media opacities or aphakia
  - VA 6/18 or better with marked field defect (e.g. homonymous hemianopia advanced glaucoma, RP)
- Severely sight impaired
  - Legally defined as "so blind that they cannot do any work for which eyesight is essential"
  - VA worse than 3/60
  - VA 3/60 or better but worse than 6/60 with contraction of their visual field
  - VA 6/60 or better with a clinically significant contracted visual field which is functionally impairing the person (e.g. loss of inferior field or homonymous or bitemporal hemianopia)
  - Homonymous or bitemporal hemianopia is specifically excluded unless VA worse than 6/18

4.10 UK Government Guidance: Data Protection Act 2018

- Data protection is the fair and proper use of information about people (ensuring people

can trust you to use their data fairly and responsibly)
- If you collect information about individuals for any reason other than your own personal, family or household purposes (e.g. personal social media activity, private letters and emails, or use of your own household gadgets), you need to comply
- The data protection act 2018 is the UK's implementation of the European General Data Protection Regulation (GDPR forms part of the UK law)
- The Information Commissioner's Office (ICO) regulates data protection in the UK
- Everyone responsible for using personal data has to follow strict rules called Caldicott principles or "data protection principles"
  - Personal data processed lawfully, fairly and in a transparent manner
  - Purpose limitation:
    Data collected for specified, explicit and legitimate purposes and not further processed in a manner that is incompatible with those purposes
  - Data minimization:
    Adequate, relevant and limited to what is necessary in relation to the purposes for which they are processed
  - Accuracy:
    Inaccurate data should be erased or rectified without delay
  - Storage limitation:
    Kept in a form which permits identification of data subjects for no longer than is necessary or the purposes for which the personal data are processed
  - Integrity and confidentiality (security):
    Appropriate security of the personal data, including protection against unauthorized or unlawful processing and against accidental loss, destruction or damage, using appropriate technical or organizational measures
  - Accountability
- The data protection officer (Caldicott Guardian) is responsible for providing advice, monitoring compliance, and is the first point of contact in the organisation for data protection matters

4.11 UK Government Guidance — Safeguarding Policy: Protecting Vulnerable Adults and Children

- Safeguarding is about protecting an adult's or child's right to live in safety, free from abuse and neglect
- Vulnerable adult: person aged 18 or over who is or may be in need of community care services by reason of mental or other disability, age or illness; and who is or may be unable to take care of him or herself, or unable to protect him or herself against significant harm or exploitation
- Neglect: persistent failure to meet a person's basic physical or psychological needs to a level that is likely to result in serious impairment of the persons health or development
- Alert the adults safeguarding team for vulnerable adults — contact the named nurse for adult safeguarding and named doctor who lead on issues related to adult safeguarding
- Alert the child protection team for vulnerable children — contact the named nurse and named doctor who lead on issues related to child protection

4.12 Never Events

NHS Improvement Never Events Policy and Framework 2018

- Never events are defined as serious incidents that are wholly preventable because guidance or safety recommendations that provide strong systemic protective barriers are available at a national level and should have been implemented and followed by all healthcare providers
- Never events list applicable to Ophthalmology include
  - Wrong site surgery
  - Wrong implant/prosthesis: an error in IOL choice after the time out WHO check is a never event. An error in IOL choice up to the time out WHO check is a serious incident (The RCOphth Ophthalmic Service

Guidance for Correct IOL implantation in cataract surgery 2018)
  - Retained foreign objects post procedure
- Never events require full investigation (completed within 60 days) under the Serious Incident Framework
  - Describes the process and procedures to help ensure serious incidents are identified correctly, investigated thoroughly and, most importantly, learned from to prevent the likelihood of similar incidents happening again
  - Incident report required within 2 days on Strategic Executive Information System (StEIS) and National Reporting and Learning System (NRLS)
  - Disclose information to patients as soon as possible
  - Organisational leaders must undertake with the whole multidisciplinary team a root-cause analysis to determine the reasons for the incident
  - Leaders must then establish strategies and implementation tools to stop it from happening again

4.13 Non-Accidental Injury (NAI)

The Royal College of Paediatrics and Child Health and The Royal College of Ophthalmologists Guideline on Abusive Head Trauma and the Eye in Infancy 2013:

- When to suspect a NAI
  - There is a delay between injury and seeking medical advice (if there is a delay, and there is no satisfactory explanation)
  - History is not consistent with the injury — parents have given different accounts at different times
  - On examination, the child has unexplained injuries and there are patterns of injury typical of abuse (e.g. multiple facial bruises, scalds, cigarette burns, any unexplained injuries in non-ambulant babies, bites, hand or implement marks, head injuries with intracranial haemorrhages in babies, multi-layered retinal haemorrhages, unexplained abdominal or genital injuries or long bone fractures especially in babies)
  - The child's behaviour and interaction with parents/carers is not appropriate
  - Any children who presents with unexplained injuries or a history that is inconsistent with the injury should be referred to the named doctor and named nurse who lead on issues related to child protection
- Recording of ophthalmological features in suspected NAI
  - The most senior ophthalmologist available should be examining a child as part of child protection investigations
  - Document:
    VA
    Ocular motility
    Pupil size and pupillary reflexes
    Periocular bruising
    Subconjunctival haemorrhages
    Anterior segment
    Retinal haemorrhages (see Fig. 4.1):
    - Number: few (1–10), many (10–20), too numerous to count
    - Location: preretinal, intraretinal, subretinal, multilayered
    - Distribution: posterior pole (zone 1 ROP), periphery (outside zone 1)
    - Size: small (<1 DD), medium (1–2 DD), large (>2 DD)
    - Morphology: white centered

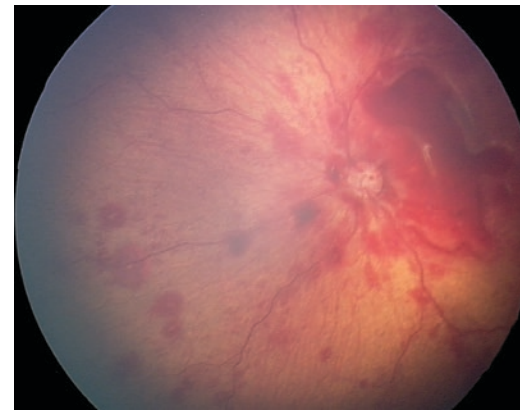

Fig. 4.1 Colour fundus photo of a patient with multi-layered retinal haemorrhages from NAI

Macular retinoschisis
Perimacular folds
Optic disc

- If a digital photographic system is used, an unmodified printout should be made at the time and signed by two witnesses

- Communication with parents
  - It is important that parents are kept informed about the child's medical care throughout any investigations
  - Parents prefer honest, clear, and early communication on what a child protection enquiry means; what referral to social services or the police means; whether emergency proceedings are taking place; what the child protection medical examination involves; how long the child has to stay in the hospital; what different tests involve; whether further tests are needed and how long it will take to receive test results
  - Sensitively explaining to parents that there is a protocol that the professional has to follow and clearly outlining the process may help parents to accept and understand
  - "Examination findings are consistent with a non-accidental injury and it was the procedure in those cases therefore to inform social services and also to do a full skeletal X-ray and dilated fundus examination in those cases"

4.14 Approach to Patient with Refractive Surprise

4.14.1 Verify the Problem

- RCOphth guidelines: achieve 85% within 1 D of intended refractive outcome
- What is the postop refraction (have it checked by a clinician experienced at refraction)?
  - Causes of a myopic surprise:
    Previous hyperopic refractive surprise
    Error in A constant calculations (e.g. placing IOL with A constant of 118 rather than 113) leading to a higher lens power than required
    Capsular block syndrome (capsular hyperextension, IOL displacement anteriorly, AC shallowing, postop myopic shift)
  - Causes of a hyperopic surprise:
    Previous unrecognized myopic refractive surgery
    Unrecognised staphyloma at most posterior portion of the globe (anatomic axial length may not correspond with the center of the macula i.e. refractive axial length)

4.14.2 Case Note Review

- Was the correct IOL selected intraoperatively?
- Was the preoperative biometry/lens selection valid?
  - Check biometry used does indeed belong to your patient
  - Look for intraocular consistency in axial length and K values
  - Look for interocular consistency in axial length and K values
- Check appropriate formula used
- Had they had previous refractive surgery?

4.14.3 Clinical Examination

- Has there been a change in the corneal curvature (K) reading since the operation?
  - Wounds: poorly constructed wounds or use of LRI's (hypermetropic effect)
  - Corneal oedema
  - Other corneal pathology previously unrecognised e.g. keratoconus, previous refractive laser surgery, CL use
- Is the IOL correctly positioned?
  - Check IOL centered and completely in the bag
  - Is there retention of Healon within the bag?
  - Is early capsule healing/phimosis affecting IOL position?

4.14.4 Investigations

- Repeat biometry ± B scan to confirm axial length (on pseudophakic mode)
- Repeat keratometry ± corneal topography

4.14.5 Treatment

- Small errors
  - Observation: post-op changes in corneal curvature may improve as oedema settles and wound heals
  - No treatment: a small myopic refractive surprise in a non-dominant eye may be useful for reading
  - Trial of spectacles
  - Intervention for specific problem: surgical repositioning of poorly placed IOL, YAG laser for capsular phimosis
- Large errors
  - CL
  - Secondary piggyback IOL: IOL power based on postop refraction
  - Laser refractive surgery for residual errors
  - IOL exchange: least preferable as carries a greater surgical risk and offers less predictability

4.15 Consenting for Cataract Surgery

- Explain what a cataract is ("clear lens in your eye has become cloudy") and what the operation does ("operation replaces the cloudy lens with a new clear plastic lens")
- General risks
  - Intraoperative risks:
    PC rupture ± vitreous loss
    Dropped nucleus with need for a second operation
  - Postoperative risks:
    Endophthalmitis
    Retinal detachment/tear
    Choroidal haemorrhage
    Posterior capsular opacification with need for laser treatment
- Specific risks
  - Technical difficulties e.g. patient positioning
  - Guarded visual prognosis e.g. amblyopia, corneal opacity, macular disease, vitreous opacities, optic nerve disease
  - Increased risk of sight-threatening complications in certain conditions:
    High myopia: RD
    Endothelial dystrophy (e.g. FED): corneal decompensation
    PXF: zonular dehiscence
    Posterior polar: PC rupture
    IFIS: iris trauma
- Anaesthetic options
  - Topical anaesthetic
  - Subtenon anaesthetic
    Globe rupture (0.006–0.1%)
    Oculocardiac reflex (0.03%)
  - General anaesthetic (GA)
- Desired refractive outcome
  - Emmetropia: require no/weak glasses for distance but will definitely require reading glasses
  - High ametropia:
    Aim for emmetropia and perform second eye operation within 6 weeks
    Aim to leave ametropic but up to 2 D nearer emmetropia than the other eye
    Aim for emmetropia and use a CL on the second eye until surgery is indicated
- IOL choice
  - Monofocal IOL
  - Toric IOL
  - Multifocal IOL

4.16 Clinical Supervision of Trainees in Difficulty

- Seek information (what is the issue, is there actually a problem, is this a one-off situation or is there a pattern)
  - Collate information from consultant colleagues who have worked with trainee
  - Initial conversation with the trainee to inform them of the concerns that have been

raised and the action that is being taken and also to get their perspective
  - Encourage trainee to commit their comments to paper
  - Training environment issues:
    Mismatches between trainee and trainer
    Alleged bullying or harassment
    Wrong levels of expertise expected of trainee
    Supervision not congruent with level of expertise expected
  - Personal issues:
    Partner/spouse relationship
    Bereavement
    Critical family illness
    VISA problems
  - Clinical performance issues:
    Clinical or surgical skill issues
  - Generic professional development issues:
    Communication issues with patients &/or staff
    Motivation, maturity, a lack of insight
    Time management and basic organisational skills
  - Professional behaviour issues:
    Integrity
    Probity
    Substance abuse
- Patient safety (is patient care compromised)
  - Training environment issues:
  - Personal issues:
  - Clinical performance issues:
  - Generic professional development issues:
  - Professional behaviour issues:
    Substance abuse: suspension from clinical duties pending full investigation
- Initiative (can you do anything yourself before you escalate the situation)
  - Training environment issues:
  - Personal issues:
    Encourage trainees to access counselling and support services of their deanery through human resources (HR) and occupational health (OH) departments
  - Clinical performance issues:
    Increased supervision of trainee
    SMART (specific, measurable, achievable, relevant, time bound) objectives
  - Generic professional development issues:
  - Professional behaviour issues:
- Escalate (involve other colleagues as needed, who will you go to, who is the most appropriate person)
  - Training environment issues:
    Discussion with educational supervisor
    Discussion with training programme director (TPD)
  - Personal issues:
    Discussion with educational supervisor
    Discussion with TPD
  - Clinical performance issues:
    Discussion with educational supervisor
    Discussion with TPD
  - Generic professional development issues:
    Discussion with educational supervisor
    Discussion with TPD
    Discussion with postgraduate dean
  - Professional behaviour issues:
    Probity — inform GMC
    Substance abuse — inform local HR department, medical director, GMC
- Support (can you support the individual or team)
  - Training environment issues:
    Relocation to a more appropriate training environment
  - Personal issues:
    Arrangements of future placements closer to trainees home or support network
    Out of programme career break (OOPC)
  - Clinical performance issues:
    Use of simulator/wet-lab facilities
    Targeted or repeat training with clear educational objectives and yardsticks of success (SMART objectives)
  - Generic professional development issues:
    Behavioural or psychometric assessment through psychologists identified through deanery or NCAS (national clinical assessment service)

- Professional behaviour issues:
  - Behavioural or psychometric assessment through psychologists identified through Deanery or NCAS
  - Stress counselling service

4.17 The RCOphth Ophthalmology Service Guidance on Theatre Procedures 2018

- Consent
  - Discuss the options of no surgery and of other or lesser interventions
  - Best practice to consent before the day of surgery in all but emergency or minor operation situations
  - On the day of surgery, the consent should be rechecked with the patient and resigned by a consenter
  - Consent must be obtained in the full knowledge of risks relevant to both the operation and anaesthesia. It is the responsibility of the individual administering the anaesthetic to discuss possible complications of the anaesthetic. A separate consent for the anaesthetic per se is not required, although it is advisable to record the discussion in the patient records
- Pre-operative assessment
  - Purpose: identify abnormalities or issues that might interfere with the safe performance and outcome of the operation and confirm the decisions made at the decision to admit were appropriate and still apply
  - Undertaken normally by trained specialist nurses or other trained ophthalmic healthcare professionals with medical anaesthetic input as required
  - General medical records should be available. If the relevant information is not available, planned surgery should be deferred
  - Should take place before the day of surgery and occur within 3–4 months of the surgery. A telephone call to confirm nothing has changed may be done in the week preceding the surgery if there is a long gap between assessment and procedure
  - Telephone pre-assessment may be appropriate when a second procedure is planned in healthy patients (e.g. second eye for cataract surgery) within 3–4 months of the first operation
  - Some patients may need help (e.g. friend, relative, carer) to accompany them to surgery and at discharge, or support from the community nursing team at home
  - Specific checks to ensure suitability for day case surgery if planned; living alone is not a contraindication but it needs to be confirmed that the aftercare, particularly instilling the eyedrops effectively at the right times, is possible
  - Specific checks to highlight any concerns about mental capacity, ability to lie flat and still for the whole duration of the operation, and communication difficulties
  - Results should be recorded on a checklist
  - Following examinations should be undertaken:
    - BP
    - HR and rhythm
    - Hearing, comprehension, co-operation
    - Tremor and abnormal body movements
    - Infection control screening (e.g. MRSA swabs)
  - Following examinations are performed if indicated:
    - If there is respiratory distress or SOB present, measure the RR, O_2 sats, and the patient review by or discussed with a doctor or an anaesthetist
    - Practice patients ability to lie flat and still in the appropriate position for the duration of the operation
    - Examination for non-ocular sepsis
    - Slit lamp examination e.g. blepharitis
  - Tests routinely indicated for the following situations:
    - Clotting profile for those on anticoagulants (e.g. warfarin)
    - Electrolytes for patients on dialysis
    - Blood glucose measurement and HBA_1C for those with diabetes

- On admission
  - Nurses, or HCA's under the supervision of nurses, will perform the pre-operative patient preparation on wards or day case areas. Results of the preoperative assessment should be available and, together with the following, be recorded on a checklist:
    Patients identity should be confirmed and a name badge should be attached to the patient's wrist
    Ensure the next of kin details are documented/updated in the patient's medical records
    Confirm that the patient has been well since the pre-operative assessment visit and does not have any acute illness e.g. URTI
    Confirm whether the patient has taken his/her medication
    Confirm allergy status as this may affect the order of the list e.g. type I latex allergy
    Ensure the patient has provision for a safe return home
    BP, HR, temperature and O_2 saturation should be checked
    Check that the consent form has been signed and rechecked on the day of surgery
    Check the marking side forms and biometry/IOL data are present
    Ensure that the pre-operative medications including eye drops or inserts are administered
  - Any change in the patient's condition or therapy since pre-operative assessment, or other concerns from these assessments, should be brought to the attention of the surgeon and, where relevant, the anaesthetist
  - The findings of the preoperative assessment and checks should be reviewed by the ophthalmologist, and where appropriate, the anaesthetist
  - The eye/adnexae should be checked to exclude acute inflammation or infection and rechecked for other factors that may affect safe local anaesthesia or surgery
  - Preop marking:
    Mandatory to mark procedure site shortly before the procedure but not in the anaesthetic room or the theatre
    Site marking must be performed by the surgeon or nominated deputy who will be present during the procedure. It is the surgeon's responsibility to check that he/she is operating on the correct eye/side
    Mark the eye or side/site to be operated on with a clear, indelible mark. This mark should remain visible after surgical cleaning, and after draping if at all possible
  - Handover to procedure teams:
    There must be a formal handover process from the ward or admission team to a member of the theatre team receiving the patient
    The handover should include a check of:
    - Patient identification (name, DOB, active confirmation), checked against identity band
    - Allergies
    - Procedure, and site or side
    - Site marking
    - Whether patient has any plates, pins, or any metal implants if monopolar diathermy is going to be used
    - Fasting status
    - Relevant clinical features e.g. blood sugar for diabetic patients, INR for warfarin
    - An appropriate patient record
    - A properly completed consent form
    - A biometry sheet if relevant
- In theatre
  - Staffing levels:
    For most LA ophthalmic lists, the following staff are the minimum acceptable theatre team:

- Two scrub nurses or practitioners: one for the current case and the other preparing the instruments for the next case
- Runner (can be a HCA): role is to supply the scrub practitioner with the necessary equipment and consumables, set up the phaco equipment etc., help position the patient and microscope, adjust the lights and other essential duties.

– Patient monitoring:

For LA patients

- Patients should be continuously monitored — clinical observation, communication and pulse oximetry as a minimum, from before the administration of the LA to the end of the operation
- ECG and BP should be monitored in sedated patients and those who are at risk of cardiovascular complications (e.g. hypertensives, patients with pacemaker, diabetics) and higher risk situations such as strabismus surgery, intraoperative use of ocular sympathomimetics (such as phenylephrine and mydricaine)
- In stable patients the non-invasive BP measurements should be kept to a minimum to avoid discomfort and undue disturbance during surgery
- A suitably trained individual must have responsibility for monitoring the patient throughout. This task may be carried out by an anaesthetist, a nurse, an ODP, an ODA, an anaesthetic nurse or, in some cases, a suitably trained HCA as long as they are trained in basic life support (BLS)
- The ultimate responsibility for the patient rests with the operating surgeon and, when present, the anaesthetist

– Anaesthetics and resuscitation:

GA and sedation requires the assistance of a trained anaesthetic technician/or anaesthetic nurse as well as an anaesthetist. In addition there should be trained recovery staff

An anaesthetist is not essential when topical, subconjunctival or subtenon's techniques without sedation are used

Ideally, an anaesthetist should be available in the theatre complex, particularly when sharp needle blocks such as peribulbar, retrobulbar are used, and when complex or long cases are being performed

For any operation, all theatre staff must be regularly trained and able to perform BLS, understand local resuscitation arrangements, and there should be a resuscitation trolley easily and quickly available

Where there is backup from a formal cardiac arrest/medical emergency team, there should be at least 1 person available with immediate life support (ILS), who should be supported by staff with the knowledge and skills to assist in resuscitation

Where the unit is free-standing and there is no immediate access to a formal cardiac arrest team there should be at least one person with advanced life support (ALS)

If an anaesthetist is not immediately available, the operating ophthalmologist is directly responsible for the management of any untoward event and should have the appropriate skills to safely manage resuscitation, or to have these skills within the theatre team

– Five steps to safer surgery:

Team brief:

- Performed before the first patient arrives in the theatre area
- Any team member may lead the safety briefing

- As many members of the surgical team as possible should attend the briefing, but it must include the surgeon and anaesthetist who have seen and consented the patients

Sign in (first part of the WHO checklist):

- Performed when patient arrives at the procedure area
- For cataract surgery a specific cataract or ophthalmic checklist is recommended. For other ocular surgery the standard WHO checklist or an ophthalmic specific checklist can be used
- Must be performed by at least two people involved in the procedure. For procedures involving an anaesthetist, these should include the anaesthetist or anaesthetic assistant
- Any omissions, discrepancies or uncertainties identified during the sign in should be resolved before the time out is performed or any procedure starts
- Immediately before the insertion of a block anaesthetic, the anaesthetist and anaesthetic assistant must simultaneously check the surgical site marking and the site and side of the block

Time out (second part of the WHO checklist):

- Must be performed immediately before the start of the procedure
- Any member of the procedure team may lead the time out
- All team members involved in the procedure should be present at the time out. This will usually require that they stop all other tasks and face the time out lead
- The team member leading the time out should verify that all team members are participating
- Any omissions, discrepancies or uncertainties identified during the time out should be resolved before the procedure starts

Sign out (third part of the WHO checklist):

- Performed at end of procedure before patient is awoken from GA or before the patient leaves theatre
- Any member of the procedure team may lead the sign out
- All team members involved in the procedure should be present at the sign out. This will usually require that they stop all other tasks and face the sign out lead
- The team member leading the sign out should verify that all team members are participating

Team debrief:

- Performed at the end of all lists
- Every member of the procedural team should take part in the debriefing
- Any team member may lead the debriefing, but the surgeon and anaesthetist (if an anaesthetist has been involved) must be present
- If any team member, and especially the senior surgeon, scrub practitioner or anaesthetist, has to leave before the debriefing is conducted, they should have the opportunity to feedback any issues they wish to see addressed during the debriefing

- Postoperatively
  - Pain should be assessed and managed
  - After the operation, and before discharge, the patient should feel well and have stable key signs
  - For patients who have undergone GA, ensure patient has passed urine before discharge
  - Before discharge the safety arrangements for the patient's return to home, and the level of support available, should be confirmed

  - Information (including written) should be provided about post-operative recovery (post-op instructions, medication dispensing and advice, advice on post-op appointments, what to expect during recovery)
  - Written instructions should be given to the patient about what to do and whom to contact in the event of problems or concerns, especially signs of postop infections such as endophthalmitis
- Organising theatre lists
  - There should be unambiguous use of language in all communications relating to the scheduling and listing of procedures. Laterality must always be written in full i.e. 'left' or 'right'
  - The information to schedule a procedure should include when relevant:
    Source of patient e.g. ward or day case area
    Significant comorbidities
    Allergies e.g. latex or iodine
    Unusual infection risk including prion disease
    Any non-standard equipment requirements or non-stock prostheses
    Unusual BMI or extreme obesity where normal hospital equipment may have difficulty safely accommodating the patients weight e.g. theatre trolley, mobile patient hoist
  - The clinical team performing the procedures is responsible for deciding the order of procedures within a list of cases. In determining the order of a list, priority should be given to clinical criteria e.g. urgency, extremes of age, allergies such as latex allergy, and medical conditions e.g. diabetes
  - Late list changes should be avoided if possible. Any list changes made after the deadline for the publication of a final version of the list must be agreed with identified key members of the procedure team, and should be discussed by all members of the procedure team at the safety briefing

4.18 Needle Stick Injury

4.18.1 Transmission Rates

- Needle stick transmission rates from infected patients are estimated at around 0.3% for HIV (The RCOphth Ophthalmic Services Guidance on Prevention of transmission of blood-borne viruses in ophthalmic surgery 2010), up to 10% for Hepatitis C (The RCOphth Ophthalmic Services Guidance on Prevention of transmission of blood-borne viruses in ophthalmic surgery 2010), and up to 30% for Hepatitis B (The RCOphth Ophthalmic Services Guidance on Prevention of transmission of blood-borne viruses in ophthalmic surgery 2010)

4.18.2 Management

- Immediate
  - Encourage the injury to bleed
  - Wash under running water
  - If body fluids splashed onto eyes, irrigate them copiously
  - Incident report
  - Inform patient and take patient details (name, unit number, contact details)
  - Inform head of department
- Within 1 h
  - Report to the occupational health department (or A&E department if out of hours). If high risk (exposure to blood or high-risk body fluid from patient with known or suspected HIV) of HIV transmission, start post-exposure prophylaxis (e.g. TRUVADA once a day) — this should be started within 1 h by the occupational health/A&E physician:
    If donor is HIV positive (already known or discovered on testing):
    - Continue post-exposure prophylaxis for 4 weeks
    - Test recipient for HIV seroconversion at 6 weeks, 3 months, 6 months

- Follow up with occupational health

If donor is HIV negative:

- Discontinue post-exposure prophylaxis
- Test recipient for HIV seroconversion at 3 months and 6 months
- Follow up with occupational health

– Store blood from the donor and the recipient:

Screening for Hepatitis B and HIV (HIV antibody AND p24 antigen simultaneously), where appropriate, is generally arranged by the occupational health physician

The donors blood sample should not be taken by the recipient

The donor must be counseled before taking blood samples/testing for HIV (no written consent required but the benefits of testing to the individual and the details of how the result will be given [face to face provision of test result] must be discussed)

4.19 Ophthalmia Neonatorum

4.19.1 Definition

- Defined as conjunctivitis (inflammatory or infection) occurring within the first month of life

4.19.2 Causes

- Chemical neonatal conjunctivitis
  - Post-instillation of 2% silver nitrate (agglutinates and inactivates gonococci) into the conjunctival fornix immediately after birth
  - Typically appears within 1–2 days after the administration of a topical agent
  - Withdrawal of the offending agent results in resolution of symptoms within 2 days
  - Ocular features: conjunctival injection, tearing
- Bacterial neonatal conjunctivitis
  - Gonococcal neonatal conjunctivitis:

Typically appears 2–5 days after birth

Ocular features: hyperpurulent discharge, severe conjunctival injection ± pseudomembrane, chemosis, eyelid oedema, corneal ulcer ± perforation (gonococcus can invade the cornea through intact corneal epithelium)

Systemic features: meningitis, endocarditis

Investigations: prewet swab or conjunctival scrapings for gram stain (gram negative diplococci) and Gonococcal culture using modified Thayer-Martin medium. Giemsa stain and chlamydial culture should also be performed in view of frequent maternal co-infection with chlamydia

Treatment: single dose of IV or IM cefotaxime or ceftriaxone by paediatricians, frequent saline lavage of the purulent discharge, topical antibiotics are unnecessary

Referral of mother (with partner) to GUM clinic

  - Chlamydial neonatal conjunctivitis:

Typically appears 5–14 days after birth

Ocular features: mucopurulent discharge, conjunctivitis ± pseudomembrane, keratitis ± corneal scarring

Systemic features: otitis media, pneumonia, rhinitis

Investigations: pre-wet swab or conjunctival scrapings for Giemsa stain or PCR

Treatment: oral erythromycin (50 mg/kg/day divided into four daily doses) for 14 days (risk of infantile hypertrophic pyloric stenosis) — for infants with conjunctivitis but no pneumonia, systemic erythromycin can be delayed while awaiting confirmatory diagnostic tests for Chlamydia

Referral of mother (with partner) to GUM clinic (single dose of azithromycin 1 g PO)

- HSV neonatal conjunctivitis:
  - Typically occur 5–14 days after exposure
  - Ocular features: eyelid vesicles and erythema, conjunctivitis, keratitis, ant uveitis
  - Systemic features: pneumonitis, hepatitis, meningoencephalitis
  - Investigations: viral swabs or conjunctival, corneal epithelium or skin vesicle scrapings for HSV culture ± PCR, LFT's, CSF analysis
  - Treatment: IV aciclovir (60 mg/kg/day TDS) for 14 days, or for 21 days in the presence of disseminated or CNS disease + topical anti-viral (aciclovir ointment 5×/day for 7 days) ± topical steroids (for corneal stromal and endothelial disease or ant uveitis)

4.19.3 Chlamydia/Gonorrhoea

- Symptoms:
  - Females — vaginal discharge, dysuria, lower abdominal pain
  - Males — urethral discharge, dysuria, genital ulcers, testicular pain and swelling
- Treatment:
  - Antibiotics
  - Educate and counsel
  - Promote condom use and provide condoms
  - Manage and treat partner
  - Offer HIV counseling and testing

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5 Health Promotion, Audit, Research and Evidence-Based Medicine

Timothy H. M. Fung and Winfried M. K. Amoaku

5.1 Steroids

- Mechanisms of action
  - Reduction of inflammation by corticosteroids is via inhibition of phospholipase A2, thereby blocking the production of prostaglandins and leukotrienes
  - Corticosteroids have an immunosuppressive role via inhibition of NF-kB transcription factor signaling, thereby blocking the production of IL-2 and other pro-inflammatory cytokines
- Clinical applications of intravitreal corticosteroids
  - Ozurdex (Dexamethasone 700 μg intravitreal implant):
    NICE Guidance [TA349]: option for treatment of DMO if eye is pseudophakic and CSMO does not respond to non-corticosteroid treatment or such treatment is unsuitable
    NICE Guidance [TA229]: recommend as an option for treatment of macular oedema due to a CRVO or a BRVO when treatment with laser photocoagulation has not been beneficial or treatment with laser photocoagulation is not considered suitable because of the extent of retinal haemorrhages
    NICE Guidance [TA460]: recommended as an option for treating non-infectious uveitis in the posterior segment of the eye in adults only if there is active disease (current inflammation in the eye) and worsening vision with a risk of blindness
    Clinical trials:
    - **MEAD** study (Boyer et al. 2014): diabetic macular oedema
    - **GENEVA** study (Haller et al. 2010): retinal vein occlusion (BRVO/CRVO)
    - **HURON** study (Lowder et al. 2011): non-infectious posterior uveitis
  - Iluvien (Flucinolone Acetonide 170 μg):
    NICE Guidance [TA301]: option for the treatment of chronic diabetic macular oedema that is insufficiently responsive to available therapies if an eye is pseudophakic
    NICE Guidance [TA590]: option for preventing relapse in recurrent non-infectious

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uveitis affecting the posterior segment of the eye

Clinical trials:

- **FAME** study (Cunha-Vaz et al. 2014): diabetic macular oedema
- **PSV-FAI-001** Study (NICE Guidance [TA590]): non-infectious posterior uveitis

- Monitoring
  - Pre-treatment:

    BP, glucose, weight

    CXR if there is any possibility of TB
  - During treatment:

    BP, glucose, weight every 3 months

    Lipids every year

    Bone density (DXA scan) if steroid course ≥3 months
- Side-effects of corticosteroids
  - Ocular:

    Glaucoma

    Cataracts — posterior subcapsular cataracts

    Microbial keratitis
  - Systemic:

    Endocrine:
    - Cushing' syndrome
    - Adrenal suppression — risk of Addisonian crisis with withdrawal
    - Weight gain

    GI:
    - Peptic ulcer
    - Pancreatitis

    Musculoskeletal:
    - Osteoporosis
    - Osteopenia

    Skin:
    - Hirsutism

    Haematological:
    - Immunosuppression

    Psychiatric:
    - Insomnia
    - Psychosis

    Neurological:
    - Raised ICP ± papilloedema
- Prophylaxis of corticosteroid-induced osteoporosis:
  - Risk assessment (NICE Guidance [CG146]):

Consider assessment of fracture risk:

- In all women aged ≥65 years and all men ≥75 years
- In women aged under 65 years and men aged under 75 years in the presence of risk factors, e.g. current use or frequent recent use of oral or systemic glucocorticoids, previous fragility fracture, smoking, history of falls, family history of hip fracture, BMI <18.5 kg/m^2

Tools for risk assessment (see Table 5.1):

- Use either FRAX (without a BMD value if DXA scan has not been previously undertaken) or QFracture to estimate 10-year predicted absolute fracture risk of fracture. Above the upper age limits defined by the tools, consider people to be at high risk. Which computes the 10-year probability of hip fracture or a

Table 5.1 Measurement tools used to assess fragility fracture risk

- FRAX
  - Based on individual patient models that integrate the risks associated with clinical risk factors as well as BMD
  - Output is a 10-year probability of hip fracture and the 10-year probability of a major osteoporotic fracture (clinical spine, forearm, hip or shoulder fracture)
- QFracture
  - Uses a series of questions to identify individuals at risk of developing a fracture of the hip, wrist or spine
  - Offers a 10-year risk prediction for osteoporotic fractures
- DXA scan
  - Compares the BMD of the femoral neck or lumbar spine against normal (i.e. healthy Caucasian adults aged 20–29 years). The difference is calculated in SD to give the T score:

    T score 0 to −1 SD = normal

    T score −1 to −2.5 SD = osteopenia

    T score ≤−2.5 SD = osteoporosis
  - Z score is used to determine whether the BMD is less than the age-related bone loss (i.e. no. of SD the measurement is above or below the age matched mean BMD)

major osteoporotic fracture (spine, hip, forearm, or humerus fracture)
- Following risk assessment with FRAX (without a BMD value) or QFracture, consider measuring BMD with DXA in people whose fracture risk is in the region of an intervention threshold for a proposed treatment, and recalculate absolute risk using FRAX with the BMD value
- Do not routinely measure BMD with DXA to assess fracture risk without prior assessment using FRAX (without a BMD value) or QFracture
- Measure bone mineral density (BMD) with DXA to assess fracture risk in people aged under 40 years who have a major risk factor, e.g. history of multiple fragility fractures, major osteoporotic fracture, or current or recent use of high-dose oral or high-dose systemic glucocorticoids (more than 7.5 mg prednisolone or equivalent per day for 3 months of longer)

– Treatment (Compston et al. 2017):
  Women and men age ≥70 years with a previous fragility fracture, or taking high doses of glucocorticoids (≥7.5 mg/day prednisolone) should be considered for bone protective therapy
  In other individuals fracture probability should be estimated using FRAX with adjustment for glucocorticoid dose. FRAX assumes an average dose of prednisolone (2.5–7.5 mg/day or its equivalent) and may overestimate fracture risk in those taking lower doses and underestimate fracture risk in patients taking higher risks
  Bone-protective treatment should be started at the onset of glucocorticoid therapy in individuals at high risk of fracture.
  Adequate calcium intake should be achieved through dietary intake if possible, with the use of supplementation if required. An adequate vitamin D status should be maintained, using supplements if required.
  Alendronate (see Table 5.2) and risedronate are first line treatment options. Where these are not tolerated, zoledronic acid, teriparatide or denosumab are alternative options
  If glucocorticoid therapy is stopped, withdrawal of bone protective therapy may be considered, but if glucocorticoids are continued long term, bone protection should be maintained in the majority of cases
  Bone protective therapy may be appropriate in some premenopausal women and younger man, particularly in individuals with a previous history of fracture or receiving high doses of glucocorticoids

- Prophylaxis of GI side effects:
  – Higher doses of corticosteroids
  – History of GI disease
  – Co-administration of NSAIDs (avoid if possible)

Table 5.2 Key facts about alendronate

- Mechanism of action: bisphosphonate that induces apoptosis of osteoclasts
- 10 mg OD or 70 mg once weekly by mouth for up to 5 years. Treatment review should be performed after 5 years.
- Side effects include upper GI symptoms, bowel disturbance, musculoskeletal pains and headaches
- Should be taken after an overnight fast and at least 30 min before the first food or drink (other than water) of the day or any other oral medicinal products or supplementation
- Tablets should be swallowed whole with a glass of plain water (200 ml) while the patient is sitting or standing in an upright position (to prevent reflux).
- Patients should not lie down for 30 min after taking the tablet (to prevent reflux)

- Withdrawal of corticosteroids:
  - Tapering of corticosteroids is required if there is a risk of adrenal suppression:
    Daily dose has been >40 mg/day prednisolone (or equivalent)
    Duration has been >3 weeks
    Frequency has been >1×/day
    There have been other courses recently, or long-term steroid administration within the last year
- 5 mg prednisolone is equivalent to: Dexamethasone 750 μg, Betamethasone 750 μg, Methylprednisolone 4 mg, Triamcinolone 4 mg, Hydrocortisone 20 mg

5.2 Trials in Glaucoma Involving Trabeculectomy

5.2.1 **Collaborative Initial Glaucoma Treatment Study** (Lichter et al. 2001)

- Primary outcome: A RCT to determine whether patients with newly diagnosed OAG are best treated by initial treatment with topical medications or by immediate trabeculectomy
- Methods:
  - Inclusion criteria: newly diagnosed open angle glaucoma (POAG, PXF glaucoma, pigmentary glaucoma); one of three combinations of qualifying IOP (IOP ≥20 mmHg), VF changes, and optic disc findings; BCVA of 20/40 or better in both eyes; age 25–75 years; no prior ocular surgery (laser, refractive, conjunctival, intraocular); little (≤14 cumulative days of topical therapy) or no prior treatment of glaucoma
  - Exclusion criteria: use of glaucoma medication >14 cumulative days; CIGST VF score >16 in either eye; ocular disease that might affect measurement of IOP, VA, or VF; undergone ophthalmic laser, refractive, conjunctival, or intraocular surgery in either eye; PDR, DMO, or NPDR with >10 MA's by clinical count; current or expected chronic use of corticosteroids; likely require cataract surgery within 1 year of randomisation
  - Groups: topical medication group — escalating drops, if further treatment was required start with ALT, then trabeculectomy ± 5-FU, drops, then trabeculectomy + anti-fibrotic agent, then medication/trabeculectomy group — trabeculectomy ± 5-FU, if further treatment was required start with ALT, then escalating drops, then repeat trabeculectomy + anti-fibrotic agent, then medication
  - Primary endpoint: increasing CIGST VF score (0–20) reflecting increased VF loss
  - Secondary endpoints: change in VA, change in IOP, occurrence of cataract extraction, QOL (questionnaire)
  - Follow up: 5 years (initial report)
- Results: 607 patients
  - Primary endpoint: no significant difference in VF scores at 5 years in both groups
  - Secondary endpoints: initial decrease in VA in the trabeculectomy group that was not observed in the topical medication group and resulted in lower mean VA in the trabeculectomy group, that persisted through 3.5 years after surgery. After that time, mean VA levels were comparable in the two treatment groups up to 5 years of follow up (VA less in trabeculectomy group compared to topical medications group); there were no significant differences in the QOL between the two groups; both groups had significantly decreased mean IOP after treatment initiation (3 mmHg better reduction with trabeculectomy) although the amount of decrease was greater in the trabeculectomy group (48% in trabeculectomy group vs 35% in the topical medication group), and the difference was maintained over 5 years of observation; the trabeculectomy group had a higher cataract extraction probability over time compared to the topical medications group
  - Risk factors for VF progression: older age, non-white race, DM, development of cataract, maximal IOP, IOP fluctuation between visits

- Conclusion of study: CIGTS clinical outcomes do not suggest a change in the way ophthalmologists currently manage their patients with newly diagnosed OAG

5.2.2 **Advanced Glaucoma Intervention Study** (The AGIS Investigators 1998, 2001)

- Primary outcome: A RCT that assessed the effects of two surgical intervention sequences in patients with advanced POAG after the failure of medical therapy.
- Methods:
  - Inclusion criteria: eyes with either advanced (defined as glaucoma that can no longer be controlled adequately despite maximum tolerated medical therapy in the presence of some glaucomatous VF defect) POAG without previous surgery or advanced POAG in a phakic eye 4 weeks or more after PI, phakic VA better than 20/80 [6/24]), age 35–80 years old, reproducible glaucomatous VF defects in at least one eye, a table of specific combinations of elevated IOP and VF defect (range of very mild to severe) was used to define uncontrolled glaucoma and was used to determine if a second or third operation was required
  - Exclusion criteria: secondary glaucoma or congenital angle anomalies, other active eye diseases particularly those that cause field of loss or previous surgery (except PI or localised retinopexy)
  - Groups: A-T-T group: ALT followed if necessary by trabeculectomy, followed if necessary by repeat trabeculectomy / T-A-T group: trabeculectomy followed if necessary by ALT, followed if necessary by repeat trabeculectomy
  - Primary endpoints: VA and/or VF (score 0 normal to-20 blind)
  - Follow up: 7 years (initial report)
- Results: 332 black patients, 249 white patients, 10 patients of other races
  - Low post intervention IOP is associated with reduced progression of VF defect
    Predictive analysis (IOP averaged over the first three 6-month visits — designed to assess whether IOP during early follow up is predictive of subsequent change from baseline in VF defect score): Initial mean IOP <14 mmHg over the first 18 months after surgery had a mean VF score deterioration of less than 1 point from baseline and those with an initial IOP ≥18 mmHg had a mean score deterioration of three points over 7 years
    Associative analysis (% of visits over the first 6 years of follow up for which an eye presented with IOP <18 mmHg): IOP <18 mmHg on 100% of follow up visits over 6 years resulted in a mean score deterioration of close to zero, but those achieving IOP <18 mmHg on <100% of visits had a mean deterioration of two to three points
  - After 7 years of follow-up, overall (in both black and white patients) the mean decrease in IOP from baseline is greater in eyes assigned to T-A-T than in those assigned to A-T-T
  - In white patients, VF was better preserved by T-A-T only after the first year of follow-up and thereafter favour the A-T-T sequence, and acuity was better preserved by A-T-T throughout follow up.
  - For black patients, the VF and acuity loss was less for eyes in the A-T-T sequence
  - Complications of trabeculectomy: relative risk of cataract in the 5 years after trabeculectomy was 1.78 compared to those participants who avoided trabeculectomy. Youth and high IOP were key risk factors for failure of either ALT or trabeculectomy. DM or persistent postop inflammation were also significant risk factors for trabeculectomy failure
- Conclusion of study: Low IOP reduces risk of VF progression. Data supports the use of the A-T-T sequence for all black patients. For white patients the data supports the use of the T-A-T sequence

5.2.3 Tube Versus Trabeculectomy (TVT) Study (Gedde et al. 2012)

- Primary outcome: A RCT designed to prospectively compare the safety and efficacy of tube shunt surgery and trabeculectomy with mitomycin C (MMC 0.4 mg/ml) in eyes with prior ocular surgery (cataract extraction with IOL implantation or failed trabeculectomy) with uncontrolled glaucoma
- Methods:
  - Inclusion criteria: age 18–85 years; previous trabeculectomy and/or cataract extraction with IOL implantation; IOP ≥18 mmHg and ≤40 mmHg on maximum tolerated medical therapy
  - Exclusion criteria: NPL vision; pregnant or nursing women; active NVI or proliferative retinopathy; ICE syndrome; aphakia; epithelial or fibrous downgrowth; vitreous in the AC for which a vitrectomy was anticipated; chronic or recurrent uveitis; severe posterior blepharitis; previous cyclodestructive procedure; prior scleral buckling procedure; presence of silicone oil; conjunctival scarring precluding a superior trabeculectomy; unwillingness to discontinue contact lens use after surgery
  - Groups: 350 mm^2 Baerveldt glaucoma implant group/trabeculectomy + MMC group
  - Endpoints: IOP, VA, use of supplemental medical therapy, surgical complications, visual fields, failure (IOP >21 mmHg or less than 20% reduction below baseline on two consecutive follow up visits after 3 months, IOP ≤5 mmHg on two consecutive follow up visits after 3 months, reoperation for glaucoma — additional glaucoma surgery requiring a return to the OR, loss of light perception vision)
  - Follow up: 5 years
- Results: 212 eyes of 212 patients
  - IOP reduction: mean IOP was similar between the two treatment groups at 5 years (14.3 mmHg in the tube group vs 13.6 mmHg in the trabeculectomy group)
  - Use of supplemental medical therapy: no significant difference in the mean number of supplemental medications between treatment groups at 5 years
  - Failure rate: a significantly higher failure rate was seen in the trabeculectomy group than the tube group at 5 years (33% in the tube group vs 50% in the trabeculectomy group)
  - Reoperation for glaucoma: a significantly higher rate of reoperation for glaucoma was observed in the trabeculectomy group compared with the tube group at 5 years (9% in the tube group vs 29% in the trabeculectomy group)
- Conclusion of study: Tube shunt surgery had a higher success rate compared to trabeculectomy with MMC at 5 years. Both procedures were associated with similar IOP reductions and use of supplemental medical therapy at 5 years. Additional glaucoma surgery was needed more frequently after trabeculectomy with MMC than tube shunt surgery

5.2.4 Primary Tube Versus Trabeculectomy (PTVT) Study (Gedde et al. 2018)

- Primary outcome: A RCT designed to prospectively compare the safety and efficacy of tube shunt surgery and trabeculectomy with mitomycin C (MMC 0.4 mg/ml) in eyes with no prior incisional ocular surgery with uncontrolled glaucoma
- Methods:
  - Inclusion criteria: age 18–85 years; previous trabeculectomy and/or cataract extraction with IOL implantation; IOP ≥18 mmHg and ≤40 mmHg on maximum tolerated medical therapy
  - Exclusion criteria: NPL vision; pregnant or nursing women; active NVI or proliferative retinopathy; ICE syndrome; aphakia; epithelial or fibrous downgrowth; vitreous in the AC for which a vitrectomy was anticipated; chronic or recurrent uveitis; severe posterior blepharitis; previous cyclode-

structive procedure; prior scleral buckling procedure; presence of silicone oil; conjunctival scarring precluding a superior trabeculectomy; unwillingness to discontinue contact lens use after surgery
  - Groups: 350 mm^2 Baerveldt glaucoma implant group/trabeculectomy + MMC group
  - Endpoints: IOP, VA, use of supplemental medical therapy, surgical complications, visual fields, failure (IOP >21 mmHg or less than 20% reduction below baseline on two consecutive follow up visits after 3 months, IOP ≤5 mmHg on two consecutive follow up visits after 3 months, reoperation for glaucoma — additional glaucoma surgery requiring a return to the OR, loss of light perception vision)
  - Follow up: 1 year
- Results: 242 eyes of 242 patients
  - IOP reduction: mean IOP was significantly lower in the trabeculectomy group at 1 year (13.8 mmHg in the tube group vs 12.4 mmHg in the trabeculectomy group)
  - Use of supplemental medical therapy: a significantly lower mean number of supplemental glaucoma medications was used in the trabeculectomy group at 1 year (2.1 in the tube group vs 0.9 in the trabeculectomy group)
  - Failure rate: a significantly higher failure rate was seen in the tube group than the trabeculectomy group at 1 year (17.3% in the tube group vs 7.9% in the trabeculectomy group)
  - Reoperation for glaucoma: a significantly higher rate of reoperation for glaucoma was observed in the trabeculectomy group compared with the tube group at 1 year (1% in the tube group vs 7% in the trabeculectomy group)
- Conclusion of study: Trabeculectomy + MMC had a higher surgical success rate than tube shunt surgery at 1 year. Lower IOP with use of fewer glaucoma medications was achieved after trabeculectomy + MMC compared with tube shunt surgery at 1 year. Additional glaucoma surgery was needed more frequently after trabeculectomy with MMC than tube shunt surgery

5.3 The RCOphth Guideline on Standards for the Retrieval of Human Ocular Tissue Used in Transplantation, Research and Training 2008

- Eyebanks
  - Four in the UK: Moorfields, East Grinstead, Manchester, Bristol
  - Two Corneal Transplant Service (CST): Bristol, Manchester
- Consent
  - If a person has expressed a wish to be an eye donor, for example through the National Organ Donor Register or in a will, that consent is paramount and cannot be overridden by relatives
  - In the absence of prior consent given by a potential donor, consent may be given by a nominated representative of the donor or by a person in a qualifying relationship/nearest relative
  - Inform relatives that not every cornea will be suitable for transplantation, but that suitability cannot be determined before the eyes have been collected
  - Consent should also be obtained for a sample of the donor's blood to be taken for the testing of viral and other microbiological markers of transmissible disease
  - Relatives should also be asked for their permission to seek further information about a donor's medical history and behavioural background from the donor's medical records, GP and other relevant healthcare professionals
  - Research consent using a separate consent/authorisation form
  - Strongly recommended good practice that consent is recorded by a specially trained healthcare professional, such as a transplant or tissue coordinator, using the NHSBT Consent/Authorisation forms and Management Process Document or their equivalent
- Donor age

- Upper age:
  Currently no need to set an upper age limit for eye donation
  Corneal endothelium is to be carefully examined by microscopy before transplantation to exclude those corneas with low endothelial cell densities endothelial damage, or other abnormalities
- Lower age:
  There will be very little demand for corneas from donors under 3 years old

- Post-mortem time
  - Enucleation can be performed up to 24 h post-mortem time after a donors death
  - Blood sample must be taken within 24 h of a donors death
- Medical and behavioural history
  - Sources of information about donors:
    Hospital medical records
    Consultant/Senior Nursing Staff with clinical responsibility for the deceased
    Family/most relevant life partner
    GP
    Post-mortem examination request form
  - NHSBT assessment form used to record the family/partner interview
  - NHSBT GP form used to obtain information from the donors GP
  - Check for medical contraindications for donation and transplantation of ocular tissue
- Eye retrieval
  - Eye retrievers:
    Must be carried out by a person who is competent in enucleation
    Check:
    - Consent/authorization has been obtained
    - All relevant sources of medical information has been checked
  - NHS Blood Transport (NHSBT) Human Tissue Transport box:
    Contains:
    - A set of sterile, single-use instruments with a paper wrapper for use as a drape
    - Blood sample tube
    - Alcohol swabs for cleaning the skin around the eyes and the eyelids
    - Sterile saline for irrigating eyes
    - Sterile pots, 25G needles, eye stands, cotton balls and saline for creating moist chambers
    - Eye caps and cotton balls for restoring the donor's appearance
    - Enucleation protocol, list of medical contraindications, NHSBT Ocular Tissue Donor Information and Retrieval Site Risk Assessment forms

    Additional required items not included in the transport box:
    - At least 1 kg of ice is needed to keep the contents of the transport box below 5 °C for up to 24 h during transportation to the eye bank
    - 10 ml syringe and 19G needle for taking the blood sample
    - Sterile gloves and appropriate protective clothing
  - Retrieval site risk assessment:
    A requirement that a risk assessment is carried out to ensure that the retrieval site is suitable and appropriate for the removal of tissue from a deceased donor
  - Donor identification:
    In hospitals and hospices, the donor should be identified by the wrist or ankle tag using name, DOB, hospital number and any other available identifiers
    Strongly recommended good practice for identification of the donor to be confirmed by the eye retriever and another person
  - Physical examination of the donor:
    Examine those parts of a donor's body that are readily accessible, noting the areas examined and findings such as tattoos, piercings and scars on the body map provided on the NHSBT Ocular Tissue Donor information form
  - Blood sample:

If the mandatory blood tests for transmissible disease are not carried out locally, a sample of the donors blood must be sent to the eye bank with the donor's eyes

If an ante-mortem blood sample taken not more than 7 days before death is not available, a blood sample should be taken from the deceased as soon after death as possible and not more than 24 h after death

– Enucleation:

A standard enucleation protocol, such as that provided in the NHSBT Human Tissue Transport Box should be followed

Carefully transfer the eye to a plastic eye stand, passing the stump of the optic nerve through the hole in the base of the stand. Secure the eye on the stand by placing a sterile 25G hypodermic needle through the side of the optic nerve. Place the eye stand and eye (cornea uppermost) on top of a cotton wool ball moistened with saline in a sterile pot (moist chamber). The eye must not be immersed in any liquid in the moist chamber

– Restoring the donor's appearance:

Orbits should be packed with cotton wool and the lids closed over plastic eye caps to restore the original profile of the lids

– Packaging, labeling and transport to a Corneal Transplant Service (CTS) eye bank:

Labelling:

- Essential that the moist chambers and the blood sample tube are clearly and correctly labelled with the date, donor's name, DOB and at least one other identifier (e.g. hospital name)

Packaging:

- Eyes must be packed in an NHSBT Human Tissue Transport Box with the blood sample, NHSBT Retrieval Site Risk Assessment form, an NHSBT Ocular Tissue Donor form completed to the best of the eye retrievers knowledge, and any other information that may be available at the time such as a consent form, a medical history check list, or an NHSBT GP form
- Box must be packed according to the instructions provided, including at least 1 kg of ice to ensure correct maintenance of temperature during transport

Transport:

- Box should be closed using the supplied tamper-evident security tag
- Eye retriever should contact UK Transplant (UKT) when the eyes are ready for collection, providing specific details of the location and reporting the security tag number
- UKT will specify the eye bank address, which should then be clearly written on the label provided and attached to the side of the box
- The eyes must be kept at a secure location until they are collected

- Contraindications to ocular tissue transplantation
  – Infections:

HIV/AIDS
Viral hepatitis (A-C)
TB
HTLV
Syphilis
Septicaemia
Congenital rubella
Rabies
Behaviour leading to risk of contracting HIV, hepatitis or HTLV
Tattoos and body piercing within the 6 months before death
Acupuncture within the 6 months before death

Imprisonment within the 12 months before death
- Previous surgery/medical treatment:
  Immunosuppression
  Receipt of an organ transplant
  Receipt of dura mater or brain/spinal surgery before August 1992
  Receipt of human pituitary hormones
  Receipt of a cornea, sclera or other human tissue allograft
- Unknown aetiology and CNS disorders:
  Death from unknown cause
  CJD, Alzheimer's disease, Parkinson's disease, MS, motor neurone disease
- Malignancies:
  Leukaemia
  Lymphoma
  Myeloma
  Polycythaemia Ruba Vera
  Myelodysplastic syndrome
- Intrinsic eye disease:
  Active ocular inflammation/uveitis
  Any congenital or acquired disorders of the eye, or previous ocular surgery (including corneal laser surgery), that would preclude successful graft outcome
  Retinoblastoma
  Malignant tumours of the anterior segment

5.4 Recent Pivotal Age-Related Macular Degeneration Clinical Trials

5.4.1 **ANCHOR Study** (Brown et al. 2006)

- Primary outcome: To compare ranibizumab with photodynamic therapy with verteporfin (vPDT) in the treatment of predominantly classic neovascular AMD
- Methods:
  - Groups — 0.3 mg ranibizumab + sham vPDT group, 0.5 mg ranibizumab + sham vPDT group, sham injections + active vPDT group. Injections were administered monthly and vPDT (sham or active) was administered at day 0 and then if needed on the basis of investigator's evaluation of angiography at 3, 6, 9 and 12 months
  - Primary endpoint — proportion of patients losing fewer than 15 letters from baseline VA at 12 months
  - Secondary endpoints — structural outcomes on fluorescein angiography
  - Follow up — 12 months
- Results — 423 patients
  - Primary endpoint
    94.3% of patients in the 0.3 mg ranibizumab group and 96.4% in the 0.5 mg ranibizumab group lost fewer than 15 letters from baseline VA, as compared with 64.3% in the vPDT group
    The proportion of patients whose VA improved from baseline by 15 or more letters was significantly greater among those receiving ranibizumab treatment (35.7% in the 0.3 mg ranibizumab group and 40.3% in the 0.5 mg ranibizumab group, as compared with 5.6% in the vPDT group)
    Significantly greater proportions of ranibizumab-treated patients than patients in the vPDT group had VA of 20/40 or better and smaller proportions had VA of 20/200 or worse
    A severe loss of vision (defined as decrease of 30 letters or more) did not occur in any patient in the ranibizumab groups but occurred in 13.3% of patients in the vPDT group
    At 12 months, 7.1% of patients in the 0.3 mg ranibizumab group and 6.4% of patients in the 0.5 mg ranibizumab group had VA of 20/20 or better, as compared with 0.7% of patients in the vPDT group
  - Secondary endpoints
    At 12 months, the area occupied by classic CNV decreased by a mean of 0.52 optic disc area in the 0.3 mg ranibizumab group and 0.67 optic disc area in the 0.5 mg ranibizumab group, as compared with a mean increase of 0.54 optic disc area in the vPDT group

The area of leakage from CNV plus intense, progressive staining of the RPE at 12 months decreased by a mean of 2.05 optic disc area in the 0.5 mg ranibizumab group and 1.80 optic disc area in the 0.3 mg ranibizumab group, as compared with a mean increase of 0.32 optic disc area in the vPDT group

- Conclusion of study: Ranibizumab was superior to vPDT as treatment of predominantly classic neovascular AMD

5.4.2 **MARINA Study** (Rosenfeld et al. 2006)

- Primary outcome: To evaluate ranibizumab for the treatment of minimally classic or occult with no classic CNV associated with AMD
- Methods:
  - Groups — 0.3 mg ranibizumab group, 0.5 mg ranibizumab group, sham injection. Injections were administered monthly for 2 years
  - Primary endpoint — proportion of patients who had lost fewer than 15 letters from baseline VA
  - Secondary endpoint — structural outcomes on fluorescein angiography
  - Follow up — 2 years
- Results — 716 patients
  - Primary endpoints

    At 12 months, 94.5% of the patients receiving 0.3 mg ranibizumab and 94.6% of the patients receiving 0.5 mg ranibizumab had lost fewer than 15 letters from baseline VA, as compared with 62.2% in the sham-injection group

    At 24 months, 92% of the patients receiving 0.3 mg ranibizumab and 90% of the patients receiving 0.5 mg ranibizumab had lost fewer than 15 letters from baseline VA, as compared with 52.9% in the sham-injection group

    At 12 and 24 months, approximately 25% of patients treated with 0.3 mg ranibizumab and 33% of patients treated with 0.5 mg ranibizumab had gained 15 or more letters in VA, as compared with 5% or less of those in the sham-injection group

    At 12 months, mean increases in VA were 6.5 letters in the 0.3 mg ranibizumab group and 7.2 letters in the 0.5 mg ranibizumab group, as compared with a decrease of 10.4 letters in the sham-injection group. The benefit in VA was maintained at 24 months

    At 12 months, approximately 40% of patients receiving ranibizumab had 20/40 vision or better, as compared with 11.3% in the sham-injection group. At 24 months, of the patients receiving ranibizumab, 34.5% of those in the 0.3 mg ranibizumab group and 42.1% in the 0.5 mg ranibizumab group had at least 20/40 vision, whereas the proportion in the sham injection group had dropped to 5.9%

    Among patients receiving ranibizumab, 3.8% in the 0.3 mg ranibizumab group and 7.9% in the 0.5 mg ranibizumab group had 20/20 vision or better at 24 months. In the sham injection group, 0.8% of patients had 20/20 vision or better at 12 months and 0.4% of patients had 20/20 vision or better at 24 months
  - Secondary endpoints

    Ranibizumab treatment was associated with arrested growth of and leakage from CNV
- Conclusion of study: Intravitreal administration of ranibizumab for 2 years prevented vision loss and improved mean VA in patients with minimally classic or occult with no classic CNV secondary to AMD

5.4.3 **PrONTO Study** (Fung et al. 2007)

- Primary outcome: To evaluate an OCT-guided, variable-dosing regimen with intravitreal ranibizumab for the treatment of patients with neovascular AMD (eligibility — BCVA 20/40 to 20/400 in the study eye and OCT central retinal thickness ≥300 μm)

- Methods:
  - Groups — all patients received intravitreal injections of ranibizumab at baseline, month 1, and month 2. Additional reinjections were given if: (1) VA loss of at least 5 letters with OCT evidence of fluid in the macula, (2) an increase in OCT central retinal thickness ≥100 μm, (3) new macular haemorrhage, (4) new area of classic CNV, or (5) evidence of persistent fluid on OCT at least 1 month after the previous injection
  - Primary endpoints — change in VA and OCT measurements from baseline
  - Secondary endpoints — number of consecutive monthly injections required from baseline to achieve a fluid-free macula as determined by OCT
  - Follow up — 12 months
- Results — 40 patients
  - Primary endpoints:

    At 12 months, the mean and median VA scores improved compared with baseline by 9.3 letters and 11 letters, respectively

    At 12 months, the mean and median central retinal thickness measurements decreased by 177.8 and 185.5 μm, respectively
  - Secondary endpoints

    The mean number of injections for the first year were 5.6 (SD 2.3) and 5.0 (range, 3–13), respectively, of a possible 13 injections from day 0 through month 12

    A total of 39 eyes eventually became fluid-free; 37 of these eyes eventually developed some recurrent fluid during the first year. Of the 37 eyes that developed some recurrent fluid, 32 received a retreatment during the first 12 months

    After the first 3 injections, 7 patients never needed another injection. One eye never became fluid-free and received a total of 13 injections

    Of the 39 eyes that eventually achieved a fluid-free macula, the mean and median number of monthly consecutive injections from baseline that were required to achieve a fluid-free macula were 1.5 (SD 1.1) and 1.0 (range, 1–6), respectively
- Conclusion of study: OCT-guided, variable-dosing regimen with ranibizumab resulted in VA outcomes similar to the phase III clinical trials MARINA and ANCHOR. OCT appears useful for determining when retreatment with ranibizumab is necessary

5.4.4 **PIER Study** (Regillo et al. 2008)

- Primary outcome: To evaluate the efficacy and safety of ranibizumab administered monthly for 3 months and then quarterly in patients with subfoveal CNV secondary to AMD
- Methods:
  - Groups — 0.3 mg ranibizumab group, 0.5 mg ranibizumab group, sham treatment group. Injections were administered monthly, for the first three doses, followed by three-monthly intervals. Verteporfin photodynamic therapy (vPDT) was permitted at the investigator's discretion
  - Primary endpoint — mean change from baseline to 12 months in VA score
  - Secondary endpoint — proportion of subjects losing 15 letters or less from baseline; proportion gaining ≥15 letters from baseline; proportion with a Snellen equivalent of 20/200 or worse; mean change from baseline in the near activities, distance activities, and vision-specific dependency NEI VFQ-25 subscales; and mean change from baseline in total area of CNV and total area of leakage from CNV
  - Follow up — 12 months
- Results — 184 patients
  - Primary endpoints

    At 12 months, sham-treated eyes had lost a mean of 16.3 letters, whereas ranibizumab-treated subjects had lost a mean of 1.6 letters (0.3 mg ranibizumab group) or 0.2 letters (0.5 mg ranibizumab group)

    On average, there was a 4.5 letter decline in VA between month 3 and

month 12 for both ranibizumab dose groups, reflecting the effect of quarterly dosing; these declines were statistically significant

– Secondary endpoints

Significantly greater proportions of the ranibizumab groups than the sham group had lost fewer than 15 letters from baseline VA: 83.3% and 90.2% of the 0.3 and 0.5 mg ranibizumab groups, respectively, compared with 49.2% of the sham group

The three treatment groups did not differ significantly in the proportions gaining at least 15 letters: 9.5% in the sham group, 11.7% in the 0.3 mg ranibizumab group, and 13.1% in the 0.5 mg ranibizumab group

Significant smaller proportions of the ranibizumab groups than the sham group had VA of 20/200 of worse snellen equivalent at month 12: 23.3% and 24.6% of the 0.3 and 0.5 mg ranibizumab groups, respectively, compared with 52.4% of the sham group

There was no statistically significant difference between either ranibizumab dose group and the sham control for any of the 3 NEI VFQ-25 subscales that were prespecified as secondary endpoints

Ranibizumab reduced the total area of leakage of CNV plus intense progressive RPE staining on average, whereas the sham group exhibited an increase trend

- Conclusion of study: Ranibizumab administered monthly for 3 months and then quarterly provided significant VA benefits to patients with AMD-related subfoveal CNV

5.4.5 The Comparison of Age-Related Macular Degeneration Treatment Trial (The CATT Research Group 2011)

- Primary outcome — A RCT to assess the relative efficacy and safety of ranibizumab (0.5 mg) and bevacizumab (1.25 mg) and to determine whether an as-needed regimen would compromise long term VA, as compared to a monthly regimen
- Methods:
  – Groups — ranibizumab monthly group, bevacizumab monthly group, ranibizumab as needed group, bevacizumab as needed group
  – Primary endpoint — mean change in VA between baseline and 1 year
  – Secondary endpoints — proportion of patients with a change in VA of 15 letters or more, the number of injections, the change in fluid and foveal thickness on OCT, change in lesion size on FA, the incidence of ocular and systemic adverse effects
  – Follow up — 1 year
- Results — 1208 patients
  – Primary endpoint

Bevacizumab monthly (+8.0 letter) was equivalent to ranibizumab monthly (+8.5 letters)

Bevacizumab as needed (+5.9 letters) was equivalent to ranibizumab monthly (+6.8 letters)

Ranibizumab as needed was equivalent to monthly ranibizumab

Comparison of bevacizumab as needed and bevacizumab monthly was inconclusive

  – Secondary endpoints

The proportion of patients who did not have a decrease in VA of 15 letters or more from baseline was 94.4% in the ranibizumab monthly group, 94.0% in the bevacizumab monthly group, 95.4% in the ranibizumab as needed group, and 91.5% in the bevacizumab as needed group

The proportion of patients who gained at least 15 letters did not differ significantly among the groups, ranging from 24.9% in the group that received ranibizumab as needed to 34.2% in the group that received ranibizumab as needed

The proportion of patients with arteriothrombotic events (CVA, MI, death from vascular causes) were similar among the groups

The proportion of patients with serious systemic adverse events (hospitalisation from infections, e.g. pneumonia, UTI, GI disorders, e.g. haemorrhage, nausea and vomiting) was higher with bevacizumab (24.1%) than with ranibizumab (19.0%)

- Conclusion of study
  - At 1 year, effect on visual acuity of bevacizumab were non-inferior to that ranibizumab when administered according to the same schedule. Ranibizumab given as needed with monthly evaluation had effects on vision that were similar to those of ranibizumab administered monthly.
  - At 2 years, bevacizumab and ranibizumab had similar effects on visual acuity. Treatment as needed resulted in less gain in VA, whether instituted at enrolment or after 1 year of monthly treatment
  - Non-inferiority was not shown between as required bevacizumab and monthly ranibizumab or monthly bevacizumab
  - As required ranibizumab was non-inferior to monthly ranibizumab
  - In order to achieve similar effects, prn bevacizumab needs to be administered more often than prn ranibizumab
  - There was a higher incidence of adverse events associated with bevacizumab compared to ranibizumab

5.4.6 VIEW 1 and VIEW 2 Studies (Heier et al. 2012)

- Primary outcome: To compare intravitreal aflibercept, monthly or every 2 months, with monthly ranibizumab in treatment of nAMD
- Methods
  - Groups — 0.5 mg aflibercept every 4 weeks group, 2 mg aflibercept every 4 weeks group, 2 mg aflibercept every 8 weeks after 3 injections at week 0, 4 and 8 group, 0.5 mg ranibizumab every 4 weeks group
  - Primary endpoint — noninferiority (margin of 10%) of the intravitreal aflibercept regimens to ranibizumab in the proportions of patients maintaining vision at week 52 (losing less than 15 ETDRS letters)
  - Secondary endpoint — compare baseline and 52-week data regarding mean change in BCVA; gaining 15 or more letters; change in total National Eye Institute 25-Item Visual Function Questionnaire (NEI VFG-25) score; change in CNV area on fluorescein angiography
  - Follow up — 12 months
- Results — 2419 patients
  - Primary endpoints

    All aflibercept groups achieved statistical noninferiority compared with monthly ranibizumab in the treatment of CNV secondary to AMD
  - Secondary endpoints

    Similar VA scores across the entire 52-week study for all treatment groups

    On the basis of the hierarchical testing sequence, only the 2 mg aflibercept every 4 weeks group was statistically superior to ranibizumab, and only in VIEW 1, with a gain of +10.9 versus +8.1 letters

    In both studies, the proportion of patients gaining 15 or more ETDRS letters from baseline to week 52 was similar in all treatment groups

    Vision-related quality of life, assessed by the change of total score of the NEI VFQ-25, improved in all groups in both studies

    All groups demonstrated a comparable decrease in area of active CNV

    All aflibercept groups in both studies had reductions in central retinal thickness similar to those for monthly ranibizumab as assessed by OCT, with a large and rapid reduction evident by week 4 that was maintained to week 52
- Conclusion of study: Intravitreal aflibercept dosed monthly or every 2 months after 3 initial monthly doses produced similar efficacy and safety outcomes as monthly ranibizumab in the treatment of nAMD

5.4.7 Inhibition of VEGF in Age-Related Choroidal Neovascularisation (IVAN) Trial (Chakravarthy et al. 2013)

- Primary outcome — A RCT to compare the efficacy and safety of ranibizumab (0.5 mg) and bevacizumab (1.25 mg) to treat neovascular age-related macular degeneration
- Methods
  - Groups — ranibizumab continuous group, bevacizumab continuous group, ranibizumab discontinuous group, bevacizumab discontinuous group
  - Primary endpoint — BCVA at 2 years
  - Secondary endpoints — near VA, reading index, contrast sensitivity, lesion morphology and metrics from FA and OCTs, adverse events
  - Follow up — 2 years
- Results — 525 patients reached the visit at 2 years
  - Primary endpoint

    BCVA was similar between ranibizumab and bevacizumab groups and continuous and discontinuous treatment groups.

    Bevacizumab was neither inferior or non-inferior to ranibizumab

    Discontinuous regimen was neither inferior or non-inferior to the continuous regimen
  - Secondary endpoints

    Near VA, reading index, and contrast sensitivity did not differ significantly between drug groups

    Near VA and contrast sensitivity were significantly worse with the discontinuous regimen

    Mortality was higher at 2 years with discontinuous treatment than continuous treatment
- Conclusion of study: ranibizumab and bevacizumab have similar efficacy. Reduction in the frequency of retreatment resulted in a small loss of efficacy irrespective of drug. Safety was worse when treatment was administered discontinuously.

5.4.8 HAWK and HARRIER (Dugel et al. 2020)

- Primary outcome – To demonstrate that brolucizumab is noninferior to fixed-dose aflibercept with respect to the change in best corrected visual acuity (BCVA) from baseline to week 48 in patients with neovascular AMD
- Methods:
  - Groups — HAWK: brolucizumab 3 mg group, brolucizumab 6 mg group, or aflibercept 2 mg group; HARRIER: brolucizumab 6 mg group or aflibercept 2 mg group. For both trials, all treatment arms had three loading injections at weeks 0, 4, and 8 followed by 8 weeks before the next possible treatment. Brolucizumab was injected every 12 weeks (q12w) unless disease activity was identified, resulting in permanent adjustment to 8 weekly injections (q8w). Aflibercept was injected every 8 weeks (q8w)
  - Primary endpoint — mean BCVA change from baseline to week 48
  - Secondary endpoints — BCVA change from baseline averaged over the period of week 36 through week 48 (to account for differences in timing of treatment), q12w treatment status at week 48 (brolucizumab groups only), q12w treatment status at week 48 among eyes with no q8w need during the first q12w cycle (to evaluate the predictive value of the first q12w cycle; brolucizumab groups only), anatomic retinal fluid outcomes
  - Follow up — 48 weeks
- Results — total of 1817 patients (HAWK + HARRIER)
  - Primary endpoint

    In both trials, each brolucizumab arm demonstrated noninferiority versus aflibercept in least squares (LS) mean BCVA change from baseline to week 48

    In HAWK, brolucizumab 3 mg — and brolucizumab 6 mg — treated eyes gained +6.1 and +6.6 letters, respectively, versus +6.8 letters among aflibercept-treated eyes

In HARRIER, brolucizumab 6 mg-treated eyes gained +6.9 letters versus +7.6 letters among aflibercept-treated eyes

– Secondary endpoints

For brolucizumab-treated eyes, the probabilities for exclusively maintaining q12w dosing after loading through week 48 were 49.4% (brolucizumab 3 mg group) and 55.6% (brolucizumab 6 mg group) in HAWK and 51.0% (brolucizumab 6 mg group) in HARRIER

Under the condition that a brolucizumab treated eye did not show disease activity during the first q12w interval, the probabilities for remaining on q12w dosing up to week 48 increased to 80.9% (brolucizumab 3 mg group) and 85.4% (brolucizumab 6 mg group) in HAWK and 81.7% (brolucizumab 6 mg group) in HARRIER

Anatomic retinal fluid outcomes favoured brolucizumab over aflibercept

- Conclusions of study: Brolucizumab was non-inferior to aflibercept in visual function at week 48, and >50% of brolucizumab 6 mg treated eyes were maintained on q12w dosing interval through week 48. Anatomic outcomes favoured brolucizumab over aflibercept. Overall safety with brolucizumab was similar to aflibercept

5.4.9 **The Age-Related Eye Disease Study** (Age-Related Eye Disease Study Group 2001)

- Primary outcome: To evaluate the effect of high-dose vitamins C and E, beta carotene, and zinc supplements on AMD progression and visual acuity
- Methods:
  – Groups — antioxidants alone (500 mg of vitamin C, 400 IU of vitamin E, and 15 mg of beta carotene) group, zinc alone group (80 mg of zinc as zinc oxide and 2 mg of copper as cupric oxide to prevent potential anaemia), combination of anti-oxidants and zinc group, placebo group
  – Primary endpoints — (1) progression to advanced AMD and (2) at least a 15-letter decrease in VA score from baseline
  – Secondary endpoints — development of neovascular AMD, incidence of GA, progression to advanced AMD with an associated VA decrease of at least 15 letters, and worsening of AMD classification in Category 2 (multiple small drusen, single or non-extensive intermediate drusen, pigment abnormalities, or any combination of these, and VA of 20/32 or better in both eyes) participants to Category 3 (absence of advanced AMD in both eyes and at least 1 eye with VA of 20/32 or better with at least 1 large druse, extensive intermediate drusen, or geographic atrophy that did not involve the center of the macula) or 4 (VA of 20/32 or better and no advanced AMD in the study eye, and the fellow eye had either lesions of advanced AMD or VA less than 20/32 and AMD abnormalities sufficient to explain reduced VA) during follow up
  – Follow up — 5 years
- Results — 4757 participants
  – Primary endpoints:

Category 2 participants had only a 1.3% probability of progression to advanced AMD by year 5. Category 3 participants had a 18% probability of progression to advanced AMD by year 5. Category 4 participants had a 43% probability of progression to advanced AMD in the fellow study eye at 5 years

The estimated probability of progression to advanced AMD was 28% for those assigned to placebo, 23% and 22% for those assigned to antioxidants only and zinc only, respectively, and 20% for those assigned to antioxidants plus zinc

Estimates of relative risks derived from odds ratios suggest risk reductions for those taking antioxidants alone or zinc alone of 17% and 21%, respectively. The risk reduction for those taking antioxidants plus zinc was 25%.

At 5 years, the estimated probability of at least a 15-letter decrease in VA score from baseline was 29% for those assigned to placebo, 26% for those assigned to antioxidants alone, 25% for those assigned to zinc alone, and 23% for those assigned to antioxidant plus zinc

  - Secondary endpoints:

    A statistically significant benefit of treatment with antioxidants plus zinc compared with placebo was observed for neovascular AMD outcomes in participants in Categories 3 and 4

    There is no evidence of treatment benefit in delaying the progression of AMD in participants who began the study in Category 2

- Conclusions of study: Those with extensive intermediate size drusen, at least 1 large druse, noncentral geographic in 1 or both eyes, or advanced AMD or vision loss due to AMD in 1 eye, and without contraindications such as smoking, should consider taking a supplement of antioxidants plus zinc such as that used in AREDS

5.4.10 The Age-Related Eye Disease Study 2 (The Age-Related Eye Disease Study 2 (AREDS2) Research Group 2013)

- Primary outcome: To determine whether adding lutein + zeaxanthin, DHA + EPA, or both to the AREDS formulation decreases the risk of developing advanced AMD and to evaluate the effect of eliminating beta carotene, lowering zinc doses, or both in the AREDS formulation
- Methods:
  - Groups — lutein + zeaxanthin group, DHA + EPA group, lutein + zeaxanthin and DHA + EPA group, or placebo. All participants were also asked to take the original AREDS formulation or accept a secondary randomisation to four variations of the AREDS formulation, including elimination of beta carotene, lowering of zinc doses, or both
  - Primary endpoint — development of advanced AMD
  - Secondary endpoints — progression to moderate vision loss (three lines or more) from baseline or treatment for choroidal neovascularisation
  - Follow up — 5 years
- Results — 4203 participants
  - Primary endpoint:

    Kaplan-Meier probabilities of progression to advanced AMD by 5 years were 31% for placebo, 29% for lutein + zeaxanthin, 31% for DHA + EPA, and 30% for lutein + zeaxanthin and DHA + EPA

    Daily supplementation with lutein + zeaxanthin, DHA + EPA, or lutein + zeaxanthin and DHA + EPA in addition to the original AREDS formulation showed no statistically significant overall effect on progression to advanced AMD or changes in VA

    There was no apparent effect of beta carotene elimination or lower dose zinc on progression to advanced AMD
  - Secondary endpoints:

    None of the nutrients affected development of moderate or worse vision loss. No apparent effect on vision of eliminating beta carotene and reducing zinc dose was observed
- Conclusion of study: Addition of lutein + zeaxanthin, DHA + EPA, or both to the AREDS formulation in primary analyses did not further reduce risk of progression to advanced AMD. However, because of potential increased incidence of lung cancer in former smokers, lutein + zeaxanthin could be an appropriate carotenoid substitute in the AREDS formulation

5.5 The Optic Neuritis Treatment Trial (ONTT)

- The ONTT was a randomised trial that evaluated the use of corticosteroids in the treatment of acute optic neuritis
- Methods — three treatment regimens

  - 250 mg of IV methylprednisolone every 6 h for 3 days followed by 1 mg of oral prednisolone per kg of body weight per day for 11 days (IV-methylprednisolone group)
  - 1 mg of oral prednisolone per kg per day for 14 days (oral prednisolone group)
  - Oral placebo for 14 days (placebo group)
- Results
  - A 3-day course of pulsed IV treatment with methylprednisolone (250 mg QDS) followed by an 11-day course of oral prednisolone (1 mg/kg) accelerated visual recovery but did not significantly improve visual outcome at 6 months (Beck et al. 1992). However, this regimen temporarily reduced the rate of new demyelinating events over a 6–24 month follow up period (Beck et al. 1993)
  - A regimen of oral prednisolone alone (1 mg/kg for 14 days) did not improve visual outcome at 6 months and was associated with an increased rate of new attacks of optic neuritis (Beck et al. 1992)
  - At 10 years, the probability of developing MS was 22% for patients with no white matter lesions on MRI and 56% for patients with one or more white matter lesions on MRI (Optic Neuritis Study Group 2003)
  - The aggregate cumulative probability of developing MS by the 15-year examination was 50% and was strongly related to the presence of lesions on the baseline MRI (The Optic Neuritis Study Group 2008)
  - At 15 years, the probability of developing MS was 25% for patients with no white matter lesions on MRI and 72% for patients with one or more white matter lesions on MRI (The Optic Neuritis Study Group 2008)
  - Among patients without MS at the 10-year examination, the probability of developing MS by the 15-year examination was 32% when 1 or more baseline lesions were present vs 2% when there were no baseline lesions (The Optic Neuritis Study Group 2008)

5.6 Principles of Screening Applied to the NHS Diabetic Eye Screening Programme

- Screening is the presumptive identification of unrecognised disease or defect by the application of tests, examinations, or other procedures which can be applied rapidly (Wilson et al. 1968)
- World Health Organisation (WHO) Criteria for screening (Wilson et al. 1968)
  - **Condition**:

    The condition should be an important health problem:
    - Sight threatening DR is an important public health problem
    - In 1990–1991 DR was the leading cause of people registered blind among people of working age in England and Wales (Facey et al. 2002)

    There should be a recognisable latent or early symptomatic stage:
    - Sight threatening DR has a recognisable latent or early symptomatic stage in both type 1 and 2 diabetes (Early Treatment Diabetic Retinopathy Study 1991)

    The natural history of the condition, including development from latent to declared disease, should be adequately understood
    - The natural history of sight-threatening diabetic retinopathy is well understood (Kohner 1991)
  - **Test**:

    There should be a suitable test or examination:
    - Two field mydriatic digital photography with a sensitivity of

87.8%, specificity of 86.1%, and poor image quality rate of 3.7% (Scanlon et al. 2003a, b)

The test should be acceptable to the population

- Two field mydriatic digital photography (Scanlon et al. 2003b)

Facilities for diagnosis and treatment should be available

- Hospital Eye Service (HES)

– **Treatment**:

There should be an acceptable treatment for patients with recognised disease:

- PRP is of benefit in preventing severe visual loss in eyes with PDR (The Diabetic Retinopathy Study Research Group 1981)
- Focal photocoagulation of CSMO is of benefit in reducing moderate visual loss (Early Treatment Diabetic Retinopathy Study 1991)

There should be an agreed policy on whom to treat as patients

- All patients with PDR and CSMO require treatment (The Diabetic Retinopathy Study Research Group 1981; Early Treatment Diabetic Retinopathy Study 1991)

– **Cost**:

The cost of case finding (including diagnosis and treatment of patients diagnosed) should be economically balanced in relation to possible expenditure on medical care as a whole:

- The costs of screening and effective treatment of sight threatening DR are balanced economically in relation to total expenditure on health care including the consequences of leave the disease untreated (Scanlon 2008)

– **Process**:

Case finding should be a continuing process and not a "once and for all" project

- Annual eye examination for DR is offered to all people with diabetes over the age of 12

5.7 Public Health England NHS Diabetic Eye Screening Programme (DESP) (Table 5.3)

5.7.1 NHS DESP Grading Definitions for Diabetic Retinopathy

- R0: no retinopathy
- R1 (background DR/mild NPDR):
  - Venous loop
  - Microaneurysms
  - Retinal haemorrhage
  - Any exudate or cotton wool spot in presence of other non-referable DR features
- R2 (pre-proliferative DR/moderate NPDR):
  - Venous beading
  - Venous reduplication
  - Multiple blot haemorrhages (if uncertain, refer only in the presence of IRMA that are definitely seen)

    Blot haemorrhages (located in OPL and INL) are larger than the width of the smallest of the four branches of the central retinal vein as it crosses the edge of the disc
  - IRMA (check that they can still be seen on the colour image as well as the red-free image that has not been enlarged)
- R3 (proliferative DR):
  - R3A (active PDR):

Table 5.3 Key facts about the NHS DESP

- Aim is to reduce the risk of sight loss amongst people with diabetes by the prompt identification and effective treatment if necessary of sight-threatening DR, at the appropriate stage during the disease process
- Two 45° field mydriatic digital photographic screening
- All people with diabetes aged 12 or above are offered annual screening eye examinations for DR

NVD
NVE
Pre-retinal or vitreous haemorrhage
Pre-retinal fibrosis ± tractional RD

– R3S (stable treated PDR):
Evidence of peripheral laser retinal treatment AND
Stable retina with respect to reference images taken at or shortly after discharge from the hospital eye service (HES)

5.7.2 NHS DESP Grading Definitions for Diabetic Maculopathy

- Macula is defined as that part of the retina which lies within a circle centered on the centre of the fovea whose radius is the distance between the centre of the fovea and the temporal margin of the disc
- M0
  – No maculopathy
- M1:
  – Exudate within 1 DD of the centre of the fovea
  – Circinate or group of exudates within the macula:
    A group of exudates is an area of exudates that is greater than or equal to half the disc area and this area is all within the macular area
    To work out the area, the outer points of the exudates are joined and compared to half the area of the optic disc
  – Any microaneurysm or haemorrhage within 1 DD of the centre of the fovea only if associated with a best VA of 6/12 or worse

5.7.3 NHS DESP Referral Criteria to Hospital Eye Service (HES)

- Retinopathy
  – R0: screen annually
  – R1: screen annually
  – R2: Referral to HES — seen ≤13 weeks
  – R3A: Urgent referral to HES — seen ≤2 weeks
  – R3S: screen annually
- Maculopathy
  – M0: screen annually
  – M1: Referral to HES — seen ≤13 weeks

5.7.4 Treatment Time at HES

- PRP for PDR within 2 weeks
- Focal/grid laser for maculopathy within 10 weeks

5.8 Diabetic Retinopathy Clinical Research Network (DRCR.net) Protocols

- PDR
  – Protocol S (Diabetic Retinopathy Clinical Research Network 2015):
    Purpose:
    - Prompt PRP vs 0.5 mg ranibizumab ± deferred PRP

    Results:
    - Treatment with ranibizumab resulted in VA that was non-inferior to PRP treatment at 2 years
- DMO
  – Protocol B (Diabetic Retinopathy Clinical Research Network 2008):
    Purpose:
    - Intravitreal triamcinolone vs focal/grid laser for DMO

    Results:
    - At 2 years, focal/grid laser is more effective and has fewer side effects than intravitreal triamcinolone
    - For center-involving DMO, focal/grid laser produces gradual VA improvement of ≥2 lines in approximately one-third of eyes with VA of ≤20/40 at 2 years
    - For center-involving DMO, approximately 20% of laser treated eyes worsen by ≥2 lines at 2 years

– Protocol I (Elman et al. 2010):
  Purpose:
    • Sham injection + prompt focal/grid laser (within 3–10 days after injection) vs Intravitreal 0.5 mg ranibizumab + prompt (within 3–10 days after injection) focal/grid laser vs Intravitreal 4 mg triamcinolone + prompt (within 3–10 days after injection) focal/grid laser vs Intravitreal ranibizumab + deferred (≥24 weeks) focal/grid laser
  Results:
    • Intravitreal ranibizumab with prompt or deferred focal/grid laser resulted in superior VA and OCT outcomes compared with prompt focal/grid laser alone for the treatment of DMO involving the central macula at 1 year
    • In pseudophakic eyes, intravitreal triamcinolone with prompt focal/grid laser resulted in superior VA and OCT outcomes than focal/grid laser alone and the VA and OCT outcomes were comparable to intravitreal ranibizumab with prompt or deferred focal/grid laser for the treatment of DMO involving the central macula at 1 year
– Protocol T (The Diabetic Retinopathy Clinical Research Network 2015; Wells et al. 2016):
  Purpose:
    • Aflibercept (2 mg), bevacizumab (1.25 mg) and ranibizumab (0.3 mg) comparison for center-involved DMO
  Results:
    • If initial VA letter score was 78 to 69 (20/32 to 20/40), there was no significant difference in mean improvement in VA letter score from baseline at 1 year between the three anti-VEGF drugs
    • If initial VA score was <69 (<20/40), the mean improvement in VA letter score from baseline at 1 year was significantly greater with aflibercept than with bevacizumab or ranibizumab
    • If initial VA letter score was 78–69 (20/32–20/40), there was no significant difference in mean improvement in VA letter score from baseline at 2 years between the three anti-VEGF drugs
    • If initial VA score was (<20/40), the mean improvement in VA letter score from baseline at 2 years was significantly greater with aflibercept than bevacizumab but not with ranibizumab

5.9 Hydroxychloroquine and Chloroquine Retinopathy

5.9.1 Pathogenesis

- Hydroxychloroquine and chloroquine can cause toxic retinopathy due to their binding of melanin in the RPE as well as direct toxicity to retinal ganglion cells

5.9.2 History

- Symptoms: asymptomatic, reduced vision, reduced colour vision, paracentral scotomas, reduced night vision, photopsias, glare, metamorphopsia
- Ask about risk factors
  – Concomitant tamoxifen use
  – Impaired renal function with eGFR less than 60
  – >5-year duration of hydroxychloroquine use and >5 mg/kg/day dose of hydroxychloroquine

5.9.3 Examination

- Mottling of the RPE (early sign)
- Blunted foveal reflex (early sign)

- Bull's eye maculopathy (late sign): ring of depigmentation surrounding the fovea
- Geographic atrophy
- Optic atrophy

5.9.4 Investigation

- OCT: loss of IS/OS junction in early toxicity, parafoveal thinning of the ONL in moderate toxicity, widespread RPE atrophy and retinal thinning in severe cases, "flying saucer" sign — ovoid appearance of central fovea created by preservation of central foveal outer retinal structures surrounded by perifoveal loss of IS/OS junction and perifoveal outer retinal thinning
- Fundus autofluorescence (FAF): ring of increased autofluorescence initially with parafoveal hypofluorescence in severe cases
- HVF: Paracentral scotomas

5.9.5 The RCOphth Clinical Guidelines on Hydroxychloroquine and Chloroquine Retinopathy: Recommendations on Screening 2018

- Screening criteria
  - Annual screening for patients who have taken hydroxychloroquine for more than 5 years
  - Annual screening for patients who have taken chloroquine for more than 1 year
  - Annual screening for patients taking hydroxychloroquine less than 5 years who have additional risk factors for retinal toxicity (concomitant tamoxifen use, impaired renal function with eGFR <60 ml/min/1.75 m^2, dose of hydroxychloroquine >5 mg/kg/day)
  - It is the responsibility of the prescribing physician to refer patients eligible for screening to the local HES
- Baseline screening examination
  - All patients planning to be on long term therapy (>5 years for hydroxychloroquine and >1 year for chloroquine)
  - Ideally performed within 6 months of starting hydroxychloroquine or chloroquine but definitely within 12 months
  - Fundus photograph + SD-OCT
  - HVF 10-2 if macular pathology present
- Screening tests
  - All patients should have the following:
    10-2 HVF
    SD-OCT
    FAF
  - Multifocal ERG:
    Performed only if persistent and significant VF defects that are consistent with hydroxychloroquine retinopathy are present but without evidence of structural defects on SD-OCT or FAF
- Interpretation of screening results
  - No toxicity: no abnormalities suggestive of toxicity detected on any test
  - Possible toxicity: one test result typical of hydroxychloroquine retinopathy, but typical abnormalities not present in other tests
  - Definite toxicity: two test results (one subjective and one objective) with abnormalities typical of hydroxychloroquine retinopathy
- Management of patients with possible retinopathy
  - Continue drug treatment
  - Patients with one abnormal test result on retinal imaging (SD-OCT or FAF) but normal VF including 30-2 should return for an annual review
  - Patients with persistent VF abnormalities in the context of normal structural imaging (SD-OCT or FAF) may be referred for multifocal ERG. Treatment should continue until the outcome of mfERG is known.
- Management of patients with definite toxicity
  - Recommendation to stop hydroxychloroquine should be made to the prescribing physician
  - Inappropriate for ophthalmologists to stop hydroxychloroquine treatment

  - Patients should be referred for appropriate support at the point of detection of hydroxychloroquine retinopathy, e.g. low vision or eye clinic liaison officer (ECLO) services, certification of visual impairment, and referral to local and/or national charities
  - Patient should inform the DVLA and be advised not to drive until an Estermann VF test confirms it is legal to do so.
- Termination of screening
  - Screening discontinued if patients stop taking hydroxychloroquine

5.10 The RCOphth Review of the Ocular Side Effects of Topiramate 2010

5.10.1 Indications

- Monotherapy or adjunct in the control of partial and primary generalised epilepsy in adults and children above the age of 2
- Migraine prophylaxis
- Trigeminal neuralgia
- Bipolar disorder, depression, eating disorders
- IIH

5.10.2 Ocular Side-Effects

- Secondary acute angle closure glaucoma
  - Occurs within 2 weeks of initiation of treatment
  - Suprachoroidal or cilio-choroidal detachments and ciliary body oedema: causes a forward rotation of the ciliary body which displaces the iris-lens plane anteriorly to close the AC angle
  - Treatment:
    Withdrawal of topiramate
    Topical atropine
    Topical ocular hypotensive agents
    Cautious use of oral acetazolamide — may worsen ciliary body oedema
- Acute myopia on its own or with angle closure
  - Suprachoroidal or cilio-choroidal detachments and ciliary body oedema — causes a forward rotation of the ciliary body which displaces the iris-lens plane anteriorly
  - Myopia on its own resolves following discontinuation of the drug
- Diplopia and nystagmus
- Posterior scleritis

5.10.3 Recommendations

- Screening patient on topiramate for asymptomatic disease is not useful
- In case of visual blurring or ocular pain, initial advice from their local optometrist should be encouraged
- Patients referred to Ophthalmologists with acute myopia should consider drug replacement following advice from a neurologist
- Acute angle closure should be managed with:
  - Withdrawal or replacement of topiramate with an alternative drug
  - Topical atropine drops + topical ocular hypotensive agents

5.11 The Ocular Side-Effects of Vigabatrin (Sabril) Information and Guidance for Screening (The RCOphth 2008a)

5.11.1 Indications for Vigabatrin

- Anti-epileptic drug (selective irreversible inhibitor of GABA-transaminase) licensed for first line treatment of infantile spasms and for the treatment of partial epilepsy ± secondary generalization which is not satisfactorily controlled by other drugs
- Vigabatrin is not recommended for patients with pre-existing visual field defects
- No relationship between the daily or cumulative dose of vigabatrin and the risk of visual field constriction

5.11.2 History

- Symptoms: normal VA, asymptomatic absolute field loss
- Risk factors: male (two-fold higher chance of developing VF constriction compared with females — effect independent of any differences in dose duration or cumulative dose of vigabatrin)

5.11.3 Examination

- Absolute field loss can occur in the absence of any demonstratable fundal pathology observed clinically
- Optic nerve pallor
- RNFL atrophy

5.11.4 Investigations

- ERG: reduced or absent oscillatory potentials
- HVF: bilateral concentric predominantly peripheral and nasal constriction of the VF with temporal and macular sparing (spares the central field)

5.11.5 Prognosis

- VF constriction does not reverse on cessation of the drug
- Progression of VF constriction after stopping vigabatrin has not been reported to date

5.11.6 Screening

- Baseline VF (Humphrey 120/Octopus 07 or Goldmann kinetic perimetry — less sensitive compared to Humphrey) should be obtained before starting treatment (age ≥9 years). Threshold testing is not recommended
- VF testing after baseline should be repeated every 6 months for 5 years. Test interval can then be extended to annually in patients who have no defect detected.
- If VF constriction is detected it is advisable, if possible, to conduct a confirmatory field test within 1 month before considering cessation of vigabatrin
- If the drug is discontinued VF should be repeated at a future date to monitor the field loss

5.12 Uveitis

5.12.1 Classification of Uveitis

- International Uveitis Study Group Anatomical Classification (Bloch-Michel and Nussenblatt 1987)
  - Anterior uveitis: anterior chamber
  - Intermediate uveitis: vitreous
  - Posterior uveitis: retina or choroid
  - Panuveitis: anterior chamber, vitreous, and retina or choroid
- The Standardisation of Uveitis Nomenclature (SUN) Working Group 2005 Descriptors of Uveitis
  - Onset:
    Sudden
    Insidious
  - Course:
    Acute: episode with sudden onset and limited duration
    Chronic: persistent uveitis with relapse in <3 months after discontinuing treatment
    Recurrent: repeated episodes separated by periods of inactivity without treatment >3 months duration
  - Duration:
    Limited <3 months
    Persistent >3 months

5.12.2 The SUN Working Group Grading Scheme of Anterior Chamber Cells

- Field size of 1 × 1 mm slit beam:
  - 0: no cells
  - 0.5+: 1–5 cells

  - 1+: 6–15 cells
  - 2+: 16–25 cells
  - 3+ 26–50 cells
  - 4+: >50 cells

5.12.3 The SUN Working Group Grading Scheme for Anterior Chamber Flare

- 0: none
- 1+: faint
- 2+: moderate — iris and lens details clear
- 3+: severe — iris and lens details hazy
- 4+: intense — fibrin or plastic aqueous

5.12.4 Nussenblatt Scale for Vitreous Haze 1985

- Performed with an indirect ophthalmoscope and 20 D lens by visually comparing the degree of haze on examination to a colour fundus photograph printout of the six-step ordinal scale
  - 0: no evident vitreal haze at all
  - Trace (0.5+): slight blurring of optic disc margin, no visualisation of the normal striations and reflex of the nerve fiber layer
  - 1+: permits better definition of both the optic nerve head and the retinal vessels
  - 2+: permits better visualisation of the retinal vessels
  - 3+: optic nerve head is visible to the observer but its borders are blurry
  - 4+: optic nerve head is obscured

5.12.5 The SUN Working Group Activity of Uveitis Terminology 2005

- Inactive: grade 0 cells
- Worsening activity: two-step increase in level of inflammation (AC cells or vitreous haze) or increase from grade 3+ to 4+
- Improved activity: two-step decrease in level of inflammation (AC cells or vitreous haze) or decrease to grade 0
- Remission: inactive disease for >3 months after discontinuing all treatments for eye disease

5.12.6 NICE Guidance [TA460] on Adalimumab

- Based on evidence from the **VISUAL I** (Jaffe et al. 2016) and **VISUAL II** (Nguyen et al. 2016) trials
- Recommended as an option for treating of non-infectious uveitis in the posterior segment of the eye in adults with inadequate response to corticosteroids, only if there is:
  - Active disease (current inflammation in the eye) AND
  - Inadequate response or intolerance to immunosuppresants AND
  - Systemic disease or both eyes are affected (or one eye is affected if the second eye has poor visual acuity) AND
  - Worsening vision with a high risk of blindness
- Stop adalimumab for non-infectious uveitis in the posterior segment of the eye in adults with inadequate response to corticosteroids if there is one of the following:
  - New active inflammatory chorioretinal or inflammatory retinal vascular lesions, or both or
  - A two step increase in vitreous haze or AC cell grade or
  - Worsening of BCVA by three or more lines or 15 letters

5.12.7 NICE Guidance [TA460] on Ozurdex

- Based on evidence from the HURON study (Lowder et al. 2011)
- Dexamethasone intravitreal implant is recommended as an option for treating non-infectious uveitis in the posterior segment of the eye in adults, only if there is:

- Active disease (that is, current inflammation in the eye) AND
- Worsening vision with a risk of blindness

5.13 Creutzfeldt-Jakob Disease (CJD)

- CJD is a progressive, fatal neurological disease that belongs to a wider group of neurodegenerative disorders known as transmissible spongiform encephalopathies (TSE) or prion diseases
- A novel form of human prion disease, variant CJD (vCJD) is believed to result from consumption of food derived from cattle infected with bovine spongiform encephalopathy (BSE) — ingestion of contaminated beef
- The prion protein is a normal cellular protein that is widely expressed in almost all human tissues, with the highest levels seen in nerve cells. Prions are infectious particles composed of abnormally folded forms of the prion protein.
- Transmission (NICE Guidance [IPG196])
  - Iatrogenic:
    Recipient of human cadaveric derived pituitary hormones
    Antecedent neurosurgery with dura mater transplantation
    Blood transfusion
    Contaminated surgical instruments:
    - High risk procedures for transmission of CJD:
  - Posterior eye procedures that involve the retina or optic nerve:
    Excision of eye, e.g. evisceration + orbital implant
    Operations on the optic nerve, e.g. optic nerve decompression
    Operations of vitreous body ONLY if they come into contact with the posterior hyaloid face, e.g. PPV + membrane peel
    Scleral buckling with drainage of SRF
    Photocoagulation of retina for detachment (only when the retina is handled directly)
    Destruction of lesion of retina
    Operations on the retina and RPE
    - Medium risk procedures for transmission of CJD:
      - Anterior eye procedures
  - Familial
  - Variant: contaminated foods of bovine origin
  - Sporadic: de novo spontaneous generation of self-replicating protein
- Decontamination practices to reduce transmission (NICE Guidance [IGG196])
  - Keep instruments wet immediately after use until they are cleaned
  - Eliminate instrument migration between sets (keep instrument sets together)
  - Single use instruments for patients who have previously undergone high-risk procedures with incineration of instrument post usage
  - Decontamination of re-useable instruments: immerse in sodium hypochlorite for 1 h, rinse in water and subject to routine sterilisation
  - Decontamination of work surfaces: disinfection by flooding, for 1 h, with sodium hypochlorite, followed by water rinses (Table 5.4)

5.14 The RCOphth Ophthalmic Services Guidance on Ophthalmic Instrument Decontamination 2016

- Decontamination is the term used to describe a combination of processes (cleaning, disinfection and/or sterilisation) used to make reusable items safe for further use
- Cleaning
  - Most important stage in the decontamination process
  - Removes dust, dirt, excretions, secretions, organic matter and all contamination including harmful and undesirable substances as well as a large proportion of micro-organisms which may be present
  - Mechanical/automated cleaning is the most effective and reproducible method

Table 5.4 Comparison of sporadic and variant CJD

Characteristic	Sporadic CJD	Variant CJD (vCJD)
Median age at death	68 years	28 years
Median duration of illness	4–5 months	13–14 months
Clinical signs and symptoms	Progressive dementia; early neurologic signs (myoclonus, visual or cerebellar signs, pyramidal/extrapyramidal signs)	Prominent psychiatric symptoms (depression, anxiety, delusions, apathy); painful dysaesthesia; delayed neurologic signs
Periodic sharp waves (generalised triphasic periodic complexes) on EEG	Often present	Often absent
"Pulvinar sign" on MRI (hyperintensities in the posterior thalamus FLAIR sequences on brain MRI)	Not reported. High signal in caudate/putamen on MRI brain or at least two cortical regions (parietal, temporal, occipital)	Present in >75% of cases
Presence of "florid plaques" on neuropathology	Rare or absent	Present in large numbers
Immunohistochemical analysis of brain tissue	Variable accumulation of protease-resistance prion protein, spongiform change	Marked accumulation of protease-resistance prion protein, spongiform change
Presence of agent in lymphoid tissue	Not readily detected	Readily detected
Increased glycoform ratio on immunoblot analysis of protease-resistance prion protein	Not reported	Marked accumulation of protease-resistance prion protein

- Disinfection
  - Process that removes or destroys potentially harmful micro-organisms (apart from spores) to a level non-harmful to health
  - Achieved by use of liquid chemicals or by moist heat
  - Moist heat is the first-choice method except for devices unable to withstand high temperatures
- Sterilisation
  - Process that removes or destroys all micro-organisms and spores
  - Preferred method for instruments is autoclaving which achieves sterilisation by applying steam under pressure at the highest temperature compatible with the instruments being processed
- All patients undergoing elective or emergency surgery must be asked, "Have you ever been notified that you are at increased risk of CJD or vCJD for public health purposes?" — consult local infection control team if there is a positive response
- For high risk procedures, a further set of questions should be asked about FHx of CJD, growth hormone treatment, brain or spinal cord surgery, blood transfusions
- Guidance for use of instruments in the ophthalmic clinic
  - For patients with known or potential CJD (e.g. dementia of unknown cause or unexplained neurodegenerative condition):
    Single use devices or non-contact devices where possible
    For reusable contact devices, either the device must be under strict quarantine and only reused on that patient or be disposed of
  - For the majority of patients:
    Use of non-contact or disposable devices where possible
    For reusable contact devices use disposable covers if possible and after usage:
    - Do not allow the device to dry
    - Rinse immediately for at least 30 s in water for irrigation
    - Clean with liquid soap or detergent for at least 20 s
    - Rinse again with water for 30 s
    - Immerse in freshly prepared hypochlorite 10,000 ppm of chlorine (1%) for at least 10 min
    - Rinse in three changes of sterile water or saline for at least 10 min
    - Shake, dry with tissue and store dry

- Guidance for use of surgical instruments
  - For patients with no extra risk of carrying CJD prion protein:
    Low risk surgery: no extra precautions
    High risk surgery:
    - Ensure reusable instruments do not migrate between sets and that they should be fully trackable
    - Single use supplementary instruments
  - For patients with extra risk of carrying CJD or who have CJD:
    Low risk surgery:
    - Minimise instrument migration and instruments should be trackable

    High risk surgery:
    - Consider whether procedure is required at all or whether deferral might allow the diagnosis of CJD to be excluded if not certain
    - Perform procedure with minimal number of staff in theatre and at the end of the list
    - Use single instruments and incinerate at the end of the procedure
    - Reusable instruments should be kept quarantined and for reuse solely on that individual patient

5.15 The RCOphth Ophthalmic Services Guidance on the Prevention of Transmission of Blood-Borne Viruses in Ophthalmic Surgery

- Standard precautions
  - General measures:
    Hand-washing
    Barrier protection: wearing of intact gloves, surgical face masks, protective clothing
  - Avoiding sharps usage wherever possible, and exercising care in their handling and disposal:
    Sharps should not be recapped
    Sharps should not be handed from one person to another
    Avoid manipulation of sharps by hands or fingers
    Surgeons should announce the movement of sharps
    Magnetic pads should be used for keeping discarded needles
  - Exclude theatre personnel with open skin wounds on their hands or arms
- Non-exposure prone procedures
  - Hands and fingers of the surgeon are completely visible at all times during the procedure
  - Pose no risk for transmission of a blood borne virus from an infected healthcare worker to a patient
- Exposure prone procedures (EPPs)
  - Hands or fingers of the surgeon are inside a wound or body cavity and not completely visible at all times during the procedure
  - Orbital surgery and some operations in oculoplastic and lacrimal surgery
- Surgeons who are HIV, hepatitis B (HBV) or Hepatitis C (HCV) positive should inform their occupational health department. An infected practitioner does not need to disclose to prospective patients of his/her infective status
- Preventing doctor to patient transmission of HIV
  - After a single needle stick injury the risk of seroconversion is approximately 0.3%
  - No risk of transmission when blood is in contact with intact skin
  - There is a less than 1 in 1000 risk for exposure to intact mucous membranes
  - EPPs should not be performed by HIV positive surgeons
  - There are no restrictions on performing non-exposure prone procedures
  - Not all patients who have undergone an EPP by an HIV positive surgeon need to be notified and tested
- Preventing doctor to patient transmission of HBV
  - After a single needle stick injury from an e-antigen (high infectivity) positive source

to a non-immunised recipient the risk of seroconversion is up to 30% (the presence of hepatitis B surface antigen — HbsAg — indicates infection)
  - If the injured party is fully up to date with their immunisation and has shown a good antibody response to the vaccine (immunity is recognised by anti-hepatitis B surface antibodies: anti-Hbs), they are protected against infection with HBV
  - Hepatitis B surface antigen positive and e-antigen positive surgeons should not perform EPP's
- Preventing doctor to patient transmission of HCV
  - Risk of seroconversion in a healthcare worker following a single percutaneous injury from a HCV positive source is probably between 1.2% and 3%
  - Surgeons who are hepatitis C RNA positive should not perform EPPs
  - Hepatitis C infected surgeons who have responded successfully to treatment with antiviral therapy may resume EPPs.
- General principles of management of needlestick injury
  - Gently squeezing the wound to encourage bleeding
  - Washing the wound with plain soap and copious water and then covering it with a waterproof dressing
  - Injury reported to a line manager
  - Healthcare practitioner designated to manage exposure should conduct a risk assessment
  - Blood from the source, taken with their consent, should be tested for blood borne virus status — when the source lacks capacity for consent, their tissue can only be tested if held to be in their best interests in accordance with the Mental Capacity Act 2005
- HIV post-exposure prophylaxis (PEP)
  - Estimated risk of HIV transmission from a known HIV positive source after a needlestick injury is estimated at 0.3%
  - Testing of the source is performed (with consent and after pre-test counselling, and not by the direct health professional involved) ideally within 8 h and not more than 24 h after source blood is taken in order to minimise unnecessary use of PEP
  - PEP is typically given as a three-drug combination for the duration of 4 weeks. It should be commenced within 72 h after exposure
  - Post exposure HIV antibody testing should be performed at least 12 weeks after exposure or completion of PEP

5.16 Audit

- Systematic examination of current practice to assess how well an institution or a practitioner is performing against set standards. Essentially it is a method for systematically reflection on, reviewing and improving practice.
- Audit cycle
  - Identify a problem or issue
  - Identify standards
  - Collect data on current practice
  - Data analysis with comparison to the standard
  - Identify changes required and implement change
  - Re-audit to monitor effect of change

5.17 Laser Safety in Hospitals

- Designated laser protection advisor (medical engineer who is responsible for ensuring that the safety and use of lasers is in accordance with the health and safety law and regulations) is present in every hospital in the UK
- There are two designated laser safety officers (responsible for ensuring that all staff are trained to safely use lasers and that all laser procedures and clinics are in keeping with the health and safety requirements) at the local departmental level
- Safety measures for lasering patients:
  - Laser personnel:

    Ensure that any member of staff who is to perform a laser treatment on a patient

has attended an up to date training session on the fundamentals of laser safety
- Prior to laser treatment of a patient:
  Ensure laser machines are working correctly
  Ensure any windows or reflective surfaces are covered
  Ensure you have the correct patient
  Lock the laser room door before you commence the laser treatment
  Switch the "laser in use" sign on
- During laser treatment of a patient:
  Ensure the correct protective eyewear for the correct laser machine is worn by any relatives or members of staff who will be in the laser room during the laser treatment

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Communication Skill Scenarios

6

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6.1 Explaining a Diagnosis to Patients/Parents

6.1.1 Scenario 1

- Re: Mr Steven Shaw, aged 55 years
- Mr Shaw has primary open angle glaucoma in both his eyes. He has raised intraocular pressure in both eyes and cupped optic discs with correlating visual field defects.
- Your task is to explain the diagnosis, addressing his concerns

6.1.1.1 Approach

- Introduce yourself and confirm the patient's identity
- Take any relevant history from the patient that has not been provided:
  - Driving status
  - Occupation
  - Family history of glaucoma
- Clarify the task in your mind. Begin discussing the diagnosis:
  - "*Your examination and test results show that you have glaucoma*"
- Establish what the patient already knows about the diagnosis:
  - "*Have you heard of the condition glaucoma before?*"
  - "*I wonder if you know anything about this condition before we start?*"
- Tell the patient that you are going to start giving them some information ("*I am going to tell you some information now, so please feel free to stop me at any point if there is anything you don't understand*")
- Order the explanation — possible discussion points include:
  - What is glaucoma ("*a disease of the optic nerve, which is a long cable at the back of the eye*")
  - Why glaucoma occurs ("*multiple reasons why it can occur including genetic factors and the presence of high pressures in the eye*")

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  - Likely history of glaucoma with and without treatment ("*if the pressures in the eyes remain persistently high then you will lose vision permanently over time. With treatment to lower the pressures in your eyes, you can slow the progression of the condition*")
  - Treatment options ("*the aim of treatment is to lower the eye pressure. Initial options include drops or laser*")
  - Follow-up ("*we will need to see you again in clinic in …..*")
  - Driving regulations *("you will need to inform the DVLA as you have glaucoma in both your eyes*")
- Check that the patient is following your explanation and encourage patient feedback and questions:
  - "*Are you happy with everything I have said so far?*"
  - "*Do you have any questions so far?*"
  - "*I appreciate that I have given you a lot of information. Would you like me to go over anything again or do you have any questions that you would like to ask me?*"
- Provide a summary of the main points of the discussion to provide the patient with any key take home messages ("*To summarise our discussion…..*")
- Provide the patient with a point of contact should he have any questions or concerns
- General points:
  - Keep your explanations clear without using any complex medical jargon. Ensure you use language that the patient will understand (without being patronising!)
  - Throughout your explanation, take into account any ideas, concerns or expectations you elicit from the patient
  - Be prepared to admit uncertainty if the patient asks you something you don't know (assure the patient that you will find the answer and let them know)

6.1.2 Scenario 2

- Re: Master Simon Baines, aged 2 years
- A GP has referred a 2-year-old child with a white pupillary reflex. You have seen the child in your clinic and have seen a large white, round retinal mass on clinical examination. Ultrasonography shows intralesional calcification with high internal reflectivity, confirming a diagnosis of retinoblastoma. The mother of the child is present.
- Your task is to explain the diagnosis to his mother, possible prognosis, and propose referral to a specialist retinoblastoma treatment centre

6.1.2.1 Approach

- Introduce yourself and confirm the patient's and mother's identity
- Take any relevant history from the mother that has not been provided
  - Other children in family
  - Health status of other children in family
  - Any medical problems that run in the family
  - Identify mother's support system (family/friends) ("*who is at home with you?*")
- Establish what the patient's mother already knows ("*Do you know why your son was referred by your GP to the hospital?*")
- Give a warning shot to the mother ("*I am afraid that I have some bad news*"). Give the mother time to digest the warning shot. They may signal that more information is wanted or that they want some time before further information is wanted.
- Be open, honest and informative to the mother ("*the examination and ultrasound result show that your son has a type of eye cancer called a retinoblastoma*")

- Acknowledge distress and support ventilation of feelings from the mother ("*I understand that this is very hard and its normal to be upset*") — offer tissues if the mother becomes teary
- Check if mother has had previous experience/know relatives or friends with the same condition ("*do you know anyone else with the same condition to your son*?")
- Establish what the mother wants to know ("*before I provide you with further information, I just wanted to know whether you are you the type of person who likes to know everything about your sons condition?*")
- Prioritise and identify any concerns from the mother before providing the mother with information ("*what are the particular things you are thinking about?*")
- Provide information — possible discussion points (depending on the mother's earlier responses) include
  - Causes ("*40% of cases is caused by a faulty gene. The faulty gene may be inherited from a parent or a change to the gene occurred at an early stage of the child's development in the womb. Unknown what causes the remaining 60% of cases*")
  - Incidence ("*about 45 children per year are diagnosed with retinoblastoma in the UK*")
  - Referral ("*Your child will need to be referred to a specialist retinoblastoma team at either The Royal London Hospital or Birmingham Children's hospital. Do you any preference?*")
  - Treatment ("*depends on the stage of the cancer. Further details will be provided by the specialist retinoblastoma team you will be referring the child too*")
  - Prognosis ("*over 90% cure rate with appropriate treatment if the cancer has not spread beyond the eyeball*")
- Check that you have provided the mother with all her information needs ("*do you have anything else you want to ask me about?*")
- Provide contact details so that the mother can contact you if she or her relatives/friends have any questions. Make clear to the mother that she can be seen any time if she wishes to discuss any issues or concerns
- Offer to provide contact details about the Childhood Eye Cancer Trust that can give the mother further information about retinoblastoma
- Provide a summary of the main points of the discussion to provide the patient with any key take home messages ("*To summarise our discussion…..*")

6.2 Discussing Management with Patients/Parents

6.2.1 Scenario 1

- Re: Mrs Anna Smith, aged 56 years
- Mrs Smith has been referred by her GP for possible cataract surgery as the patient has noticed a reduction in her vision in her right eye. She had a breast mastectomy for breast cancer 5 years ago. On examination, you see a visually insignificant cataract, but found an elevated mass at her right macula.
- Your task is to explain your findings to the patient, possible diagnoses and your proposed management plan

6.2.1.1 Approach

- Introduce yourself and confirm the patient's identity
- Take any relevant history from the patient that has not been provided
  - Ask if she was given the all clear from her breast cancer since her mastectomy and whether she has been discharged from oncology
- Establish what the patient already knows ("*can you tell me what you understand about the problem with your eye?*")
- Give a warning shot ("*I am afraid that it is not a cataract that is causing the reduction in your vision*"). Give the patient time to digest

the warning shot. They may signal that more information is required
- Be open, honest and informative to the patient ("*there is a lump in the back of your eye that is causing a reduction in your vision*")
- Outline the possibilities ("*There are several causes for a lump to appear in the back of the eye. Some are serious and others are not so serious. At this stage, I am not certain of the cause of your lump. However, given your previous history of breast cancer, there is a possibility that the lump in the back of the eye is cancerous*")
- Acknowledge distress and support ventilation of feelings from the patient ("*I understand that this is very hard and its normal to be upset*")—offer tissues if the patient becomes teary
- Explain to the patient that you will be urgently referring her to a specialist centre ("*I will be urgently referring you to a specialist center to investigate the cause of the lump in the back of your eye. This will be at Liverpool, Sheffield or London. Do you have a preference?*")
- Check that the patient is following your explanation and encourage patient feedback and questions ("*I appreciate that I have given you a lot of information. Would you like me to go over anything again or do you have any questions that you would like to ask me?*")
- Provide contact details so that the patient can contact you if she or her relatives/friends have any questions. Make clear to the patient that she can be seen any time if she wishes to discuss any issues or concerns
- Identify patient support systems ("*who do you live at home with?*")
- Provide a summary of the main points of the discussion to provide the patient with any key take home messages ("*To summarise our discussion…..*")

6.2.2 Scenario 2

- Re: Miss Tina Carter, aged 30 years
- You are seeing Mrs Carter in the outpatient's clinic. She was seen in Eye Casualty 6 weeks previously with pain on eye movements and loss of vision in her left eye (VA HM). Her right eye was unaffected. She presents to you today in clinic with the vision in her left eye remaining poor at 6/60 and her vision in her right eye has now dropped to 6/36. On examination, both optic nerves are pale.
- Your task is to address her questions and to talk about management

6.2.2.1 Approach
- Introduce yourself and confirm the patient's identity
- Take any relevant history from the patient that has not been provided
  - Presence of paraesthesia, weakness of limbs, bowel and bladder incontinence
  - Any recent infections or vaccinations
  - Past medical history (autoimmune disorders, lymphoproliferative diseases, connective tissue disorders)
  - Concurrent or recent treatments
  - Driving status
  - Occupation
- Establish what the patient already knows ("*can you tell me what you understand about the problem with your eyes?*"/"*have you thought about any possibilities for the cause of your symptoms?*")
- Prioritise and identify any concerns from the patient before providing the patient with information ("*what are the particular things you are thinking about?*")
- Provide information (be open and honest)—possible discussion points (depending on the patient's earlier responses)

  - Reason for the patient's symptoms ("*In the back of each eye there is a bright long yellow cable called the optic nerve, which contains lots of wires that enable us to see well with our eyes. In your eyes, your optic nerves are pale, which is why your vision is reduced in both of your eyes. At this point I am not sure what has caused this*")
  - Outline the possible causes ("*There are several different causes of pale optic nerves which requires investigations with tests. Would you like to know all the possibilities?*")
  - Outline the tests you want ("*I would advise blood tests, a chest x-ray, and an MRI scan of the brain to investigate possible causes for your pale disc*")
  - Follow-up ("*we will see you in clinic again in ….*")
  - Driving ("*your current level of vision does not meet the legal requirements for driving and you must inform the DVLA*")
- Check that the patient is following your explanation and encourage patient feedback and questions ("*I appreciate that I have given you a lot of information. Would you like me to go over anything again or do you have any questions that you would like to ask me?*")
- Provide contact details so that the patient can contact you if she or her relatives/friends have any questions. Make clear to the patient that she can be seen any time if she wishes to discuss any issues or concerns
- Provide a summary of the main points of the discussion to provide the patient with any key take home messages ("*To summarise our discussion…..*")

6.2.3 Scenario 3

- Re: Master Robert Gale, aged 5 years
- Robert is a 5-year-old boy who you have been seeing regularly in clinic. He is currently under treatment with patching for amblyopia secondary to a squint. His mother is insisting on squint surgery.
- Your tasks are to explore her reasons for wanting squint surgery, addressing her concerns

6.2.3.1 Approach

- Introduce yourself and confirm the patient's and mother's identity
- Establish what the mother already knows ("*can you tell me what you understand about the problem with the eyes of your son?*")
- Explore the reasons for why the mother wants squint surgery ("*you have expressed that you are keen for your son to have squint surgery. What are your reasons for this?*")
- Counter any misunderstandings ("*squint surgery will not improve the vision in your child's eyes. It will only improve the cosmetic appearance. The patching is necessary to try to maximise the vision in your child's eyes*")
- Explore whether compliance with patching is an issue ("*how are you finding the patching regimen for your son?*"). If patching compliance is an issue then advise on possible solutions (e.g. possible reward for son by letting him put a sticker on a calendar for each day they wear the patch)
- Check that the mother is following your explanation and encourage feedback and questions from the mother ("*I appreciate that I have*

given you a lot of information. Would you like me to go over anything again or do you have any questions that you would like to ask me?")
- Agree a way forward ("*at present we need to try to maximise the vision in your child's eyes with patching. Once we have achieved this then squint surgery can be an option in the future if the cosmetic appearance becomes an issue*") and ensure appropriate follow up arrangements are in place
- Provide a summary of the main points of the discussion to provide the mother with any key take home messages ("*To summarise our discussion…..*")
- Provide the mother with a point of contact should she have any questions or concerns

6.2.4 Scenario 4

- Re: Mr Jackson Francis, aged 72 years
- Mr Francis was referred by his optician, for evaluation of possible diagnosis of age-related macular degeneration (AMD). On clinical examination, he has a dry disciform macular scar in both eyes with a visual acuity of CF in his right eye and 6/60 in his left eye.
- Your task is to consult and advise on appropriate management, addressing his concerns

6.2.4.1 Approach

- Introduce yourself and confirm the patient's identity
- Take any relevant history from the patient that has not been provided
  - Smoking history
  - Past medical history: hypertension
  - Family history of AMD
  - Driving status
  - Identify patients support system ("*Who is at home with you*")
- Establish what the patient already knows ("*can you tell me what you understand about the problem with your eyes?*")
- Clarify the task in your mind. Begin discussing the diagnosis:
  - "*Your examination shows that you have age-related macular degeneration*"
- Establish what the patient already knows about the diagnosis:
  - "*Have you heard of the condition age-related macular degeneration before?*"
  - "*I wonder if you know anything about this condition before we start?*"
- Prioritise and identify any concerns from the patient before providing the patient with information ("*what are the particular things you are thinking about?*")
- Order the explanation (be open, honest and informative) — possible discussion points (depending on the patient's earlier responses)
  - What is AMD ("*age-related macular degeneration is a common condition that affects the central part of your vision*")
  - What is the cause of AMD ("*the exact cause is unknown; it has been linked to smoking, high blood pressure and genetic factors*")
  - Types of AMD ("*there are 2 forms of age-related macular degeneration: a dry form and a wet form*")
  - Treatment options ("*unfortunately you have the dry form of AMD. This form of AMD has no treatment to help improve your vision*")
  - Support for the patient ("*to help reduce the effect on your life, we can refer you to our low visual aids team who can provide you with useful advice and practical support such as providing you with magnifying lenses and suggest changes you can make to your home. I can also register you today as severely sight impaired. This will make it easier for you to claim financial benefits, such as help with health costs. I will also provide you today with an amsler grid, which you can use to detect any future changes in your eyesight*")
  - Promote healthy living ("*try to eat a balanced diet, exercise regularly, stop smoking*")
  - Driving ("*your current level of vision does not meet the legal requirements for driving and you must inform the DVLA*")

- Check that the patient is following your explanation and encourage patient feedback and questions ("*I appreciate that I have given you a lot of information. Would you like me to go over anything again or do you have any questions that you would like to ask me?*")
- Provide a summary of the main points of the discussion to provide the patient with any key take home messages ("*To summarise our discussion…..*")
- Provide the patient with a point of contact should he have any questions or concerns

6.3 Explaining Surgical Complications

6.3.1 Scenario

- Re: Mr Andrew Taylor, aged 72 years
- You have just performed a cataract operation on Mr Taylor that did not go according to plan. You ruptured the posterior capsule and dropped the lens into the vitreous during the operation. You have left the patient aphakic.
- Your task is to explain the complication to Mr Taylor, addressing his concerns

6.3.1.1 Approach

- Introduce yourself to the patient as the surgeon who performed the operation
- Explain that you had a problem during the surgery and apologise that it occurred ("*I had some trouble with the thin capsule that surrounds the lens. This thin capsule tore during the operation, and the lens fell into the back of the eye and I was unable to put an artificial lens into your eye. You will need another operation to remove the lens that has dropped into the back of your eye and at the same time we will insert a new artificial lens into your eye. I am so sorry this has happened*")
- Inform the patient that you are working on the next steps and that you have a plan to take them safely forward ("*I will have to follow you more closely and I would like to see you again tomorrow in clinic to make sure that the pressure in the eye is ok. In the meantime, I will also arrange for you to see my retinal specialist colleague who will be performing your second operation*")
- Check that the patient is following your explanation and encourage patient feedback and questions ("*I appreciate that I have given you a lot of information. Would you like me to go over anything again or do you have any questions that you would like to ask me?*")
- Reassure the patient that his vision will be poor until after his second operation ("*Your vision will be poor when I see you in clinic tomorrow as you don't have an artificial lens in place. The vision will improve once the second operation has been performed. I know this is an inconvenience and difficult for you*")
- Reassure patient that you are going to be with them all the way and that you will stay in touch with them following their second operation
- Provide a summary of the main points of the discussion to provide the patient with any key take home messages ("*To summarise our discussion…..*")
- Provide the patient with a point of contact should he have any questions or concerns

6.4 Explaining Surgical Errors

6.4.1 Scenario

- Re: Master Craig Burton, aged 3 years
- You have just finished a routine squint operation on a 3-year old boy before you realised that you have operated on the wrong muscle in the wrong eye. His mother is in the waiting room and wants an update on how things went during the operation.
- Your task is to explain the surgical error to the mother, addressing her concerns

6.4.1.1 Approach

- Introduce yourself to the mother as the surgeon who performed the operation
- Explain that you had an incident during the surgery and apologise that it occurred ("*after I finished the operation on your child, which was routine, I realised that I had operated on the wrong muscle in the wrong eye. I am so sorry this has happened*")
- Identify any concerns from the mother ("*I know that there must be some concerns on your part as a result of this incident, and I would like to find out what is worrying you the most*"). Listen and acknowledge any concerns from the mother. Allow her to say what she wants to, without interruption before addressing the concerns
- Inform the mother that you are keen to follow up on her son but would understand if she wanted you to refer her son to one of your colleagues for further care ("*Going forwards, I would like to follow up your son closely in clinic to see how his eyes are doing. However, given what has happened I would understand if you would prefer one of my colleagues to look after your son in the future*")
- Inform the mother that you are working on the next steps and that you have a plan to take them safely forward ("*your son will need to be seen more closely in clinic by our orthoptists to determine how his eyes are recovering from the operation. This will help us determine what the best course of action going forwards would be*")
- Give an assurance of further action in relation to the incident ("*the incident will be reported as a never event to the risk management team, who will investigate it further to determine why the event occurred and decide what actions might be taken to prevent this event from happening again*")
- Invite further questions from the patient's mother and provide further information if required
- Provide an opportunity for the mother to make a complaint ("*if you wish you can lodge a written complaint with our PALS department and it will be taken seriously*")
- Provide a summary of the main points of the discussion to provide the mother with any key take home messages ("*To summarise our discussion…..*")
- Provide the mother with a point of contact should she have any questions or concerns

6.5 Consent for Treatment

6.5.1 Scenario 1

- Re: Mrs Susan Spencer, aged 60 years
- Mrs Spencer has noticed a reduction in her vision and distortion in her left eye for 6 months. Clinical examination and OCT scan revealed an idiopathic stage 4 full thickness macular hole.
- Your task is to explain the diagnosis and to counsel her for surgery

6.5.1.1 Approach

- Introduce yourself and confirm the patient's identity
- Take any relevant history from the patient that has not been provided
  - Driving status
  - Occupation
- Establish what the patient already knows ("*can you tell me what you understand about the problem with your eyes?*")
- Begin explaining the diagnosis ("*your eye examination and tests shows that you have a hole in the back of your left eye*")
- Explain the best way forward and explain any possible alternatives ("*the best way to close the hole and to try to improve your vision in the left eye would be to perform an operation called a vitrectomy. Without an operation the hole is very unlikely to close*")
- Explain the nature of the operation ("*a vitrectomy is where we surgically remove the jelly at the back of the eye. Following a vitrectomy, a thin layer of tissue surrounding the hole will be peeled. At the end of the operation, we will be injecting a temporary gas bubble into the*

back of your eye. You may need to spend several hours during the day face down after the operation for up to 5 days and will not be able to fly whilst the gas bubble is in the eye. The operation can be performed either with you awake where you will be given a local anaesthetic injection or with you asleep under a general anaesthetic")

- Explain the risks and benefits of the operation ("*the operation is successful in closing the hole in 9 out of 10 people who have had the hole for less than 6 months, and 6 out of 10 people who have had the hole for a year or longer. Complications include the development of a cataract, failure of the hole to close and requiring a second operation, retinal detachment and much more rarely serious complications such as an infection and bleeding in the back of the eye*")
- Driving: if the patient drives then inform her that she will not be able to drive for 6 to 8 weeks after her operation while the gas bubble is present in her eye
- Work: if patient is still working then she will need some time off work — she will be provided with a sick note after the operation
- Check that the patient is following your explanation and encourage patient feedback and questions ("*I appreciate that I have given you a lot of information. Would you like me to go over anything again or do you have any questions that you would like to ask me?*")
- Seek permission to proceed ("*Would you like to proceed with the operation? Local or general anaesthetic?*")
- Provide the patient with a point of contact should she have any questions or concerns

6.5.2 Scenario 2

- Re: Colin Kent, aged 40 years
- Mr Kent presents to clinic with a macular on rhegmatogenous retinal detachment in his right eye. He has previously lost all vision in his left eye from a previously unsuccessful retinal detachment repair. Mr Kent works fulltime in a sales job and drives regularly. He suffers from anxiety and depression. He is due to go abroad on a holiday of a lifetime in a week's time.
- Your task is to explain the diagnosis and counsel the patient for surgery

6.5.2.1 Approach

- Introduce yourself and confirm the patient's identity
- Establish what the patient already knows ("*can you tell me what you understand about the problem with your right eye?*")
- Begin explaining the diagnosis ("*examination of your right eye shows a retinal detachment from a retinal tear*")
- Explain the best way forward and explain any possible alternatives *(*"*similar to your left eye, you will need an operation in the right eye called a vitrectomy to fix the retinal detachment. Without an operation, you will eventually lose the vision in your right eye*")
- Explain the nature of the operation ("*a vitrectomy is where we surgically remove the jelly at the back of the eye. Following a vitrectomy, any retinal tears will be closed with a freezing therapy. At the end of the operation, we will be either injecting a temporary gas bubble into the back of your eye or inserting silicone oil into the back of your eye*")
- Explain the risks and benefits of the operation ("*the operation is intended to repair the retinal detachment in your right eye. Complications include re-detachment with the need for further operations, cataract formation, high pressures in the eye and much more rarely serious complications such as infection or bleeding in the back of the eye*")
- Discuss patients upcoming holiday ("*if we insert gas into the eye then you will not be able to fly after the operation. If we insert silicone oil into the eye then you can still fly but you will require a second operation to remove the oil in the future*")
- Address patients driving ("*you will not be able to drive for 6 to 8 weeks after the operation*

while the gas bubble is present in the eye"/"*you will not be able to drive after the operation until the oil has been removed from your eye and your vision has improved*")
- Work ("*you will need some time off work after the operation and you will be provided with a sick note after the operation*")
- Check that the patient is following your explanation and encourage patient feedback and questions ("*I appreciate that I have given you a lot of information. Would you like me to go over anything again or do you have any questions that you would like to ask me?*")
- Seek permission to proceed ("*Would you like to proceed with the operation? local or general anaesthetic? silicone oil or gas?*")
- Provide the patient with a point of contact should he have any questions or concerns

6.6 Encouraging Compliance with Treatment

6.6.1 Scenario

- Re: Mr Mark Davis, aged 70 years
- Mr Davis has primary open angle glaucoma in both eyes. His IOPs were previously stabilised on Latanoprost once a night in both eyes and Brinzolamide twice a day in both eyes. His intraocular pressures were 14 mmHg in both eyes 6 months ago, but today in clinic his IOPs were 32 mmHg in both eyes. His visual fields today showed increased field loss in both eyes. He had mentioned to the visual field technician that he had not been taking his drops because he felt his eyes have been well.
- Your task is to discuss ways to improve his intraocular pressure control

6.6.1.1 Approach

- Introduce yourself and confirm the patient's identity
- Explain to the patient that his intraocular pressures today are not well controlled and that his visual fields today show progression. Make it clear that achieving better control of his IOP's is the aim of the discussion ("*I am afraid to say that the pressures in your eyes today is very high and your field test shows that your glaucoma has progressed. We need to try to achieve lower pressures in your eyes*")
- Explore whether poor compliance could be a problem ("*how are you getting on with the current drops? do you take the drops regularly?*")
- Explore reasons for poor compliance ("*do you experience any problems with the drops*?")
- Counter misunderstandings ("*some drops can cause*")
- Explain the importance of drop compliance and the risk of uncontrolled IOP ("*it is important to take your drops regularly as it keeps the pressure in your eyes under control. Without the drops, the pressures in your eyes will be very high which can lead to permanent loss of vision in your eyes*")
- Offer an alternative solution ("*if you find taking your drops difficult then we could perform a laser treatment or an operation as an alternative method to reduce the pressures in your eyes*")
- Check that the patient is following your explanation and encourage patient feedback and questions ("*I appreciate that I have given you a lot of information. Would you like me to go over anything again or do you have any questions that you would like to ask me?*")
- Agree a way forward, ensure follow-up arrangements are in place and reassure him that you will be happy to review him sooner if there are questions or concerns

6.7 Communicating with Angry Parents

- Re: Master Thomas Edwards, aged 1 year
- You suspect NAI in a 1-year old boy, who was brought to the hospital by his mother. The child has multiple unexplained bruises. The paediatrician is not onsite until tomorrow and in the interest of the child, you had recommended

admission for 'observation' despite the fact you are not doing anything active in terms of treatment of the eye. The mother is very angry at you for detaining the child for 'observation' and would like to take the child home.
- Your tasks are to discuss with the mother, addressing any concerns

6.7.1 Scenario

6.7.1.1 Approach

- Introduce yourself and confirm the patient's and mother's identity
- Explain you will need a chaperone (nurse or health care assistant) present
- Establish what the mother already knows ("*can you tell me what you understand about why your son has been bought into hospital today?*")
- Take any relevant history from the mother that has not been provided
  - History of events ("*when did you notice the bruises? how did the bruises occur? Any other witnesses around at the time?*")
  - *Who normally looks after the child at home?*
  - *Who is in the house? Do you have any other children? Where are your other children at present?*
- Be open and honest to the mother about your reasons for wanting admission. Be non-judgemental ("*I have some concerns that some of the bruises found on your son may have occurred in a non-accidental manner. I am not here to judge but when I find injuries like this then it is mandatory for me to ask a paediatrician to examine your child. This examination is performed nationwide in an effort to safeguard children and is a requested as part of a national guidance. Unfortunately, the paediatrician is not available until tomorrow and therefore the hospital protocol is to have your son admitted into hospital for observation*")
- Explore the mothers understanding and concerns ("*I appreciate that I have given you a lot of information. Would you like me to go over anything again or do you have any questions that you would like to ask me?*")
- Explain that admission is mandatory and not optional ("*I understand why you are feeling upset/angry by this and I know that this will be an inconvenience to you, but your son will have to be admitted into hospital today as unfortunately the paediatrician is not available today to examine your son*")
- Explain possible consequences of refusal if the mother is insistent on leaving the hospital with her son despite your best efforts to convince her otherwise ("*My priority is to make sure your son is well and safe. If you decide to leave the hospital with your son then I won't restrain you. However, the police will be called immediately and they will then initiate a police protection order to admit your son to hospital*")
- Allow the mother time to think about what has been discussed and invite questions
- Agree a way forward

6.8 Breaching Confidentiality in the Public Interest

6.8.1 Scenario

- Re: Mrs Emma Smith, aged 65 years
- Mrs Smith is a patient you have been seeing regularly in clinic for her advanced primary open angle glaucoma in both eyes. You performed an Estermann visual field test which she failed. Mrs Smith is keen to continue to drive no matter what.
- Your task is to explain to the patient that she should not be driving

6.8.1.1 Approach

- Introduce yourself and confirm the patient's identity
- Explain the test result ("*the visual field you performed today shows that you have lost a large proportion of your peripheral vision.*

Your visual fields do not meet the legal requirements for driving"). Allow the patient time to digest this information

- Explore patient understanding and concerns ("*how do you feel about that*?")
- Explore the patient's reasons for not wanting to adhere to advice
- Explain the risks of continuing to drive and possible alternatives ("*With the amount of visual field you have lost, if you continue driving you will be at a high risk of threatening your own life as well as the lives of others. Would public transport work for you as an alternative method of getting around?*)"
- Explain possible consequences of refusal ("*I find myself with a dilemma of interests. Whilst my first concern is for you, I am concerned that should you continue driving, you would be at risk personally as well as a risk to other on the road. If you continue to drive despite my best efforts to dissuade you, then I may have to inform the DVLA's medical advisor*")
- Offer a second opinion ("*I am happy to refer you to my colleague for a second opinion if that would help you. Please do not drive in the meantime*")
- Allow the patient time to think about what has been discussed and invite questions
- Agree a way forward together

Part II

Objective Structured Clinical Examination (OSCE)

7 Objective Structured Clinical Examination (OSCE) Technique: Do's and Don'ts

Timothy H. M. Fung and Winfried M. K. Amoaku

7.1 Formalities

- Ensure that you have adequate amounts of sleep and rest in the lead up to the exam
- Dress professionally on the day of the exam
- Arrive at the exam venue in good time
- Do not forget to alcohol gel your hands before examining each patient

7.2 Practice Examination Routines

- Develop your own system for examining
  - The anterior and posterior segment with the slitlamp
  - The posterior segment with the direct ophthalmoscope (practice viewing the optic disc in non-dilated pupils) and indirect ophthalmoscope
  - Eyelids
  - Orbits
  - Pupils
  - Confrontational visual fields
  - Ocular motility
- Practice the examinations at every opportunity again and again before the OSCE
- When you go into the OSCE you should appear as though you have performed your examination of each system of the eye hundreds of times previously (ideally and hopefully because you have!)

7.3 Equipment

- Make sure that you bring the following equipment with you on the day of the OSCE (a pouch or small bag to hold the kit comfortably together is useful)
  - Pen torch (bring two, in case one does not work during the exam!)
  - Visual field pins
  - Slit-lamp and indirect ophthalmoscopy lenses
  - Clear ruler in mm (×2)
  - Occluder
  - Fixation stick
  - Direct ophthalmoscope (not mandatory)
  - Indirect ophthalmoscope (not mandatory)

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7.4 What the Examiners Are Looking For

- The examiners need to be satisfied that you are a safe, competent doctor, suitable to be an independent consultant general ophthalmologist
- They are not looking for in depth sub-specialty knowledge (they are not looking for the next Professor of Ophthalmology!)
- They do not want to see arrogance on the day of your exam. They respect a friendly and confident manner
- Examiners come with a wide range of personalities. Do not worry about what sort of examiners you get. They are not trying to catch you out but want to find out what you can do and know

7.5 Examining Patients

- Be nice and treat patients with respect at all times
- Always introduce yourself to the patient and ask the patient for permission to examine them
- Ensure patient is positioned correctly before you begin (e.g. ensure correct position of a patient on a slit-lamp before beginning to examine the anterior segment)
- Don't look for feedback from the examiners
- Whilst examining patients, look for signs, decide how best to interpret the signs and think about how you will present your findings to the examiner
- Tell patients what you will be doing, smile and show that you care
- Say thank you to the patient at the end of your examination

7.6 Examining and Presenting

- Listen carefully to the examiners instructions and just examine what they have asked you to examine. If in doubt, clarify with the examiner.
- Try to avoid the "running commentary" approach while examining a patient unless the examiner asks you to do it. The vast majority of examiners prefer you to present your findings at the end of the examination. A running commentary slows you down, and may disrupt the flow of your examination routine.
- Have a structured approach to presenting your findings to the examiner
  - Describe what you have seen. Make sure you are honest. Do not ever make up signs
  - Give the examiner either what you think is the diagnosis or two to three differential diagnosis (start with commonest things first before mentioning the rarities)
  - If the diagnosis is uncertain, describe what else you might have expected to find in support of your differential diagnosis. State what else you could do to help resolve the issue (history, further examination, investigations)
  - Remember that even if you don't know a diagnosis for a case, you can still give a good structured answer and pass
- Practice describing your findings: your technique, findings and interpretation are all under assessment!

7.7 Answering Examiners Questions

- Listen to the questions
- Answer the question that you have been asked
- Take a moment or two to gather your thoughts before answering the questions
- Maintain eye contact with the examiner when talking (and not at the floor!)
- Speak clearly and succinctly. Do not speak too quietly or too quickly
- Try to give a well-structured answer to the questions

- Be confident in your answer if you think you are right, but do not argue with the examiner!
- Avoid emotive words like "senile" in front of patients
- The examiner may ask "*are you sure*" in response to your answer. Have a think about your answer and do not feel afraid to stick to your answer or afraid to retract statements you feel were wrong
- If you do not know the answer to a question, be honest and say so
- Really important that you avoid saying anything that would pose a danger to patients

7.8 When You Think Things Are Going Wrong

- Remember that difficult cases are likely to be difficult to all candidates
- Remember that difficult questions often reflect a good performance
- Each case of an OSCE station is marked separately. Try to stay positive (easier said than done) if you feel you have performed badly in a case. A poor performance in a station does not necessarily mean that you will fail the exam overall. Try to maximise your marks in every case for every station.

Anterior Segment

8

Timothy H. M. Fung and Winfried M. K. Amoaku

8.1 Anterior Segment Examination Sequence

- Introduce yourself to patient
- Set patient up on slit lamp
- Examine lower eyelid — punctum first (ectropion, plug) then eyelashes and eyelid margin for anterior or posterior blepharitis, slide finger across lid to look for lumps
- Ask the patient to look up and pull lower eyelid down and look at conjunctiva for scars, symblepharon
- Ask patient to look down and lift upper eyelid — look for punctum first (ectropion, plug) then eyelashes and eyelid margin for anterior or posterior blepharitis, slide finger across lid to look for lumps
- Look at upper bulbar conjunctiva for blebs/tubes

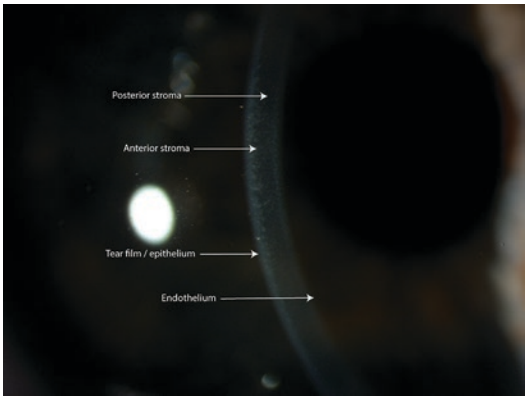

Fig. 8.1 Anterior segment image of a slit beam of the cornea

- Ask the patient to look to the right to look at temporal conjunctiva and then to the left to look at nasal conjunctiva
- Ask the patient to look straight ahead and then examine cornea (epithelium, anterior stroma, posterior stroma, thickness of cornea, endothelium — see Fig. 8.1)
- Examine AC for cells
- Examine iris for PI, areas of atrophy (transillumination), PXF, PS, ectropion uveae, nodules, comment on any corectopia
- Examine lens and comment on position, aphakia, pseudophakia, PCO, previous Yag capsulotomy, cataract and its density, as may apply
- Examine anterior vitreous for cells, degenerations

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8.2 Epithelial Basement Membrane Dystrophy (EBMD) (Fig. 8.2 and Table 8.1)

8.2.1 History

- History of RCES without previous trauma

8.2.2 Examination

- Findings should be present in both eyes
- Grayish-white maplike opacities in the superficial corneal epithelium ("maps") — characteristic and pathophysiologic feature and represent corneal epithelial basement membrane present within the epithelium itself — best seen on retroillumination
- Parallel fingerprint-like lines in the corneal epithelium ("fingerprint") — represent parallel rows of thickened basement membrane within the epithelium — best seen on retroillumination

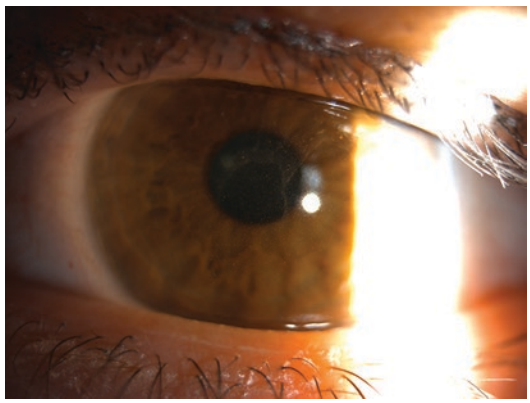

Fig. 8.2 Anterior segment image of a patient with the typical "dot" and "map" changes associated with EBMD

Table 8.1 Theoretical pathogenesis of EBMD

• Epithelial cells produce abnormal multi-laminar basement membrane, both in normal location and intraepithelially, as the intraepithelial basement membrane thickens it blocks normal migration of epithelial cells toward the surface, trapped epithelial cells degenerate to form intraepithelial microcysts, abnormal intraepithelial basement membrane produces map and fingerprint changes

- Intraepithelial gray microcysts (most unusual finding — "dot") — represents individual small mounds of thickened basement membrane beneath the basal layer of epithelium — best viewed by retroillumination

8.2.3 Treatment

- Management of RCES: lubricants, cycloplegia, patching, BCL insertion, mechanical debridement of the loosened epithelium, anterior stromal puncture for recalcitrant recurrent erosions below the visual axis (80% first time success rate), PTK for recurrent erosions in the visual axis — superficial ablation just into Bowman's layer ensuring that all abnormal epithelial basement membrane is removed, alcohol delamination

8.2.4 Other Diagnoses to Consider

- Meesman's dystrophy (see Sect. 8.3)
- Corneal dystrophies of Bowman's layer: Reis Bucklers/Thiel-Behnke dystrophy (see Sect. 8.4)

8.3 Meesman Dystrophy (Fig. 8.3 and Table 8.2)

8.3.1 History

- Positive family history: AD condition
- Symptoms: reduction of vision, photophobia

8.3.2 Examination

- Multiple diffusely distributed tiny vesicles that extend all the way to the limbus
- Vesicles are more numerous in the interpalpebral area and are best visualised with retroillumination
- The epithelium adjacent to the cysts is clear, but there can be whorled and wedge-shaped epithelial patterns
- Findings are bilateral and limited to the corneal epithelium

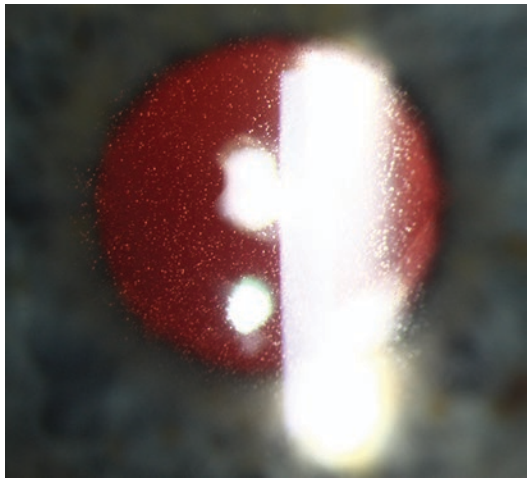

Fig. 8.3 Anterior segment image of a patient with Meesman corneal dystrophy showing the typical tiny vesicles distributed diffusely across the corneal epithelium

Table 8.2 Key facts of Meesman dystrophy

- A type of corneal epithelial dystrophy — defined as a corneal opacity or alteration which is most often bilateral and progressive, occurs after birth, and is not inflammatory
- AD condition caused by mutations in the genes for cytokeratins CK3 and CK12
- Microcysts contain "peculiar substance" — an electron dense accumulation of granular and filamentary material

8.3.3 Treatment

- Rarely required as patients are usually asymptomatic or have minimal symptoms
- Indications for treatment: significant photophobia or visual impairment
- Treatment options
  - Superficial keratectomy
  - Excimer laser phototherapeutic keratectomy
  - Lamellar keratoplasty: DALK

8.3.4 Other Diagnoses to Consider

- "Dot" changes of epithelial basement membrane dystrophy (irregular round, oval, or comma-shaped, non-staining, gray-white intraepithelial opacities of various sizes in close proximity to the maplike patches): hx of recurrent corneal erosions (pain, lacrimation, photophobia), dots alone are never seen — look for maps (geographic circumscribed gray lesions best seen with broad oblique illumination) and fingerprint lines (branching refractile lines with club-shaped terminations — best seen in retroillumination)
- Lisch epithelial corneal dystrophy — x-linked dominant (positive FHx), densely crowded transparent epithelial microcysts in a feathery whorled pattern

8.4 Reis-Buckler Dystrophy (Fig. 8.4 and Table 8.3)

8.4.1 History

- History of RCES since childhood

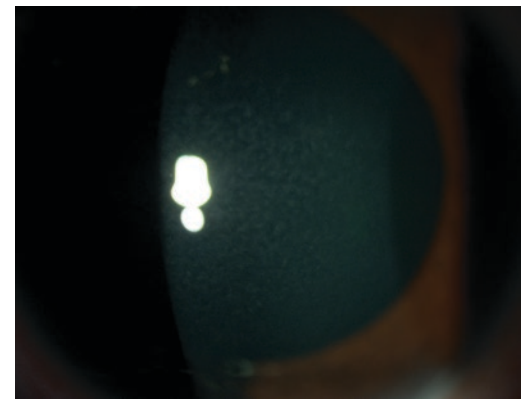

Fig. 8.4 Anterior segment image of a patient with Reis-Buckler dystrophy with typical honeycomb shaped opacities in the Bowman's layer

Table 8.3 Key facts of reis-buckler dystrophy

- A corneal dystrophy of Bowman's layer
- AD condition caused by mutations in the keratoepithelin gene (TGFB1)
- Characterised by replacement of Bowman's layer with a fibrocellular scar tissue (stains blue with Masson trichrome)

8.4.2 Examination

- Honeycomb shaped opacities in the Bowman's layer involving the center of the cornea with/without scarring.

8.4.3 Treatment

- RCES: lubricants, mechanical debridement, BCL with prophylactic topical antibiotics, anterior stromal puncture, PTK, alcohol delamination
- If vision reduced: PTK, lamellar or penetrating keratoplasty

8.4.4 Other Diagnoses to Consider

- Thiel-Behnke corneal dystrophy: distinguished from Reis-Bucklers by electron microscopy looking a fibrocellular scar that is characterised by curly collagen fibers and a saw-tooth configuration.

8.5 Lattice Dystrophy (Fig. 8.5 and Table 8.4)

8.5.1 History

- History of RCES
- Family history of lattice dystrophy

8.5.2 Examination

- Refractile radially orientated branching lines that overlap one another creating a latticework pattern ± a diffuse central anterior stromal haze
- Examine for facial paresis (lagophthalmos and exposure keratopathy), blepharochalasis, and laxity of the facial skin (Type II)

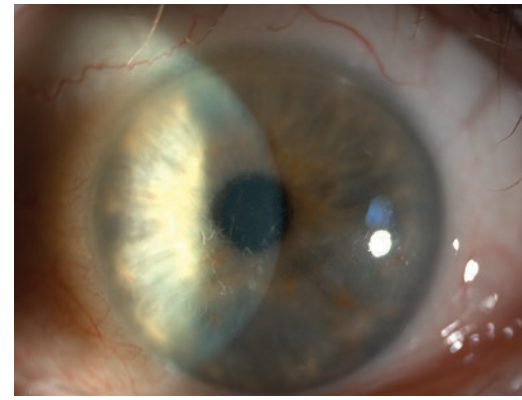

Fig. 8.5 Anterior segment image of a patient with lattice dystrophy with the typical refractile radially orientated branching lines that overlap one another

Table 8.4 Key facts of lattice dystrophy

- Bilateral AD inherited primary localised corneal amyloidosis with progressive deposition of amyloid in the corneal stroma
- Type I: mutation in the TGFβ1 gene on chromosome 5, isolated to the eye
- Type II (Meretoja's syndrome): mutation in the gelsolin gene, ocular and systemic features (cardiac conduction abnormalities, peripheral neuropathy)
- Amyloid stains with Congo red and demonstrate apple green birefringence and dichroism at polarising microscopy

8.5.3 Treatment

- RCES: topical lubricants, BCL, patching, anterior stromal puncture, PTK, alcohol delamination
- VA impaired: lamellar or penetrating keratoplasty (highest rate of recurrence in lattice dystrophy compared to granular and macular dystrophy)
- Refer to medics If type II suspected for assessment of systemic involvement

8.5.4 Other Diagnoses to Consider

- Granular dystrophy (see Sect. 8.6)
- Macular dystrophy (see Sect. 8.7)

- Avellino dystrophy (see Sect. 8.8)
- Schnyder's crystalline dystrophy (see Sect. 8.9)

8.6 Granular Dystrophy (Fig. 8.6 and Table 8.5)

8.6.1 History

- Positive family history
- History of RCES

8.6.2 Examination

- Small discrete sharply demarcated grayish white opacities in the anterior central stroma with intervening clear stroma and sparing of the periphery
- Opacities vary in shape and can be grouped into three basic morphologic types: drop-shaped, crumb-shaped, and ring shaped.

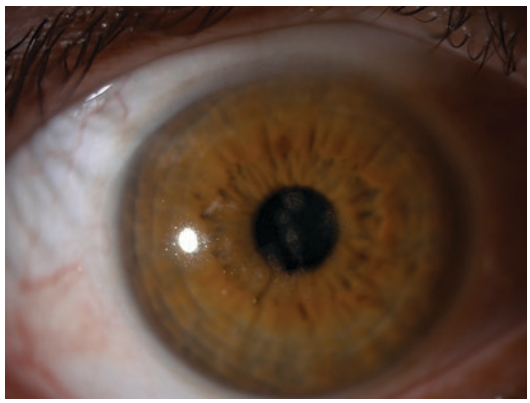

Fig. 8.6 Anterior segment image of a patient with granular dystrophy, with typical multiple white anterior stromal opacities with clear intervening stromal spaces between each opacity

Table 8.5 Key facts of granular dystrophy

- AD condition involving the deposition of hyaline material in the corneal stroma (hyaline material in the stroma stains red with Masson trichrome)
- Caused by a mutation in the keratoepithelin gene (TGFB1)

8.6.3 Treatment

- RCES: lubricants, BCL with prophylactic topical antibiotics, mechanical debridement, anterior stromal puncture, PTK, alcohol delamination
- If vision reduced: keratoplasty (PK or DALK) but high chance of recurrence

8.6.4 Other Diagnoses to Consider

- Macular dystrophy (see Sect. 8.7): recessive family history, decreased CCT, involvement of peripheral stroma, early intervening stromal haze
- Avellino dystrophy (see Sect. 8.8): combination of lattice dystrophy and granular dystrophy
- Schnyder's crystalline dystrophy (see Sect. 8.9)

8.7 Macular Dystrophy (Fig. 8.7 and Table 8.6)

8.7.1 History

- History of RCES

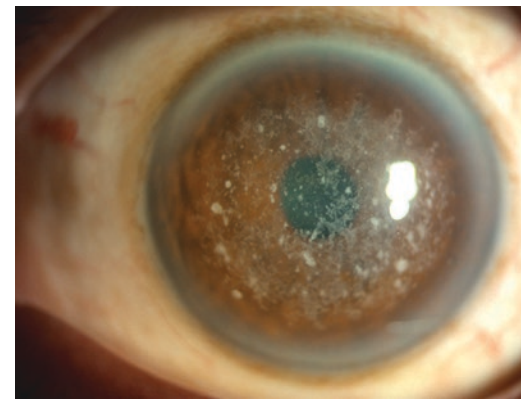

Fig. 8.7 Anterior segment image of a patient with macular dystrophy, showing multiple white opacities in the anterior stroma on a background of diffuse haze of the corneal stroma

Table 8.6 Key facts of macular dystrophy

- AR disorder involving the deposition of a GAG (keratin sulphate) in the stroma (GAG stains with Alcian blue or colloidal iron)
- Arises from mutations in the gene for carbohydrate sulfotransferase (CHST6)

8.7.2 Examination

- Multiple gray-white opacities in the anterior stroma on a background of diffuse clouding in the anterior stroma, extending from limbus to limbus. Guttae are commonly present.
- Associated with reduced CCT

8.7.3 Treatment

- RCES: lubricants, mechanical debridement, BCL with prophylactic topical antibiotics, anterior stromal puncture, PTK, alcohol delamination
- Photophobia: tinted glasses or tinted cosmetic CL
- Reduced vision: keratoplasty (DALK or PK)

8.7.4 Other Diagnoses to Consider

- Granular dystrophy (see Sect. 8.6)
- Avellino dystrophy (see Sect. 8.8)
- Schnyder's crystalline dystrophy (see Sect. 8.9)

8.8 Avellino Dystrophy (Fig. 8.8)

8.8.1 History

- History of RCES

8.8.2 Examination

- Anterior stromal, discrete gray-white granular deposits with anterior stromal haze
- Mid to posterior stromal lattice lesions

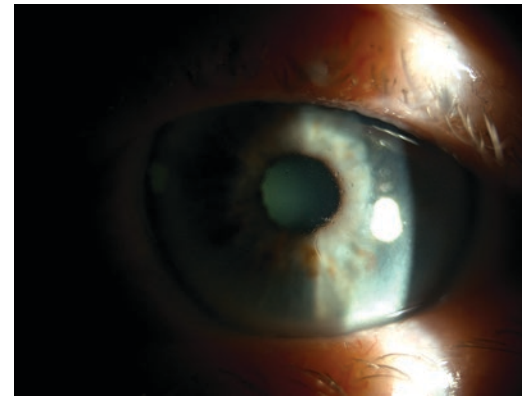

Fig. 8.8 Anterior segment image of a patient with Avellino dystrophy showing signs of both lattice dystrophy and granular dystrophy

8.8.3 Treatment

- RCES: lubricants, mechanical debridement, BCL with prophylactic topical antibiotics, anterior stromal puncture, PTK, alcohol delamination
- Photophobia: tinted glasses or tinted cosmetic CL
- Reduced vision: PK

8.8.4 Other Diagnoses to Consider

- Lattice dystrophy/Granular dystrophy

8.9 Schnyder's Crystalline Dystrophy (SCD) (Fig. 8.9 and Table 8.7)

8.9.1 History

- History of hypercholesterolaemia
- History of paraproteinaemias

8.9.2 Examination

- Bilateral central refractile crystals/opacities in the central anterior stroma with associated arcus lipoides

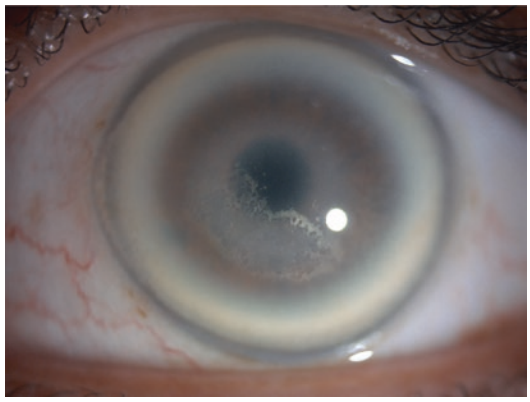

Fig. 8.9 Anterior segment image of a patient with Schnyder's crystalline dystrophy showing subepithelial crystalline deposition

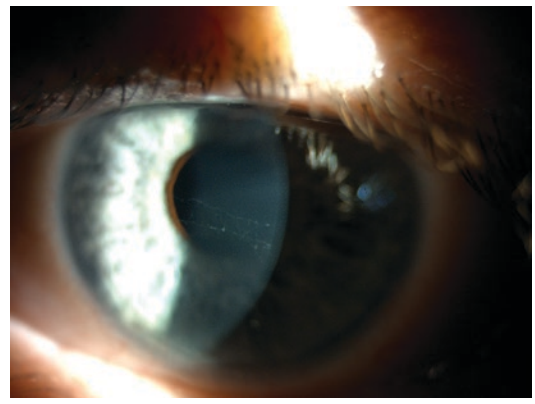

Fig. 8.10 Anterior segment image of a patient with PPCD with typical horizontal band lesions

Table 8.7 Key facts of SCD

• AD stromal dystrophy caused by mutations in the UBIAD1 gene • Characterised by the deposition of cholesterol crystals and phospholipids in the corneal stroma (crystals stain red with Oil Red O)

Table 8.8 Key facts of PPCD

• Bilateral, AD inherited corneal dystrophy • Normally non-progressive although has potential of decreasing vision due to corneal oedema and glaucoma

- Diffuse stromal haze, which may affect all levels of the stroma

8.9.3 Investigations

- Bloods: fasting cholesterol and triglyceride levels (SCD), leucocyte cysteine content (cystinosis), lymphocytosis (leukaemia)

8.9.4 Treatment

- If visual problems: keratoplasty (lamellar or penetrating) although recurrence of cholesterol crystals may occur

8.9.5 Other Diagnoses to Consider

- Cystinosis
- Dysproteinaemia's: multiple myeloma, Waldenstrom's macroglobulinaemia, Hodgkin's disease, leukaemia, benign monoclonal gammopathy, cryoglobulinaemia
- Medications: gold
- Bietti's peripheral crystalline dystrophy — peripheral location of crystals + retinal degeneration

8.10 Posterior Polymorphous Corneal Dystrophy (PPCD) (Fig. 8.10 and Table 8.8)

8.10.1 History

- History of Alport syndrome: 85% XR condition, anterior lenticonus, sensorineural deafness, dot and fleck retinopathy, glomerulonephritis

8.10.2 Examination

- Vesicular-like lesion (hallmark of PPCD): appears as sharply demarcated transparent round cysts surrounded by a grey halo at the

level of DM and endothelium and commonly occur in lines or clusters
- Band lesions: typically horizontal, have parallel scalloped edges, and do not taper towards the ends
- Diffuse deep stromal opacities: small, macular, gray-white lesions at the level of DM. There may be deep stromal haze adjacent to these lesions
- Endothelial guttae
- Corneal oedema occurs infrequently and ranges from minimal stromal thickening to bullous keratopathy
- PAS (characteristic feature of PPCD) seen with or without gonioscopy, corectopia, areas of iris atrophy
- Check IOP — open (compression of TM secondary to high iris insertion) and angle closure (endothelial cell migration across the TM onto the iris forming synechiae) glaucoma
- Look for trabeculectomy or glaucoma drainage implant
- Fundus examination: CDR (glaucoma), dot and fleck retinopathy (Alport syndrome)

8.10.3 Investigations

- Bloods: deranged renal function tests — glomerulonephritis — Alport syndrome
- Urinalysis: haematuria and proteinuria — glomerulonephritis — Alport syndrome
- Hearing test: sensorineural hearing loss — Alport syndrome

8.10.4 Treatment

- Observation: in the great majority of patients, PPCD is stable and asymptomatic
- Treat any glaucoma present: medical/surgical intervention
- PK: if significant reduced vision — presence of PAS visible without gonioscopy and increased IOP must be considered relative contraindications to corneal transplantation

8.10.5 Other Diagnoses to Consider

- ICE syndrome — unilateral, sporadic occurrence, female predilection, always has iridocorneal adhesions, displays iris atrophy, always has glaucoma, progressive and symptomatic
- Posterior corneal vesicle syndrome
- Early-onset CHED
- Congenital glaucoma
- Axenfeld-Rieger syndrome

8.11 Fuchs Endothelial Dystrophy (FED) (Figs. 8.11, 8.12 and Table 8.9)

8.11.1 History

- Symptoms: reduced vision (most predominantly in the morning)

8.11.2 Examination

- Corneal guttae ± melanin pigment pigmentation — appear as dark spots on the posterior corneal surface by direct illumination (beaten

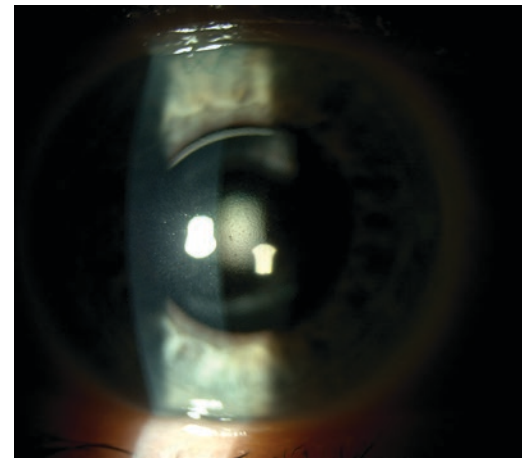

Fig. 8.11 Anterior segment image of a patient with FED showing multiple corneal guttae

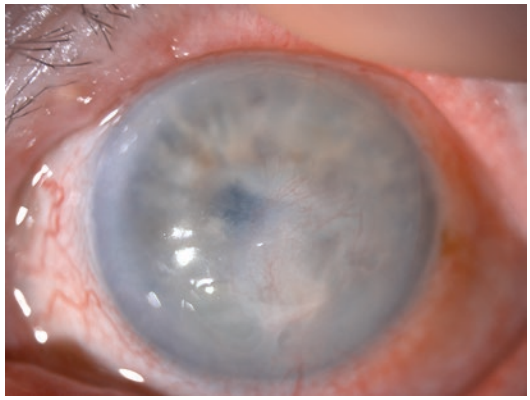

Fig. 8.12 Anterior segment image of a patient with end stage FED with diffuse corneal oedema and vascularised subepithelial fibrosis

Table 8.9 Key facts of FED

• Age of onset over age 50
• Female: Male ratio of 3:1

metal appearance — coalescence of central guttae)
- Corneal stromal oedema with DM folds, microcystic epithelial oedema (seen as a stippled pattern that stands out in sclerotic scatter, using fluorescein stain the microcystic pattern is highlighted as a disruption in the tear film) that eventually coalesces to form bullae, which can lead to erosions and fingerprint lines.
- In end stage disease, subepithelial fibrous scarring occurs between the epithelium and Bowman's membrane (best seen with tangential illumination)
- Measure IOP and examine the optic disc for glaucoma: increased incidence of primary open angle glaucoma (POAG) in FED

8.11.3 Investigations

- Specular microscopy — reduced endothelial cells counts, increased average cell volume, loss of hexagonality of the cells and increased variation of cell sizes
- Pachymetry — increased CCT

8.11.4 Treatment

- Medical
  - Indication(s): visually significant corneal oedema.
  - Options:
    Topical hypertonic saline solutions
    Dehydration of cornea by a blow dryer in the morning or throughout the day
    Reduction of IOP (avoid topical carbonic anhydrase inhibitors)
    BCL for treatment of recurrent erosions caused by epithelial bullae
- Surgical
  - Indication(s): blurring of vision in the morning, evidence of epithelial oedema on slitlamp examination
  - Options:
    Lamellar keratoplasty (DSEK, DMEK)
    Full thickness PK — preferred if significant corneal scarring present
- FED and cataract (Table 8.10)
  - Staged cataract extraction followed by keratoplasty:
    Advantages: IOL stability in the bag, easier to manage if complications occur, delay of graft procedure
    Disadvantages: two operative procedures on separate occasions required for patient, longer visual rehabilitation procedure for patient
  - Triple procedure (keratoplasty with cataract extraction and IOL implant):
    Indications(s): consider if CCT more than 650, endothelial cell count <1000, dense cataract present

Table 8.10 Management of a patient with FED and a cataract

• If the patient has no cataract and mild corneal oedema — consider conservative medical management
• If the patient has a dense cataract and severe corneal oedema — consider triple procedure
• If the patient has no cataract but has severe corneal oedema — consider keratoplasty first and cataract extraction if a visually significant cataract develops
• If the patient has a dense cataract and no corneal oedema — consider cataract extraction first and keratoplasty if corneal decompensation develops

Advantages: faster visual recovery and reduced number of operations
Disadvantages: may be unable to perform keratoplasty (with subsequent loss of valuable graft tissue) if complications arise from initial cataract surgery

8.11.5 Other Diagnoses to Consider

- Pseudophakic bullous keratopathy
- Chandler's syndrome — unilateral ICE syndrome with a hammered silver appearance of the corneal endothelium, corectopia, iridocorneal adhesions
- Posterior polymorphous dystrophy — corectopia, iridocorneal adhesions
- Central herpetic disciform keratitis — presence of underlying KP's
- Macular dystrophy
- Congenital hereditary endothelial dystrophy — present at birth (CHED 2 — AR)
- Corneal pseudoguttae: post-trauma, post-intraocular inflammation — these apparent guttae are transient and disappear with resolution of underlying condition

8.12 Interstitial Keratitis (IK) (Fig. 8.13 and Table 8.11)

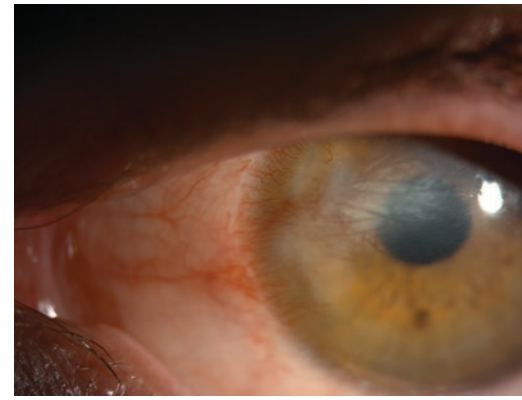

Fig. 8.13 An anterior segment image of a patient with interstitial keratitis. Note the ghost vessels in the corneal stroma arising from the limbus

Table 8.11 Key facts of IK

• Defined as a nonsuppurative inflammation characterised by cellular infiltration and vascularisation of the corneal stroma with minimal primary involvement of the corneal epithelium or endothelium

8.12.1 Causes of IK

- Infectious: bacterial (congenital — if bilateral or acquired — if unilateral syphilis, TB, leprosy, lyme disease, trachoma, brucellosis), viral (HSV, HZV, EBV, mumps, rubeola, HTLV-1), parasitic (acanthamoeba keratitis, microsporidiosis, leishmaniasis, onchocerciasis, trypanosomiasis)
- Non-infectious: cogan's syndrome, sarcoidosis, lymphoma

8.12.2 History

- Syphilis: history of congenital syphilis or hx of parents being treated for STI, symptoms of meningism (headaches, photophobia, neck stiffness), hearing loss
- HSV: History of HSV keratitis, hx of herpetic "cold sores"
- HZV: Risk factors for immunosuppression: immunosuppressive drugs, organ transplant recipients, neoplastic diseases, HIV
- Acanthamoeba: History of CL wear (extended wear CL), poor CL hygiene (rinsing in tap water), swimming with CL in situ (ponds, hot tubs, swimming pools), corneal trauma (rural or agricultural setting)
- TB: fever, night sweats, weight loss, cough, hx of TB, recent travel to endemic areas, contacts of active TB
- Cogan's syndrome: acute tinnitus, vertigo (dizziness), bilateral hearing loss

8.12.3 Examination

- Vascularised corneal opacification is a sign of prior stromal inflammation. Look for ghost vessels (a tracery of intertwined phantom ves-

sels forming a thread like network weaving through a stromal haze) from the limbus
- Syphilis: bilateral in congenital and unilateral in acquired, cellular infiltration of stroma with stromal oedema, stromal neovascularisation (superficial capillaries bud from venules of the limbal arcades, deeper vessels arise as terminal branches of the anterior ciliary vessels), anterior and posterior uveitis, associated findings in congenital syphilis — salt and pepper retinopathy, Hutchinson's teeth (widely spaced teeth with notched incisors), frontal bossing, saddle shaped nose, sabre shins, associated findings in acquired syphilis — maculopapular rash (trunk, palms, soles), lymphadenopathy, painless chancre, painless ulcer of mouth or conjunctiva, light-near dissociation (Argyll Robertson pupil — neurosyphilis)
- HSV: stromal oedema (suggested by increased width of slit beam and DM folds), stromal neovascularisation, stromal cellular infiltration (three hallmarks of IK) ± scleritis or uveitis, pattern of stromal infiltration may be central or peripheral, focal or multifocal, superficial or full-thickness, wessely-type immune rings (if present supports the diagnosis — best seen on sclerotic scatter), look for anterior stromal scars (footprints or ghost dendrites) from previous HSV disease, raised IOP, sectoral iris atrophy, check for reduced corneal sensation
- HZV: stromal infiltration with stromal oedema, pseudodendrites (lack central ulceration, have blunt ends, raised epithelial cells), vesicular eruption of periocular skin and eyelids (look for scabbed lesions), uveitis
- Acanthamoeba: stromal oedema with infiltration, ring infiltrate, perineural infiltrates, pseudodendrites
- TB: unilateral, cellular infiltration of stroma is often peripheral or quadrantic and is followed by localised oedema, and later stromal vascularisation ± scarring or thinning. May have additional uveitis, particularly choroiditis.
- Cogan's syndrome: patchy cellular infiltration of the mid-stroma with stromal oedema, stromal neovascularisation from the limbus, stromal scarring and ghost vessels (late-finding)

8.12.4 Investigations

- Syphilis: non-treponemal tests (VDRL, RPR — better for screening), treponemal tests (FTA-ABS, hemagglutination, enzyme immunoassay — ELISA), HIV test (check for co-infection, HIV antibody detection via ELISA. Positive ELISA results are confirmed with western blot), LP (if active intraocular disease or neurosyphilis — leukocytosis, raised protein levels). Treponemal tests remains reactive for life in patients with congenital or acquired syphilis. Over time, the non-treponemal test titres decrease, ultimately becoming undetectable.
- Acanthamoeba: corneal scrape and stain with calcofluor white (stain cysts visualised under UV light) and culture on non-nutrient agar with E. coli overlay ± PCR, in-vivo confocal microscopy with direct visualisation of cysts
- TB: CXR, tuberculin skin test, Interferon gamma release assay (IGRA — T-spot or QuantiFERON), sputum culture for AFB, early morning urine sample for AFB, corneal scraping for culture and histopathological evaluation
- Cogan's syndrome: bloods for FBC (leukocytosis, eosinophilia), ESR (raised), p-ANCA (PAN), c-ANCA (GPA), hearing test (sensorineural hearing loss), VDRL/RPR (to rule out syphilis)

8.12.5 Treatment

- Syphilis: topical steroids, GU referral with contact tracing, benzylpenicillin, PK for corneal scarring
- HSV: topical steroids with topical antivirals (prevent breakout of epithelial keratitis) — no benefit of adding oral aciclovir (HEDS I), oral acyclovir 400 mg BD reduced the probability of stromal keratitis recurrence by 50% from 28% to 14% at the 1 year time point (HEDS II), cycloplegia (for uveitis), PK for corneal scarring
- HZV: topical steroids, oral aciclovir 800 mg 5×/day (IV aciclovir if patient is immunocompromised to avoid complication of disseminated infection), cycloplegia (for uveitis), PK (high risk of failure) or Boston keratoprosthesis

for corneal scarring. PK only generally performed for tectonic reasons.
- Acanthamoeba: admit, topical biguanide (PHMB 0.02% or chlorhexidine 0.02%) + diamidine (propamidine 0.1% or hexamidine 0.1%), PK for corneal scarring
- TB: topical steroids, systemic anti-TB medication (rifampicin, isoniazid, pyrazinamide, ethambutol), cycloplegia (for uveitis), PK for corneal scarring
- Cogan's syndrome: low dose topical steroids for IK, high dose systemic corticosteroids for inner ear disease

8.12.6 Other Diagnoses to Consider

- Microbial keratitis — bacterial (pseudomonas, syphilis, chlamydia), viral (HSV. HZV), fundal (candida, aspergillus, fusarium), parasitic (onchocerca)
- Traumatic corneal scarring from chemical burns
- LESC failure
- OCP
- SJS
- Terrien's marginal degeneration
- Ocular rosacea
- Atopic keratoconjunctivitis

8.13 Lipid Keratopathy (Figs. 8.14 and 8.15)

8.13.1 Causes

Secondary lipid keratopathy is more common than primary lipid keratopathy and occur in corneal neovascularisation.

- Primary: no history of trauma, corneal vascularisation, or known disorders of lipid metabolism
- Secondary: interstitial keratitis, trauma: surgical — corneal intacs implantation, corneal ulceration, corneal hydrops, mustard gas injuries, disorders of lipid metabolism (fish eye disease, tangier disease, familial LCAT deficiency, apolipoprotein A1 deficiency)

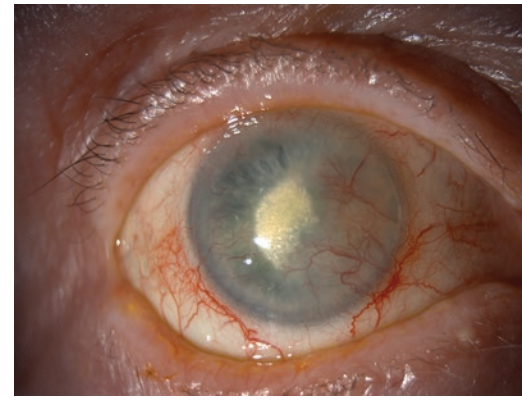

Fig. 8.14 Anterior segment image of a patient with lipid keratopathy in a region of corneal scarring and stromal neovascularisation resulting from previous herpes simplex keratitis

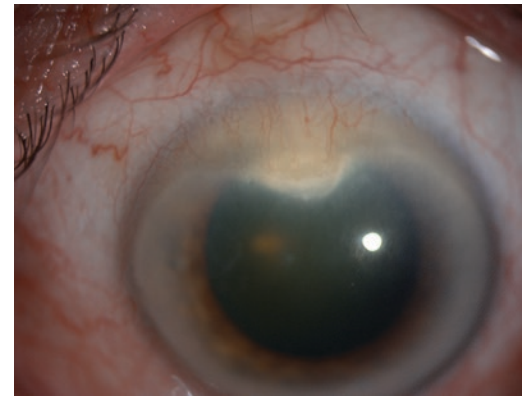

Fig. 8.15 Anterior segment image of a patient with lipid deposition at the leading edge of the superior pannus associated with Terrien marginal degeneration

8.13.2 Examination

- Primary lipid keratopathy: lipid deposition centrally or peripherally
- Secondary lipid keratopathy: gray to yellow-white infiltrates (often at edge of scars/lesions) associated with the presence of an adjacent corneal blood vessel

8.13.3 Treatment

- Indications: vision, cosmesis
- Options

- Argon laser to limbal feeder vessel or needle point cautery to induce absorption of the lipids through destruction of the feeder vessels
- Intrastromal anti-VEGF agents with off license avastin
- Keratoplasty: PK or DALK

8.14 Radial Keratotomy (RK) (Fig. 8.16 and Tables 8.12 and 8.13)

8.14.1 Examination

- Radial incision lines (from center to peripherally)
- Star shaped iron deposit forming centrally (tear star — no effect on vision)

8.14.2 Indications of RK

- Refractive surgery procedure to correct myopia (−1.00 to −4.00 D)

8.14.3 Complications of RK

- Intraoperative: penetration into AC causing iris/lens damage

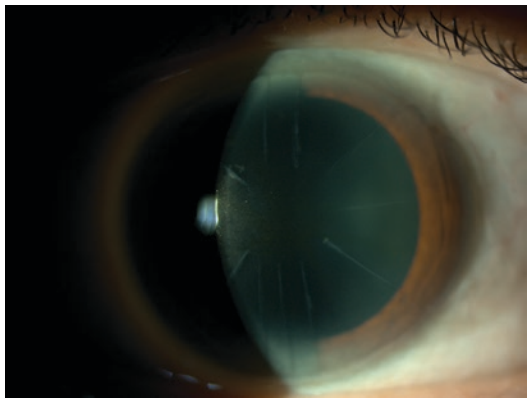

Fig. 8.16 Anterior segment image of a patient who previously underwent a radial keratotomy refractive procedure to correct an underlying myopic refractive error

Table 8.12 Cataract surgery considerations in patients who have undergone a previous radial keratotomy refractive procedure

- IOL power calculation may be problematic and may result in undercorrection and hyperopia
- Calculation of implant power for cataract surgery after RK should be done using a third-generation formula (Haigis, Hoffer Q, Holladay 2, or SRK/T) rather than a regression formula (SRK I or II)
- Keratometric power is determined in one of three ways: direct measurement using corneal topography; application of pre-RK keratometry minus the refractive change; or adjustment of the base curve of a plano contact lens by the overrefraction.
- Scleral tunnel incisions preferred (clear corneal incisions increase the risk of the blade transecting the RK incision, which can induce irregular astigmatism)
- Place incision in the steep meridian of the cornea or use of toric IOLs to reduce preoperative astigmatism
- Prevent overhydrating the cataract incision in order to avoid rupture of the RK incision

Table 8.13 Measuring intraocular pressures in patients who have undergone a previous radial keratotomy refractive procedure

- Changes in the corneal shape without corneal thinning can lead to falsely low IOP values with central applanation tonometry
- In eyes that have undergone RK, non-Goldmann measurement of IOP and continued examination of the optic nerve and possibly VF is recommended.

- Postoperative: irregular astigmatism (visual glare + distortion) due to wound gape and epithelial plugs, epithelial downgrowth, endophthalmitis, traumatic cataract, starburst effects (starburst patterns around lights at night — light scattering off radial incisions), perforation of the cornea, progressive hyperopic shift (can be corrected with LASIK or PRK)

8.15 Vortex Keratopathy (Fig. 8.17)

8.15.1 History

- Use of medications (dose and duration): amiodarone, hydroxychloroquine, chloroquine, phenothiazines (chlorpromazine), tamoxifen, indomethacin

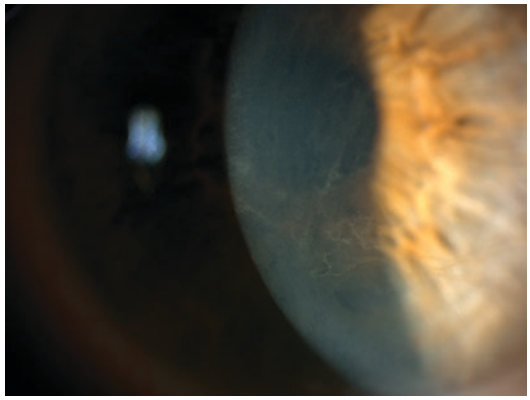

Fig. 8.17 Anterior segment image of a patient with vortex keratopathy who was on long term amiodarone treatment

- History of Fabry's disease: x-linked recessive disorder, deficiency of alpha-galactosidase A enzyme, renal failure, cardiovascular disease, neurologic changes, cutaneous angiokeratomas

8.15.2 Examination

- Pattern of non-elevated white to brown whorl-shaped opacities within the basal corneal epithelium, consisting of fine lines emanating from a central nodal point (most commonly located in the inferior paracentral region — typically bilateral and symmetric)
- Look for aneurysmal dilatations and tortuosity of the conjunctival and retinal vessels and a spoke-like posterior subcapsular cataract: Fabry's disease
- Look for bulls eye maculopathy (ring of depigmentation surrounded by an area of hyperpigmentation seen centered on the fovea): hydroxychloroquine toxicity, chloroquine toxicity
- Look for optic neuropathy (VA, RAPD, colour vision, VF), retinopathy, and anterior subcapsular lens opacities: amiodarone

8.15.3 Investigations

- Screening for greatly deficient or absent alpha-galactosidase A activity in plasma or peripheral leukocytes or gene sequencing: Fabry's disease

8.15.4 Treatment

- Cornea verticillata is visually insignificant and is not an indication for stopping any associated medications.
- Discontinuation or reduction of the dose of amiodarone should be considered if optic neuropathy is observed.

8.15.5 Other Diagnoses to Consider

- Corneal iron lines (faint yellow to dark brown discolouration in the corneal epithelium): tear star after RK, Hudson-Stahli line (horizontal line located in the lower third of the cornea), Ferry line (appears on cornea anterior to filtering bleb), Stocker's line (advancing edge of pterygium), Fleischer ring (base of the cone of KC)
- Corneal stromal deposits: gold (chrysiasis — gold to violet like fine deposits scattered from the corneal epithelium to the deep stroma ± bulbar conjunctiva), silver (argyrosis — lids and conjunctiva have a light to dark slate-grey appearance, deposits of blue-gray material in the peripheral deep stroma of the cornea), antacid, retinoid deposition

8.16 Calcific Band Keratopathy (BK) (Fig. 8.18 and Table 8.14)

8.16.1 Causes of BK

- Ocular: chronic anterior uveitis, JIA, herpetic keratouveitis, long standing interstitial keratitis, phthisis bulbi, prolonged corneal oedema, silicone oil in AC
- Systemic: hypercalcaemic states (CKD, hyperparathyroidism, sarcoidosis), hyperphosphataemia (CKD), hyperuricaemia (CKD), x-linked ichthyosis

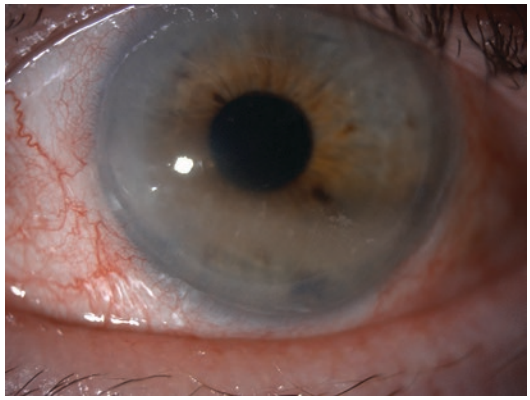

Fig. 8.18 Anterior segment image of a patient with calcific band keratopathy

Table 8.14 Key facts about BK

• Calcific BK is a deposition of calcium hydroxyapatite across the cornea at the level of Bowman's layer

8.16.2 History

- History of uveitis
- History of RD repair requiring the use of silicone oil
- History of chronic kidney disease (CKD)
- History of gout
- Symptoms suggestive of hypercalcaemia: abdominal pain, depression, renal stones
- Use of vitamin D and calcium supplements

8.16.3 Examination

- White and chalky band of opacity beginning peripherally at the 3 and 9 o'clock positions, with a sharply demarcated peripheral edge separated from the limbus by a lucent zone
- Lucent holes are scattered throughout the opacity and represent penetrating corneal nerves through Bowman's layer
- Exclude the presence of uveitis and the presence of silicone oil in AC.
- Exclude phthisis bulbi: hypotony, small eye

8.16.4 Investigations

- Bloods: U&E's, calcium, phosphorus, uric acid, ACE (if sarcoidosis suspected), PTH levels (if hyperparathyroidism suspected)
- CXR: sarcoidosis

8.16.5 Treatment

- Indication: patient becomes symptomatic with reduced VA, FB sensation, tearing or photophobia
- Options:
  - Lubricants and BCL for comfort (temporary measure)
  - Removal of epithelium followed by application of ethylenediaminetetraacetic acid (ETDA) to calcific areas. No. 15 blade used to remove any residual calcium
  - Excimer laser phototherapeutic keratectomy (PTK)

8.16.6 Other Diagnoses to Consider

- Spheroidal degeneration (climatic droplet keratopathy): bilateral golden-yellow globular deposits within the interpalpebral area, deposits located within Bowman's layer and the anterior stroma
- Urate keratopathy: brown scintillating crystal deposits in the superficial cornea

8.17 Infectious Crystalline Keratopathy (ICK) (Fig. 8.19 and Table 8.15)

8.17.1 History

- ICK: history of keratoplasty, history of chronic use of topical steroids
- Multiple myeloma: backache
- Waldenstrom's macroglobulinaemia: epistaxis, bleeding gums

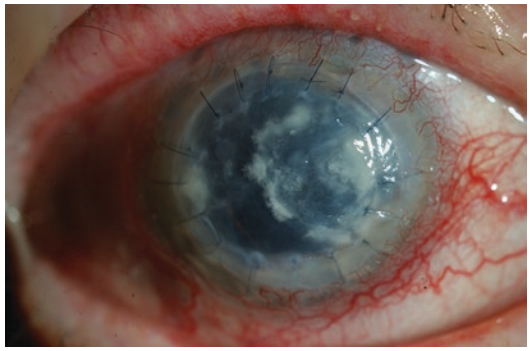

Fig. 8.19 Anterior segment image of a patient with infectious crystalline keratopathy secondary to Candida

Table 8.15 Key facts about ICK

- A non-inflammatory intrastromal microbial colonization of a graft: bacterial (*S. viridans*, *S. pneumoniae*, coagulase negative *streptococcus, P. aeruginosa*), fungal (*Candida*)
- Diagnosis of ICK can be made clinically based upon a history of keratoplasty, a history of topical steroid use, and the clinical appearance of the lesion

- Cryoglobulinamia: raynaud's phenomenon, urticaria, ulceration of the skin
- Drug history: gold

8.17.2 Examination

- ICK: crystalline fine needle like branching opacities in the anterior or mid-stroma (resembling a snowflake) occurring beneath an intact epithelium in the absence of clinically evident stromal inflammation
- Cystinosis: myriad of fine needle shaped, highly refractile opacities present in the conjunctiva and corneal epithelium, stroma, and endothelium (see Fig. 8.20)
- Multiple myeloma: prominent corneal nerves, presence of numerous scintillating polychromatic crystals scattered throughout the corneal stroma and conjunctiva, BRVO/CRVO
- Waldenstrom's macroglobulinaemia: needle-like crystals scattered throughout the corneal stromal and conjunctiva, BRVO/CRVO
- Cryoglobulinaemia: superficial scattered crystalline corneal deposits

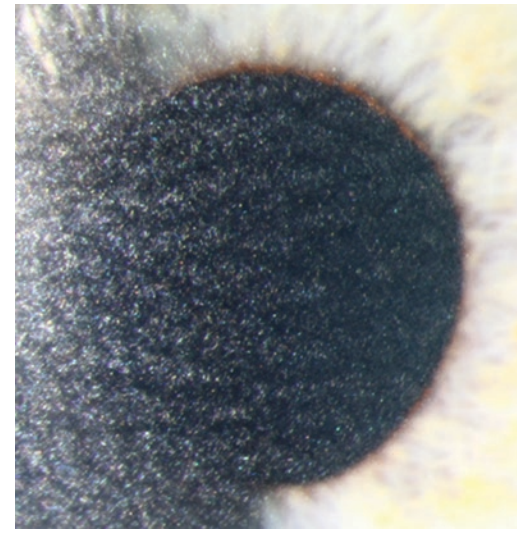

Fig. 8.20 Anterior segment image of a patient with cystinosis showing the diffuse presence of needle-shaped crystals throughout the corneal surface

- Benign monoclonal gammopathy: diffuse deposition of gray-white, yellow, gray-brown, or polychromatic iridescent dot-like opacities with a diffuse, fine stippled appearance

8.17.3 Investigations

- ICK: corneal scrapings for cultures and smears (help select appropriate antibiotics)
- Corneal biopsy: histopathologic analysis of the crystalline deposition
- Cystinosis: measure the leucocyte cysteine content, U&E's, conjunctival biopsy to measure the extracted free cysteine, electron microscopy to detect the characteristic crystals
- Multiple myeloma: bloods — hypercalcaemia and pancytopenia, XR spine — vertebral fractures and lytic punched out lesions, serum and urine electrophoresis, bone marrow biopsy

8.17.4 Treatment

- ICK: fortified intensive topical antibiotic drops — coverage for S.viridans includes top-

ical vancomycin, stop topical corticosteroids, repeat PK in order to eradicate the infection or to treat scar formation that may have caused decreased VA
- Cystinosis: oral and topical cysteamine

8.17.5 Other Diagnoses to Consider

- Lipid keratopathies: Schnyder's crystalline dystrophy, Tangier disease, familial lipoprotein disorders, lecithin-cholesterol acyltransferase (LCAT) deficiency
- Errors of protein metabolism: cystinosis, tyrosinaemia, hyperuricaemia
- Acquired immunoprotein keratopathies: multiple myeloma, benign monoclonal gammopathy, cryoglobulinaemia, Waldenstrom's macroglobulinaemia
- Drug deposition: chrysiasis

8.18 Bullous Keratopathy (Fig. 8.21 and Table 8.16)

8.18.1 Causes (Table 8.17)

- FED
- Trauma from cataract surgery
- Angle-closure glaucoma (ACG)
- PXF keratopathy
- HSV endotheliitis
- Chandler's syndrome
- PPCD

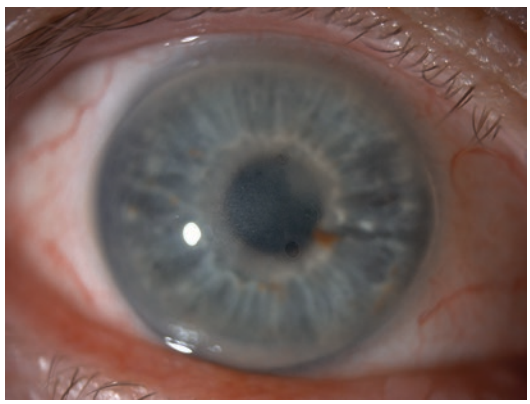

Fig. 8.21 Anterior segment image of a patient with pseudophakic bullous keratopathy, showing diffuse epithelial microcysts with several larger epithelial bullae

8.18.2 Examination

- Diffuse epithelial microcysts with the presence of adjacent epithelial bullae
- Examine for aphakia or pseudophakia: ABK/PBK
- Examine for guttae: FED
- Examine for a fixed and dilated pupil, iris atrophy (transillumination defect), presence of patent PIs (transillumination), shallow AC (using gonioscopy or Van Herrick's method — narrow slit beam at angle of 60° onto cornea just anterior to the limbus — narrow if distance between iris and posterior cornea is <¼ of the corneal thickness), glaukomflecken, increased CDR, defects on HVF testing: ACG
- Examine for whitish dandruff-like material on pupillary margin and anterior lens capsule centrally and peripherally with clear intermediate zone (if phakic), peripupillary transillumination defects, iridodonesis/phaco- or pseudo-phacodonesis: PXF
- Examine for KP's overlying stromal and epithelial oedema (pattern of KP's and distribution of oedema — diffuse, disciform, linear) and anterior uveitis: HSV endotheliitis (stromal infiltrate and neovascularisation, which

Table 8.16 Characteristics of bullous keratopathy

• Bullous keratopathy is characterised by corneal oedema with formation of epithelial bullae. It is secondary to loss or dysfunction of the corneal endothelial cells

Table 8.17 Causes of pseudophakic bullous keratopathy

• Pre-operative factors: pre-existing endothelial disease — FED, PXF, trauma, ACG, HSK
• Intraoperative factors: phacoemulsification in the AC, IOL-to-cornea touch, vitreous loss ± nuclear loss, instrumentation, ultrasound damage
• Postoperative factors: retained lens fragment in the AC, IOL dislocation — touch, vitreous-to-endothelial touch, flat AC (immediate with wound leakage or delayed with pupil block) with IOL touch to cornea, chronic post-op uveitis, ACIOL (chronic uveitis, IOL-to-cornea — touch)

are signs of stromal inflammation, are absent in endotheliitis)

8.18.3 Treatment

- Medical management: topical corticosteroids for inflammation, reduction of IOP if raised, hypertonic agents (5% NaCl), BCL, anterior stromal puncture (form adhesions between epithelium and stroma, decreasing formation of bullae) — reserved for eyes that have poor visual potential or are poor surgical candidates
- Surgical management: repositioning or exchange of IOL, if IOL subluxed or dislocated, removal of retained lens fragment if present, endothelial keratoplasty when visual loss and discomfort becomes medically untreatable, conjunctival flap — reserved for eyes with poor visual potential or patients who are not candidates for corneal transplantation

8.19 Salzmann Nodular Degeneration (Fig. 8.22 and Table 8.18)

Table 8.18 Key facts about Salzmann nodular degeneration

- Dense collagen plaques with hyalinisation are located between the epithelium and Bowman's layer
- Female predilection

8.19.1 Causes

- Vernal keratoconjunctivitis
- Phlyctenular keratitis
- IK
- Post-corneal surgery
- MGD/Ocular Rosacea
- Trachoma

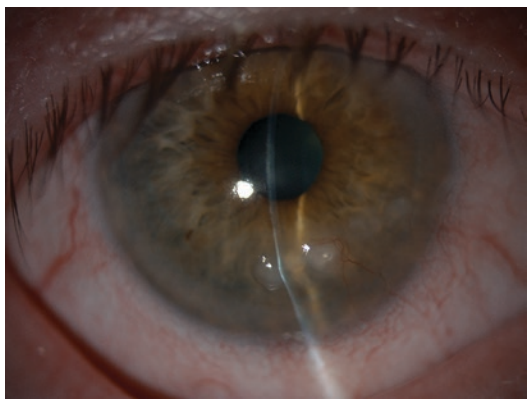

Fig. 8.22 Anterior segment image of a patient with Salzmann nodular degeneration with multiple elevated nodules inferiorly

8.19.2 History

- History of allergic eye disease, dry eye, rosacea, or trachoma
- History of previous corneal surgeries

8.19.3 Examination

- Single or multiple white or blue elevated nodular lesions adjacent to areas of corneal scarring or a corneal pannus
- An iron line may be seen at the edge of the nodules (indicate chronicity)
- Examine for rosacea
- Examine for ghost vessels
- Examine everted upper eyelid for papillary changes, Horner-trantas dots (VKC)
- Examine everted upper eyelid for Herbert pits or Arlt line

8.19.4 Treatment

- Indications: comfort and vision
- Options:
  - Lubricants and BCL for comfort
  - Superficial keratectomy by manual dissection or PTK for nodules involving visual axis and causing decreased vision

8.19.5 Other Diagnoses to Consider

- Corneal keloids: more frequently in men, younger age group, occur post-trauma or in

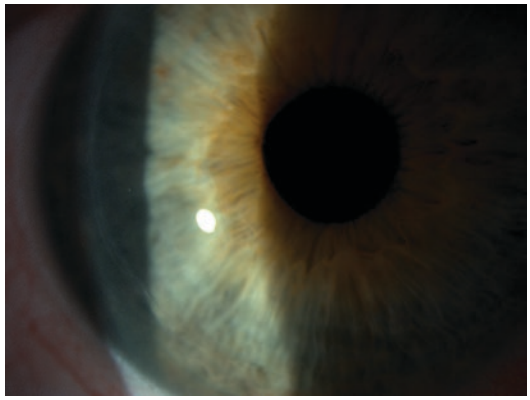

Fig. 8.23 Anterior segment image of a patient who previously had a LASIK refractive procedure to correct myopia. The LASIK flap is seen as a fine white line (concentric with limbus) in the anterior corneal stroma

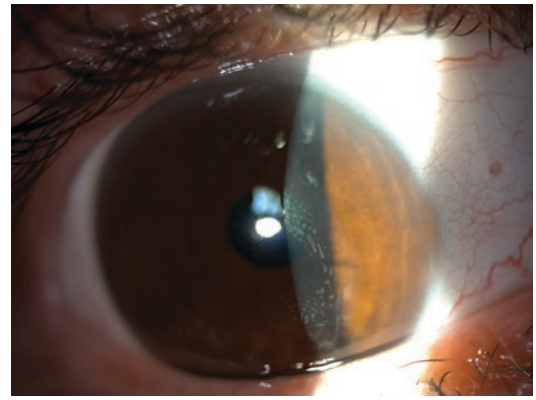

Fig. 8.24 Anterior segment image of a patient who previously had a LASIK refractive procedure, which has been complicated with epithelial downgrowth

association with chronic ocular surface inflammation
- Spheroidal degeneration

8.20 Laser In-Situ Keratomileusis (LASIK) (Fig. 8.23)

8.20.1 LASIK Surgical Technique

- Two stage procedure:
  - Creation of a thin flap (consists of epithelium, Bowman's layer, and superficial stroma) on the surface of the cornea using a microkeratome blade or using a FemtoSecond laser
  - Flap is lifted and the stromal bed is then reshaped with the excimer laser

8.20.2 Complications of LASIK

- Intraoperative:
  - Creation of the flap with the microkeratome related problems:
    Incomplete or irregular cut flap
    Button hole
    Corneal perforation
  - Photoablation-related problems:
    Treatment decentration
    Interface debris
    Wrinkles
- Postoperative
  - Early:
    Dislodged flaps:
    - First 24 h
    - Emergency repositioning ± sutures + BCL to prevent fixed folds and epithelial ingrowth

    Diffuse lamellar keratitis (shifting sands of Sahara):
    - First 24 h
    - Diffuse inflammation at flap interface without microbial cause
    - White sand-like deposits in lamellar cut plane in absence of both epithelial defect and AC activity
    - Aggressive topical steroid leads to rapid resolution

    Infectious keratitis:
    - ≤10d — gram +ve organisms, >10/7d — mycobacteria
    - Flap lift, scrape, frequent topical antibiotics

    Epithelial downgrowth (see Fig. 8.24):
    - Flap lift and scrape
  - Late
    Iatrogenic keratectasia
    Dry eye

8.21 Keratoconus (KC) (Fig. 8.25 and Table 8.19)

8.21.1 Associations of KC

- Ocular: retinitis pigmentosa (RP), vernal keratoconjunctivitis (VKC), leber's congenital amarousis (LCA), floppy eyelid syndrome
- Systemic: *atopic disease* (asthma, eczema, hayfever), *Down's syndrome* (habitual ocular massage), *craniosynostosis* (Crouzon's syndrome, Apert syndrome), *connective tissue disorders* (Marfan's syndrome, Ehlers-Danlos syndrome, Osteogenesis Imperfecta)

8.21.2 History

- Atopic disease — asthma, eczema, hayfever
- History of connective tissue disorders — Marfan syndrome, Ehlers-Danlos syndrome, Osteogenesis Imperfecta
- History of Down's syndrome
- History of craniosynostosis
- Previous laser refractive surgery

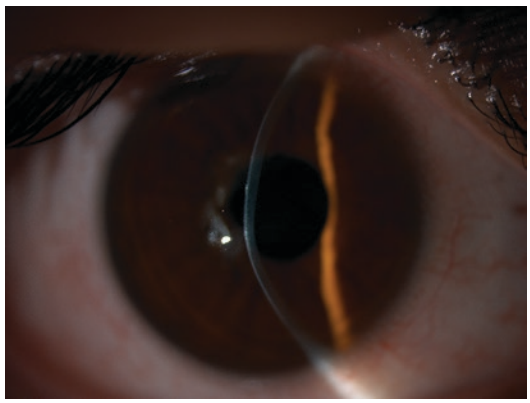

Fig. 8.25 Anterior segment image of a patient with KC showing thinning and scarring of the corneal stroma

Table 8.19 Key facts about KC

- Clinical term used to describe a bilateral condition in which the cornea assumes a conical shape because of thinning and protrusion
- Process is non-inflammatory with no cellular infiltration and vascularisation
- Onset occurs at about the age of puberty, where the cornea begins to thin and protrude, resulting in irregular astigmatism

8.21.3 Examination

- Corneal thinning from one-half to one-fifth of normal thickness is observed at the cone apex, the point of maximal protrusion
- Prominent corneal nerves
- Munson's sign: angulation of the lower lid in downgaze
- Vogt's striae (ruptures in Bowman's layer): fine vertical posterior stromal folds, which disappear when external pressure is applied to the globe
- Fleischer ring (provides a landmark for the peripheral edge of the cone): partial or complete annular iron line commonly seen at the base of the cone — cobalt blue illumination in the widest possible slit beam can enhance the appearance of a subtle iron ring
- Rizutti's sign: conical reflection on nasal cornea when pentorch is shone temporally
- Charleaux oil droplet sign: dark reflex in area of cone on observation of the cornea with the pupil dilated using a direct ophthalmoscope set on plano
- Corneal hydrops (ruptures in DM): stromal imbibition of aqueous and result in marked corneal oedema
- Deep stromal scarring of cornea: suggestive of previous hydrops
- Examine lids for upslanting of palpebral aperture (Down's syndrome) and floppy eyelid syndrome (easily everted upper eyelid tarsal plates + upper palpebral conjunctival papillary reaction)
- Examine for conjunctival papillae, Horner-Trantas dots (raised white accumulations of eosinophils at the limbus), shield ulcer: VKC
- Examine for blue sclera (results from visualisation of the underlying choroid through a thin sclera): Osteogenesis Imperfecta, Ehlers-Danlos syndrome
- Examine for ectopia lentis: Marfan's syndrome (superotemporal lens subluxation), Ehlers-Danlos syndrome

- Dilated fundus examination for mid-peripheral bone spicule retinal pigmentation, waxy pallor of the optic disc, arteriolar attenuation (RP), retinal detachment (Marfan's syndrome, Ehlers-Danlos syndrome)
- Examine for nystagmus: LCA

8.21.4 Investigations

- Refraction: scissoring on retinoscopy (see Table 8.20), irregular astigmatism, high myopia (Marfan Syndrome)
- Keratometer: inability to superimpose the central keratometric rings suggest irregular astigmatism, look for inferior corneal steepening (early sign of KC) by performing central keratometry followed by keratometry in upward gaze
- Placido disc: a focal area of increased corneal curvature appears as an isolated area of smaller ring spacing and distortion — look for decreased ring spacing inferiorly in early KC. As the condition progresses, the ring spacing decreases overall and becomes increasingly irregular
- Corneal topography (see Sect. 2.9.4)

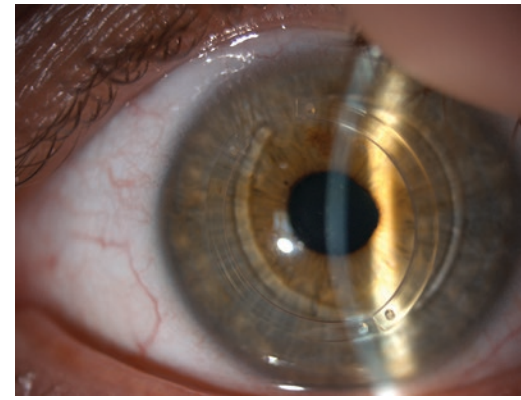

Fig. 8.26 Anterior segment image of a patient with KC who had corneal intacs implanted into the mid-peripheral corneal stroma to improve vision

Table 8.21 Dresden protocol for CXL

- Gold standard protocol for CXL
- Technique:
  - Topical anaesthesia
  - Central 9 mm of corneal epithelium removed
  - 0.1% riboflavin every 1–5 min for 30 min
  - Exposure to UVA light (3 mW/cm^2, 365 nm wavelength) for 30 min (total energy 5.4 J/cm^2)
  - Topical antibiotic
  - BCL insertion
- Contraindications:
  - CCT <400
  - Age >35 years old

8.21.5 Treatment

- Spectacle correction
- Rigid gas permeable (RGP)/scleral/miniscleral CL fitting
- Intacs (see Fig. 8.26): improves VA by flattening the central cornea, reducing astigmatism and centering the cornea, indicated for mild to moderate KC without corneal scarring — goal of procedure is to improve CL fit and comfort ± improve BCVA, ideal candidates have low spherical equivalent and average K readings of <53 D, ring segments do not prevent progression of the underlying disease, CCT needs to be ≥450 µm
- CXL (Table 8.21): slows or halts progression of the underlying disease + improves CL fit, improves VA by decreasing both corneal curvature and astigmatism, CCT needs to be >400 µm thick. Failure of CL is not an indication for CXL
- Keratoplasty (PK or DALK — if normal DM): Indications — intolerance to CL wear or severe irregular astigmatism with poor vision despite gls or CL or significant stromal scarring involving the visual axis
- Corneal hydrops: hypertonic NaCL drops and/or ointment, BCL, topical steroids, cycloplegia, intracameral gas — 20% SF6 (acts as a mechanical barrier, reducing aqueous flow into the stroma through the rupture in DM)

Table 8.20 Causes of a scissoring reflex on retinoscopy

- Corneal ectasias: KC, pellucid marginal degeneration
- Corneal scars
- Tilted lens
- Irregular retina (e.g. from a RD)

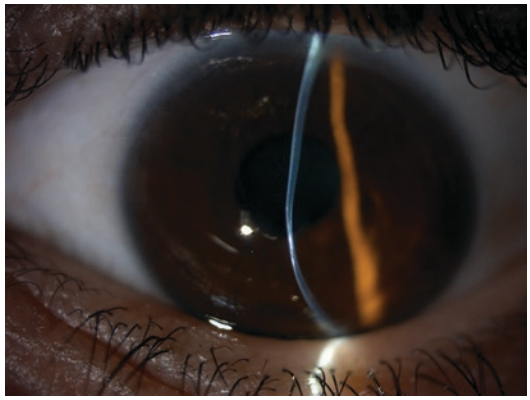

Fig. 8.27 Anterior segment image of a patient with pellucid marginal degeneration with inferior corneal thinning and corneal protrusion above the area of inferior thinning

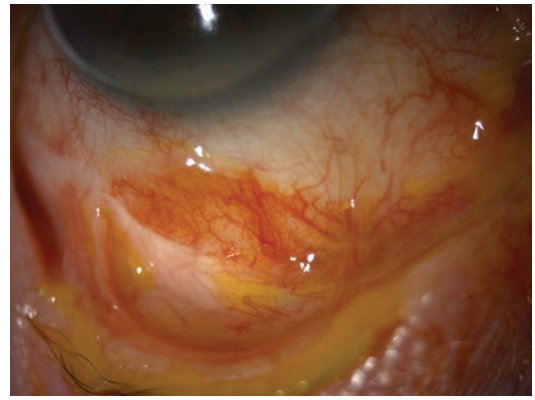

Fig. 8.28 Anterior segment image of a patient with OCP with symblepharon formation

8.21.6 Other Diagnoses to Consider

- Pellucid marginal degeneration: bilateral inferior corneal thinning (typically from 4 to 8 o'clock position) with maximal protrusion occurs just superior to the area of thinning (see Fig. 8.27), shift in axis of astigmatism from against-the-rule superiorly to with-the-rule near the point of maximal protrusion, crab-claw appearance on power map of corneal topography (see Fig. 2.63)
- Keratoglobus: bilateral globular protrusion of the cornea results from generalised thinning most marked in the periphery, prone to corneal rupture after minimal trauma, corneal topography reveals diffuse steepening on the power map and diffuse thinning on the pachymetric map
- Post-traumatic ectasia e.g. post-LASIK ectasia
- Protrusion of cornea subsequent to corneal thinning from ulceration

8.22 Ocular Cicatricial Pemphigoid (OCP) (Fig. 8.28)

8.22.1 Causes of Symblepharon Formation

- Steven-Johnson syndrome (SJS)/Toxic epidermal necrolysis (TEN)
- Chemical burns
- Trachoma
- Avitaminosis A
- Severe chronic keratoconjunctivitis caused by bacteria or viruses
- Medications (causing cicatricial conjunctivitis): systemic — penicillamine, topical — pilocarpine, timolol, gentamicin 1.5%)

8.22.2 History

- Exclude SJS/TEN: drug history (sulfonamides, anti-convulsants, allopurinol) and previous or current infections (mycobacteria, HSV)
- Exclude avitaminosis A: nyctalopia, history of cystic fibrosis or hx of jejunoileal bypass (fat malabsorption)
- Ask about previous chemical injury to eye
- Ask about history of trachoma

8.22.3 Examination

- OCP
  - Subepithelial conjunctival fibrosis (stage I)
  - Fornix foreshortening (stage II)
  - Symblepharon formation (stage III)
  - Ankyloblepharon and surface keratinisation of ocular surface (stage IV)
  - Progressive sicca syndrome with unstable tear film (obstruction of lacrimal

ductules and meibomian gland ducts), trichiasis and entropion occur from subepithelial fibrosis with eventual corneal neovascularisation, corneal ulceration and scarring

- SJS/TEN
  - Acute eye findings (bilateral): pseudomembranous conjunctivitis ± secondary purulent bacterial conjunctivitis, corneal ulceration, anterior uveitis
  - Chronic eye findings (bilateral): lid margin keratinisation, scarring (subconjunctival fibrosis), symblepharon formation, and cicatrization of the conjunctiva — leads to entropion formation, trichiasis, and instability of tear film (goblet cell dysfunction), keratoconjunctivitis sicca (KCS), persistent ED, corneal scarring and stromal neovascularisation, LESC failure
  - Non-ocular findings:

    SJS: erythematous macules that develop central necrosis to form vesicles, bullae, and areas of denudation on the face, trunk, and extremities, two or more mucosal surfaces are involved (conjunctiva, oral cavity, upper airway or oesophagus, GI tract, anogenital mucosa), less than 20% of body surface area involved, *TEN*: involvement of more than 30% of the body surface area, positive Nikolsky's sign (friction applied to healthy areas of skin, causing epidermis is wrinkle and separate), mucous membranes are usually involved with severe erosions of the lips, oral surface, conjunctiva, and genital areas.
- Trachoma (*C. trachomatis* Serovars A–C): follicular conjunctivitis, Herbert's pits (breakdown of follicles around limbus with subsequent tissue necrosis), Artl's line (linear scarring on the upper tarsus), cicatricial lid changes with tarsal plate contraction with accompanying trichiasis — lead to superior pannus, scarring or opacification of cornea (Table 8.22).
- Avitaminosis A: conjunctival xerosis (metaplastic keratinised surface) and Bitot spots (foamy), corneal xerosis (localised or generalised oedema with a typical dry, lackluster appearance, later the cornea may develop a "peau d'orange" appearance from keratinization), corneal ulceration/keratomalacia (frank necrosis or sloughing of the corneal stroma)

Table 8.22 WHO grading system for Trachoma

TF grade: 5 or more 0.5 mm or more in diameter follicles in upper tarsal conjunctiva
TI grade: inflammatory thickening of tarsal conjunctiva that obscures more than half of normal deep tarsal vessels
TS grade: scarring in tarsal conjunctiva
TT grade: trichiasis
CO grade: corneal opacity over pupil

8.22.4 Investigations

- OCP: conjunctival biopsy to look for linear immune deposits (must be demonstrated before treatment initiated) along the epithelial basement membrane zone (immunofluorescence microscopy — Michel's transport medium)
- SJS/TEN: bloods for raised inflammatory markers, conjunctival biopsy to look for absence of goblet cells in SJS, referral to dermatologists/plastic surgery for skin biopsy in TEN
- Avitaminosis A: vitamin A levels
- Trachoma: swabs for immunofluorescent staining, cell culture, PCR, ELISA

8.22.5 Treatment

- OCP
  - Treat sicca syndrome (artificial tears, ointments, punctal occlusion if Schirmer values less than 5 mm/5 min)
  - Treat chronic blepharitis and meibomitis (warm compresses, lid hygiene, oral doxycycline 100 mg OD for 3 months then 50 mg OD)
  - Immunomodulatory therapy if cases that are active and rapidly progressive (mild: dapsone + oral prednisolone, moderate:

MTX, AZT or MMF + oral prednisolone, severe: IV/PO cyclophosphamide + oral prednisolone)
  - Keratoprosthesis for stage IV disease
- SJS/TEN
  - Systemic disease: refer to intensive burn care unit for monitoring of fluid balance, respiratory function, nutritional requirements, and wound care
  - Ophthalmic disease — acute stage: frequent conjunctival irrigation + prophylactic topical antibiotics to prevent secondary infection, frequent PF topical lubricants (lubricate conjunctival and corneal epithelium), cycloplegics (anterior uveitis), topical steroids but monitor for secondary bacterial keratitis (anterior uveitis), lamellar keratoplasty or PK if perforation impending or occurs, conjunctival flap (Gunderson flap) for an impending perforation, daily lysis of the symblepharon or placement of a symblepharon ring
  - Ophthalmic disease — chronic stage: repair cicatricial entropion and treat trichiasis (epilation, electrolysis, cryotherapy), frequent PF topical lubricants to treat KCS, fornix reconstruction through mucous membrane grafts, BCLs, AMG or tarsorrhaphy for persistent ED, limbal stem cell transplant for LECS failure, keratoprosthesis for end stage corneal scarring and neovascularisation
- Avitaminosis A
  - Vitamin A supplementation
- Trachoma
  - TF grade — azithromycin 1 g PO, TT grade — bilamellar tarsal rotation, TI grade — azithromycin 1 g PO, TS grade — lubricants (infection no longer present at TS stage and so antimicrobial therapy is not useful), CO grade — PK

8.23 Penetrating Keratoplasty (PK)

8.23.1 Definition

- Transplant procedure in which full-thickness host corneal tissue is replaced with donor tissue

8.23.2 Examination

- Examine for a full thickness graft with no graft-host interface present to identity patients who have had a PK surgical procedure

8.23.3 Indications

- Visual (restoration of corneal clarity): keratoconus, pseudophakic/aphakic corneal oedema, FED, deep stromal corneal dystrophies, corneal scarring secondary to herpes simplex keratopathy, infections, trauma
- Tectonic (restoration of structural integrity): corneal thinning, actual or threatened perforation
- Therapeutic: infective keratitis

8.23.4 Contraindications

- Relative
  - Epithelial dysfunction secondary to limbal stem cell deficiency (aniridia, chemical injuries), severe neurotrophic, and dry eye states
  - Stromal vascularisation, especially when involving more than two quadrants
  - Multiple (two or more) graft failures

8.23.5 Advantages of PK

- Familiarity

8.23.6 Disadvantages of PK

- Higher risk of graft rejection
- Risk of suture-related complication
- Risk of traumatic wound dehiscence and globe rupture

8.23.7 Complications

- Intraoperative
  - Scleral perforation from bridal suture placement or scleral ring placement

  - Damage to donor cornea
  - Trephine reversal: causes unwanted hyperopia and difficulty in closing wound
  - Retained Descemet's membrane: suggested by presence of double AC on post-op day 1 (patient will need re-grafting)
  - Iris-lens damage during trephination
  - AC haemorrhage from iris damage
  - Suprachoroidal expulsive haemorrhage
- Early postoperative
  - Wound leaks (shallow AC, seidel positive): if leak controlled with BCL resuturing is not necessary
  - Epithelial defect: treat with lubricants, topical antibiotics ± BCL ± tarsorrhaphy, decrease application of topical steroids
  - Filamentary keratitis: treat with lubricants and removal
  - Suture-related complications:
    Infection
    Immune infiltrates: multiple on recipient side of cornea and treated with intensive topical steroids and removal of suture
    Endophthalmitis
    Kaye dots: small epithelial dots a short distance from sutures on the donor side — not pathologic and usually disappear after suture removal
  - Glaucoma
  - Anterior synechiae: increases graft oedema and risk of rejection — postop dilatation increases AC depth
  - Pupillary block: shallow AC, raised IOP, intact wound — aqueous misdirection, choroidal detachment
  - Urrets-Zavalia pupil: irregular pupil a few days post PK for KC — iris stromal atrophy, ectropion uvea, multiple posterior synechiae, discrete subcapsular opacities
- Late postoperative
  - Graft failure (see Fig. 8.29): causes include immunologic rejection, poor donor quality, intraoperative trauma to donor endothelium, prolonged flat AC in the immediate postoperative period, HSV reactivation

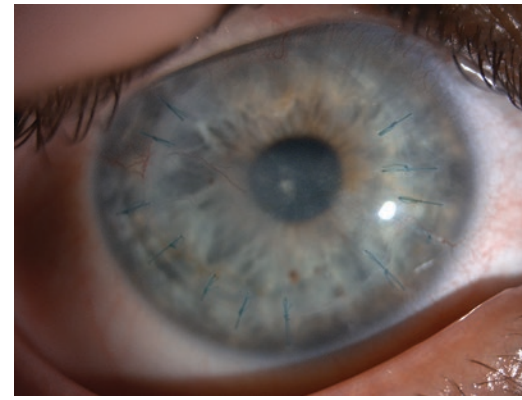

Fig. 8.29 Anterior segment image of a patient with a failed penetrating keratoplasty showing diffuse corneal haze with stromal neovascularisation

  - Immunologic rejection (risk of an immunologic rejection episode is constant over the first 3 years after transplantation):
    Epithelial rejection: elevated epithelial rejection line that stains with fluorescein — responds to topical steroids
    Subepithelial infiltrates: immune reaction seen only in the donor tissue without associated conjunctivitis — responds to topical steroids
    Endothelial rejection line (Khodadoust line): does not extend beyond graft-host junction with KP's at the leading edge with an overlying hazy and oedematous stroma ± DM folds — if left untreated this line will proceed across the donor endothelium from the point of origin at the graft wound leaving damaged endothelium behind it — treat with intensive topical steroids or IV methylprednisolone
    Diffuse endothelial rejection: isolated or diffuse KPs are scattered across the endothelium and are limited to the donor endothelium and often associated with an AC reaction — treat with intensive topical steroids or IV methylprednisolone)
    Post-operative astigmatism

8.23.8 Risk Factors for Immunologic Rejection (Poor Prognostic Factors)

- Corneal stromal vascularisation
- Reduced corneal sensation
- Ocular surface disease (Dry eye, OCP, SJS)
- Previous graft failure
- Large graft size (8–8.5 mm) and eccentric grafts
- Uncontrolled glaucoma
- Active or recurrent herpetic inflammation

8.23.9 Penetrating Keratoplasty in Children

- Preoperative complications
  - Need for frequent topical drop applications
  - Requirement of frequent postoperative visits
  - Commitment to amblyopia therapy
- Intraoperative complications
  - Higher posterior pressure: forward displacement of lens and iris with increased risk of iris prolapse, lens extrusion, suprachoroidal haemorrhage
  - Smaller donor grafts and more pliable tissue with more difficulty with suturing
- Postoperative complications
  - Stronger inflammatory response to surgery than adults: increased risk of graft rejection and failure, contraction of tissue at the 360° interface between host and donor tissue can lead to loosening of the sutures which is a risk factor for suture abscesses and neovascularisation of the corneal tissue
  - Frequent application of topical steroids to reduce high risk of rejection
  - High risk of infection: loose sutures, wound dehiscence, high dose of topical steroids — longer use of prophylactic topical antibiotics
  - Amblyopia: high rate of vision loss despite clear graft
- Prognosis
  - Only about 33% of the grafts performed for Peter's anomaly, Sclerocornea, or intrauterine infection were clear at 1 year
  - In infants less than 1 year old, only 25% of grafts were clear at 1 year
  - In children between 1–4 years old, about 50% were clear at 1 year
  - In children older than 4 years, about 65% were clear at 1 year

8.24 Deep Anterior Lamellar Keratoplasty (DALK) (Fig. 8.30)

8.24.1 Definition

- Surgical technique whereby the majority of the corneal stroma down to the Descemet's membrane is replaced by donor tissue, leaving the host endothelium intact

8.24.2 Examination

- Examine for a graft-host interface to identify patients who have had a DALK surgical procedure

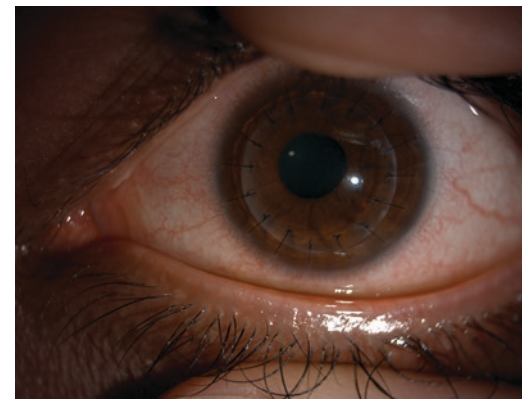

Fig. 8.30 Anterior segment image of a patient who had a DALK procedure

8.24.3 Indications

- Visual: corneal ectasias, stromal dystrophies sparing Descemet's membrane and endothelium, corneal stromal scars from previous infections or chemical injuries
- Tectonic: descemetocoele, pellucid marginal degeneration, advanced Terrien's marginal degeneration, peripheral corneal melts from autoimmune disorders (e.g. rheumatoid arthritis)

8.24.4 Contraindications

- Absolute: endothelial dysfunction
- Relative: epithelial dysfunction

8.24.5 Advantages of DALK

- Preserve host endothelium
- Lower incidence of graft rejection

8.24.6 Disadvantages of DALK

- Working near or at Descemet's membrane with potential risk for perforation

8.24.7 Complications

- Intraoperative
  - Perforations and ruptures of Descemet's membrane during trephination, stromal dissection or with a suture needle
- Postoperative
  - Urrets-Zavalia syndrome (fixed dilated pupil from irreversible damage to the iris sphincter): associated with air/gas injection into the AC at the end of surgery
  - Suture-related complications:
    - Loosening of sutures
    - Suture abscesses
  - Stromal rejection

8.25 Descemet Stripping Automated Endothelial Keratoplasty (DSAEK) (Fig. 8.31)

8.25.1 Definition

- Partial thickness cornea transplant procedure that involves selective removal of recipient Descemet's membrane and endothelium, followed by transplantation of donor corneal endothelium in addition to donor corneal stroma

8.25.2 Examination

- DSAEK grafts can be visualised as a subtle ring in the diffuse illumination and can be seen protruding posteriorly from the cornea in the inferior aspect of the slit beam.

8.25.3 Indications

- Endothelial dystrophy: FED, posterior polymorphous corneal dystrophy
- Bullous keratopathy: aphakia, pseudophakia
- Endothelial failure: trauma, previous surgery, angle closure, tubes

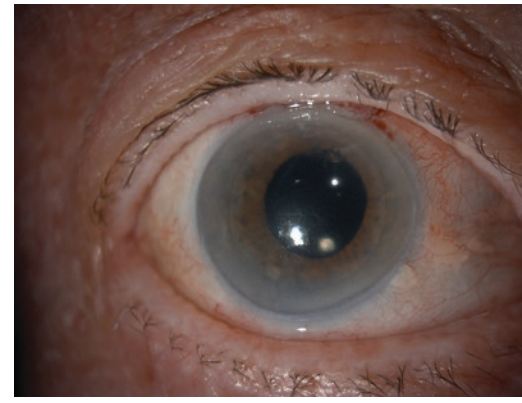

Fig. 8.31 Anterior segment image of a patient who had a DSAEK procedure

- ICE syndrome
- Failed PK — if acceptable refractive result was achieved

8.25.4 Contraindications

- Stromal opacity or scarring that limits visual potential
- Keratoconus, ectasia
- Hypotony/pre-phthisical eye

8.25.5 Advantages of DSAEK

- No suture-related complications
- Reduced incidence of graft rejection
- Rapid visual rehabilitation

8.25.6 Disadvantages of DSAEK

- Possible interface haze and deposits
- Potential significant loss of donor endothelium during surgical procedure
- Risk of graft dislocation

8.25.7 Complications

- Intraoperative
  - Complications with donor tissue preparation: damaged donor tissue, eccentric trephination, thin donor tissue (increase chance of graft striae)
  - Retained Descemet's membrane: prevents proper attachment of the DSAEK graft
  - Air management: donor tissue attachment appears to be dependent on the maintenance of air in the AC (challenge in aphakic eyes or pseudophakic eyes with an open posterior capsule and in patients with previous trabeculectomy or glaucoma drainage implants)
- Postoperative
  - Donor dislocation (methods to avoid: cornea surface massage with a flap roller, vents are made in the midperipheral recipient cornea down to the graft interface)
  - Primary graft failure (graft failing to clear within the first 2 weeks after the op):
    Primary failure: unhealthy donor endothelial, inadequate preservation of the corn, or traumatic pre- or intraoperative technique
    Secondary failure: graft rejection, detached donor from residual fluid or viscoelastic in interface, retained Descemet's membrane
  - Graft rejection: presence of AC cells ± KP's and concomitant corneal oedema
  - Pupillary block glaucoma: due to placement of excessively large gas bubble in the AC or migration of the air bubble behind the iris — tx by partial evacuation of the air bubble and concurrent replacement with BSS to maintain the AC
  - Endothelial cell loss
  - Refractive change: hyperopic refractive shift post DSAEK
  - Interface deposits and epithelial ingrowth: epithelial cells may be dragged onto stromal surface during insertion of the donor tissue — if epithelial ingrowth does not progress to the visual axis and if the donor is well attached to the recipient surface, the patient can be followed closely without surgical intervention

8.26 Anterior Scleritis (Fig. 8.32 and Table 8.23)

8.26.1 Associations of Scleritis

- Non-infectious: systemic diseases (RA, GPA, relapsing polychondritis, PAN, IBD, SLE, Churg-Strauss syndrome), surgically induced (strabismus surgery, trabeculectomy, cataract extraction, RD repairs, pterygium excisions)
- Infectious: traumatic ± FB, post-surgical, extension from other structures (keratitis, choroiditis, endophthalmitis, conjunctivitis, orbital cellulitis, sinusitis, dacryocystitis)

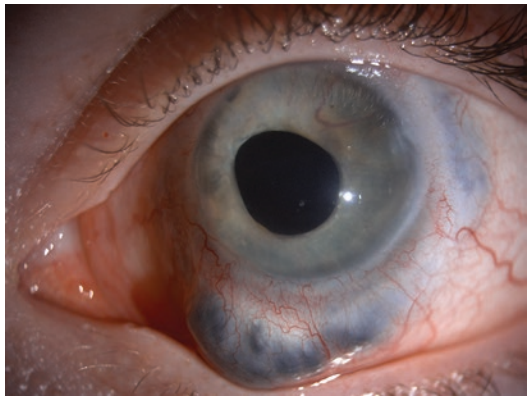

Fig. 8.32 Anterior segment image of a patient with multiple previous episodes of scleritis showing severe scleromalacia with diffuse purple or blackish hue from increased uveal visibility. There is a large area of uveal protrusion with only a thin layer of conjunctiva overlying the uvea

Table 8.23 Causes of a blue sclera

- Scleritis
- Osteogenesis Imperfecta: hx of fractures (brittle bones), hyperextensibility of the joints, sensorineural hearing loss, hyperopia
- Connective tissue disorders: Ehlers-Danlos syndrome (ectopia lentis, RD, hyperelasticity and fragility of the skin), Marfan's syndrome (ectopia lentis, RD, myopia, arachnodactyly, high arched palate), Pseudoxanthoma elasticum — PXE (angioid streaks ± CNV, optic disc drusen, yellowish lumps on the skin of the neck, axillae, and antecubital fossa)
- Keratoconus/Keratoglobus

8.26.2 History

- Scleritis: severe pain enough to awaken patient at night
- Episcleritis: mild discomfort or FB sensation
- POHx of previous ocular surgeries
- PMHx of any systemic diseases (GPA — sinusitis, bloody nasal discharge, saddle nose, relapsing polychondritis — degenerative pinna cartilage)

8.26.3 Examination

- Anterior scleritis (no blanching with topical phenylephrine): diffuse (distortion and tortuosity of both episcleral and scleral vascular networks, post resolution the sclera appears translucent or bluish-gray suggesting thinning of the sclera), nodular (firm, immobile, and tender yellow to deep red nodule to palpation), necrotising with inflammation (white avascular areas of sclera and conjunctiva, with surrounding scleral oedema and congestion, blue-black uveal tissue may appear as the overlying sclera becomes thin and translucent), necrotising without inflammation (scleromalacia perforans — complete lack of symptoms with thinned and avascular areas of episclera and sclera with no surrounding inflammation)
- Posterior scleritis: choroidal folds, choroidal effusions, exudative RD, CMO, optic disc oedema
- Examine hands for RA: swollen MCP, PIP, wrist, or MTP joints, Z-deformity of thumb, swan-neck and Boutonniere deformity of fingers
- Examine for skin rashes: SLE (discoid rash, malar rash), PAN (livedo reticularis)

8.26.4 Investigations

- B-scan: T-sign — posterior scleritis
- Bloods: c-ANCA (GPA, PAN), p-ANCA (Churg-Strauss syndrome), ANA (SLE), rheumatoid factor (RA), anti-CCP (RA), HLA-B27 (IBD)
- CXR: GPA (pulmonary haemorrhage), Churg-Strauss syndrome
- Urinalysis: proteinuria and haematuria (GPA)

8.26.5 Treatment

- Oral NSAIDS: reduce pain and inflammation in non-necrotising scleritis
- Systemic corticosteroids: indicated in severe non-necrotising scleritis unresponsive to oral NSAIDs and in necrotising scleritis — oral prednisolone at a starting dose of 1 mg/kg/day followed by a slow taper according to response
- Systemic immunosuppressants: indicated in cases of necrotising scleritis and scleritis of any type in the setting of GPA (cyclophospha-

mide) or PAN, or when maintenance dose of oral prednisolone ≤7.5 mg OD is not possible without recurrence of disease

8.26.6 Other Diagnoses to Consider

- Episcleritis: simple: sectoral or diffuse redness which blanches with topical phenylephrine, globe non-tender, no investigations required unless history suggestive of systemic disease, treatment with topical lubricants, oral NSAIDS, topical corticosteroids / nodular: red nodule arising from episclera that can be moved separately from the sclera and conjunctiva, globe non-tender, blanches with topical phenylephrine, no investigations required unless history suggestive of systemic disease, treat as for simple episcleritis
- Peripheral ulcerative keratitis (PUK): unilateral crescent-shaped peripheral corneal ulceration with overlying epithelial defect and stromal thinning, sectoral or diffuse scleritis, treatment involves ensuring adequate tear film (lubricants, punctal plugs, punctal cautery), prophylactic topical antibiotics, oral doxycycline and oral vitamin C (inhibit proteases and free radicals, respectively), systemic immunosuppression (liaise with rheumatologist, corticosteroids — IV methylprednisolone or oral prednisolone, MTX, AZT, MMF, ciclosporin, cyclophosphamide), BCL + cyanoacrylate glue for pending/actual perforation, conjunctival recession, tectonic freehand lamellar keratoplasty, conjunctival flaps
- Mooren's ulcer: diagnosis of exclusion (rule out Hepatitis C), unilateral peripheral ulceration with stromal melt with leading edge undermining epithelium, ulcer advances centrally and circumferentially, no associated scleritis (but conjunctiva and episcleral inflammation), treatment similar to PUK — nay require interferon if coexistent hepatitis C (as directed by hepatologist)

8.27 Limbal Epithelial Stem Cell (LESC) Deficiency (Fig. 8.33)

8.27.1 Causes

- LESC deficiency occurs when there is sufficient disturbance or destruction of the limbal stem cells of the corneal epithelium, resulting in disruption of the normal physiologic regenerative process and repopulation of corneal epithelium
- Typical causes include
  - Aniridia
  - Chemical (alkali injury) or thermal injury
  - Chronic contact lens wear
  - Preservative drop toxicity
  - OCP
  - SJS/TEN
  - Ocular surgery: multiple previous pterygium excisions

8.27.2 History

- History of ocular chemical injuries
- History of contact lens wear
- History of ocular surgeries e.g. pterygium surgery
- History of aniridia

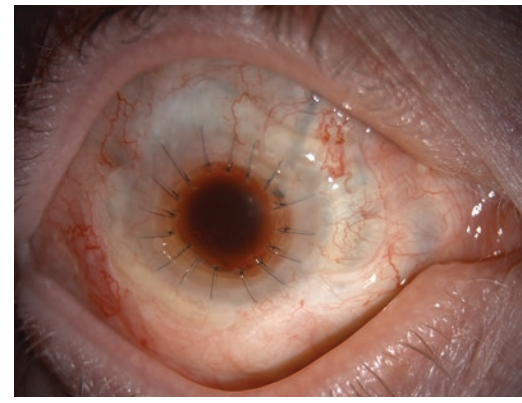

Fig. 8.33 Anterior segment image of a patient with congenital aniridia who had a limbal stem cell transplantation

8.27.3 Examination

- Examine for loss of palisades of Vogt, late staining of the corneal epithelium with fluorescein, persistent epithelial defects, corneal neovascularisation, corneal scarring, and the development of a peripheral pannus
- A "whorled" appearance of the corneal epithelium (results from conjunctivalisation of the corneal epithelium — invasion of conjunctival epithelium onto the corneal surface — occurs when <25–33% of LESC remain)
- Examine for a limbal stem cell transplant graft

8.27.4 Investigations

- Impression cytology (nitrocellulose paper is pressed onto cornea and examined under the microscope): presence of mucin-containing goblet cells on the corneal epithelium and the absence of normal differentiation markers of corneal epithelium (CK 3 and 12)

8.27.5 Treatment

- Any chronic inflammation of the conjunctiva, conjunctival scarring, symblepharon formation, trichiasis, and MGD must be identified and treated prior to limbal stem cell grafting
- Partial: conjunctivalised metaplastic epithelium on cornea — if visual axis affected: sequential sector conjunctival epitheliectomy + AMG, if visual axis is not affected: sequential sector conjunctival epitheliectomy, with fibrovascular pannus — sector limbal transplant + AMG
- Total: unilateral — conjunctival limbal autograft (CLAU) from contralateral better eye, bilateral — living-related keratolimbal allograft (CLAL), cadaveric CLAL

8.28 Gundersen Flap (Fig. 8.34)

8.28.1 Definition

- A Gundersen flap is a surgical technique that uses a thin, bipedicle, total conjunctival bridge flap to achieve a number of purposes including
  - To restore the integrity of a compromised ocular surface
  - To provide a metabolic and mechanical support for corneal healing
  - To relieve pain
  - To provide an alternative to invasive surgery or enucleation

8.28.2 Indications

- Persistent corneal epithelial defect
- Unresponsive ulcerative microbial keratitis
- Corneal thinning and perforation

8.28.3 Advantages

- Can improve quality of life in patients with an eye with poor visual potential and a chronically irritated anterior segment

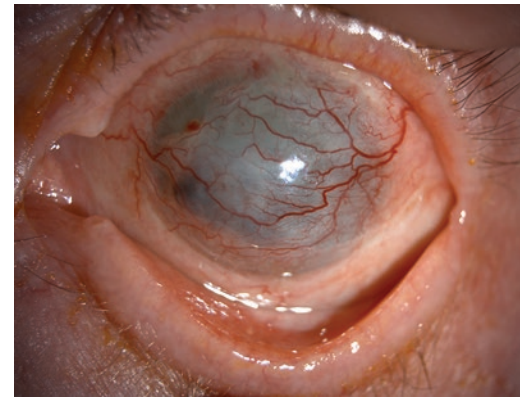

Fig. 8.34 Anterior segment image of a patient with a Gundersen flap

- Can eliminate the need for chronic medication and bandage lenses

8.28.4 Disadvantages

- Vision significantly decreased by the conjunctival flap that covers the visual axis
- Prevents monitoring of disease progression by obstructing any view of the cornea and anterior chamber
- Poor cosmetic appearance

8.28.5 Complications

- Intraoperative
  - Buttonhole formation
  - Dissection of an inadequate flap
  - Excessive haemorrhage
- Postoperative
  - Ptosis
  - Retraction of the flap
  - Vascularisation and opacification of the underlying cornea

Glaucoma and Lid

9

Timothy H. M. Fung and Winfried M. K. Amoaku

9.1 Pseudoexfoliation (PXF) Syndrome
(Fig. 9.1 and Table 9.1)

9.1.1 Risk Factors

- Female sex
- Increasing age
- Polymorphisms in LOXL1 (lysyl oxidase-like 1) gene

9.1.2 Examination

- Whitish dandruff-like material on pupillary border and anterior lens capsule (centrally and peripherally with clear intermediate zone)
- Peripupillary transillumination defects
- Poor mydriasis
- Iridodonesis/phacodonesis

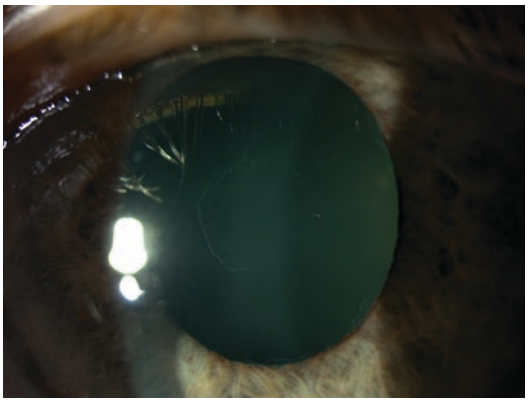

Fig. 9.1 Anterior segment image of a patient with PXF syndrome showing the whitish dandruff-like material on the lens capsule

Table 9.1 Useful information about PXF syndrome

• A systemic condition in which white dandruff like material is deposited over the anterior segment of the eye and other organs such as the heart, skin, lungs, kidneys

- Cataract: nuclear, PSC
- Check IOP
- Perform gonioscopy (Table 9.2)
  - Open angle
  - Closed angle from weak zonules with anterior movement of lens-iris diaphragm
  - Increased but irregular TM pigmentation
  - Flecks of PXF material
  - Sampaolesi's line — pigmented line anterior to Schwalbe's line

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Table 9.2 Locating Schwalbe's line on gonioscopy

- Finding Schwalbe's line on gonioscopy: dark room, short narrow slit beam at oblique angle, identified by the corneal wedge that is created at the junction between the inner light beam along the corneal endothelium and the outer light beam along the corneoscleral junction

- Examine the optic nerves to look for signs of glaucoma:
  - Generalised signs: CDR 0.7 or more, asymmetry of CDR of 0.2 or more, progressive enlargement of cup
  - Focal signs: rim thinning/notching (ISNT rule), regional pallor, NFL haemorrhage, NFL loss

9.1.3 Investigations

- HVF
  - Early: paracentral defect, nasal step — IT or ST rim thinning, temporal wedge — nasal disc thinning
  - Late: arcuate defect, double arcuate defect, central vision only
  - Ensure VF defects correlate with optic nerve head findings

9.1.4 Treatment

- If raised IOP: medical, SLT, trabeculectomy (higher complication rate but similar overall success to trabeculectomy in POAG)
- Cataract extraction if IOP controlled: weak zonules (CTR), small pupil (I/C phenylephrine, Iris hooks)

9.1.5 Prognosis

- Compared to POAG, the disease course is more severe, with poorer response to medical therapy and more frequent need for surgery
- Glaucoma risk: 1% at 1 year, 5% at 5 years, 15% at 15 years

9.2 Pigment Dispersion Syndrome (PDS) (Fig. 9.2 and Table 9.3)

9.2.1 Risk Factors for PDS

- Myopia
- Age 20–40
- Male sex
- Caucasian ethnicity

9.2.2 Risk Factors for Conversion of PDS to Pigmentary Glaucoma

- Male gender
- Black race
- Higher degrees of myopia
- Krukenberg spindles

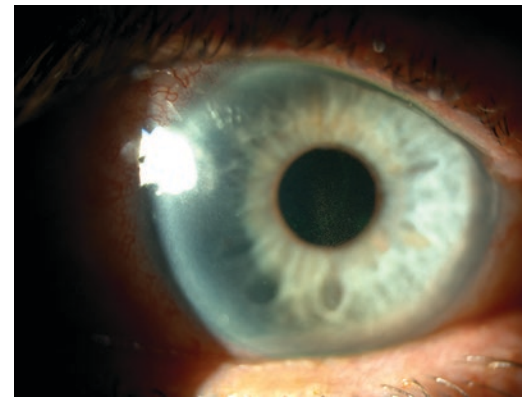

Fig. 9.2 Anterior segment image of a patient with PDS showing a krukenberg spindle

Table 9.3 Useful information about PDS

- A condition characterised by the release of pigment from the mid-peripheral posterior surface of the iris, from where it is distributed around the anterior segment
- Pigment release is thought to occur as a result of posterior bowing of the mid peripheral iris rubbing against the zonules
- Reverse pupillary block: AC pressure greater than PC pressure (pushing peripheral iris backwards against the lens zonules)

9.2.3 Examination

- Krukenberg spindle: pigment on the endothelium in a vertical line
- Mid-peripheral spoke like iris transillumination defects
- Scheie strip: pigment deposit along the insertion of the zonular fibers to the anterior lens capsule
- Check IOP
- Perform gonioscopy
  - Open angle
  - 360° of homogenous pigmentation of TM (see Fig. 9.3)
  - Sampaolesi's line
  - Posterior bowing of the iris
  - Dilated fundus exam:
    Look at optic disc for signs of glaucoma:
    - Generalised signs: CDR 0.7 or more, asymmetry of CDR of 0.2 or more, progressive enlargement of cup
    - Focal signs: rim thinning/notching — ISNT rule, regional pallor, NFL haemorrhage, NFL loss

    Look at the peripheral retinal for lattice degeneration

9.2.4 Investigations

- HVF
  - Early: paracentral defect, nasal step (IT or ST rim thinning), temporal wedge (nasal disc thinning)
  - Late: arcuate defect, double arcuate defect, central vision only

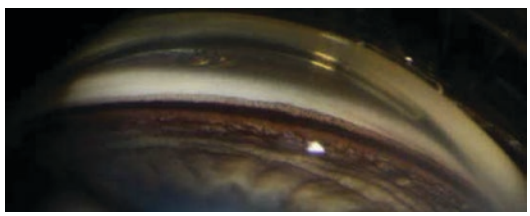

Fig. 9.3 Gonioscopic view of a patient with PDS syndrome showing homogenous pigmentation of the TM

9.2.5 Treatment

- If IOP raised
  - Medical
  - SLT: good response initially — less effective in patients who are older and who have had glaucoma for a longer period of time — use lower initial power settings to reduce post laser IOP spike
  - Trabeculectomy: increased risk of post-op hypotonus maculopathy
- With increasing age, there is an apparent improvement or at least an arrest in the disease process — postulated to result from an increasing AL of the lens over time, which lifts the peripheral iris off the lens zonules, preventing the rubbing between iris and zonules and the subsequent release of pigment granules

9.2.6 Role of PI in PDS/Pigmentary Glaucoma

- Insufficient evidence of high quality on the effectiveness of PI for pigmentary glaucoma or PDS

9.2.7 Other Diagnoses to Consider

- Trauma: surgical (pigment dispersion with PCIOL — rubbing of lens haptic and optic against posterior iris — transillumination defects corresponding to position of lens haptic and edges of optic) and non-surgical (angle-recession)
- Uveitis: photophobia, KP's, cells/flare, PS, gonioscopy (PAS, increased TM pigmentation but is seen as irregular clumps of pigment randomly dispersed, usually in the inferior quadrants/widened ciliary body band in angle recession)
- POAG with increased pigmentation: TM pigmentation tends to be more segmental, patients typically older

9.3 Neovascular Glaucoma (NVG) (Fig. 9.4)

9.3.1 Causes of NVG

- Retinal ischaemic diseases: Ischaemic CRVO (50% risk of conversion to NVG), DR, OIS, chronic RD, BRVO, CRAO, SCR
- Inflammatory diseases: Uveitis
- Tumours: iris (melanoma), retinal or choroidal

9.3.2 Examination

- Iris rubeosis: small, fine tortuous vessels at the pupillary margin, mid and peripheral anterior surface of the iris
- Ectropion uvea
- Check the IOP
- Perform gonioscopy
  - Look for NVA (see Fig. 9.5) — vessels on the TM and ciliary body band
  - Open angle or closed angle with PAS (typically ends at Schwalbe's line)
- Examine the optic nerve for signs of glaucoma:
  - Generalised signs: CDR 0.7 or more, asymmetry of CDR of 0.2 or more, progressive enlargement of cup
  - Focal signs: rim thinning/notching (ISNT rule), regional pallor, NFL haemorrhage, NFL loss)
- Dilated fundus examination to look for any underlying retinal ischaemic diseases

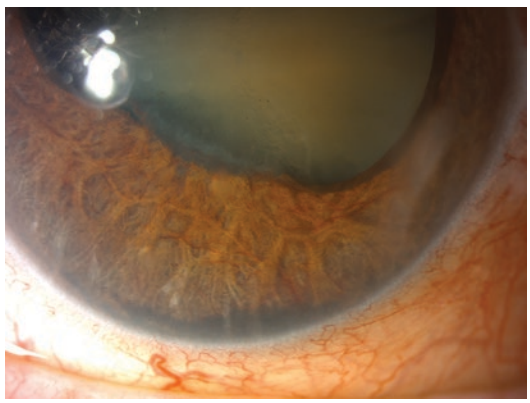

Fig. 9.4 Anterior segment image of a patient with neovascular glaucoma with NVI. The eye also has posterior synechiae and a dense cataract

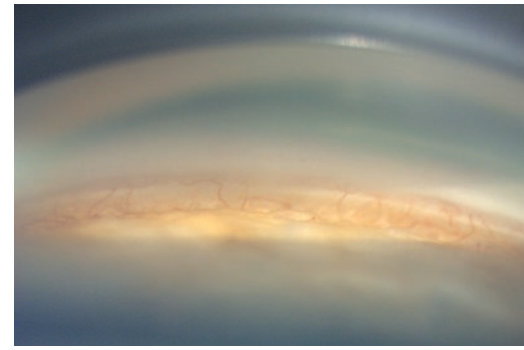

Fig. 9.5 Gonioscopic view of a patient with neovascular glaucoma with NVA

9.3.3 Investigations

- Carotid doppler US: if no retinal pathology or asymmetric DR (rule out OIS)
- B-scan US: if poor/no fundal view from dense cataract (tumours, RD)
- HVF: early: paracentral defect, nasal step — IT or ST rim thinning, temporal wedge — nasal disc thinning / late: arcuate defect, double arcuate defect, central vision only

9.3.4 Treatment

- Treat underlying cause: RD repair for RD, carotid endarterectomy for OIS
- Neovascularisation: PRP ± anti-VEGF injection
- IOP control: reduction of raised IOP with medical treatment and surgical treatment if medical treatment fails (GDI, trabeculectomy, cyclodiode — visual potential of eye will determine best surgical option for patient)
- Pain control: reduction of IOP if raised, cycloplegia, topical steroids, if vision poor and eye phthisical — retrobulbar alcohol, evisceration/enucleation

9.4 Primary Congenital Glaucoma (PCG) (Fig. 9.6 and Table 9.4)

9.4.1 Examination

- Enlargement of globe/cornea if onset less than age 4 years: Buphthalmos
- Dense corneal stromal opacification
- Curvilinear lines in Descemet's membrane (from stretching of the cornea): Haab striae
- Measure the corneal diameter (more than 13 mm)
- Check IOP
- Perform gonioscopy: high iris insertion, indistinct angle landmarks, fine iris processes
- Examine the optic disc for signs of glaucoma
  - Generalised signs: CDR 0.7 or more, asymmetry of CDR of 0.2 or more, progressive enlargement of cup
  - Focal signs: rim thinning/notching (ISNT rule), regional pallor, NFL haemorrhage, NFL loss

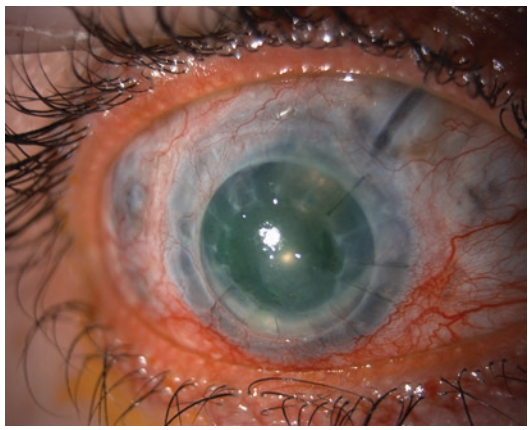

Fig. 9.6 Anterior segment image of a patient with congenital glaucoma with a tube and a failed PK graft

Table 9.4 Useful information about PCG

- Angle dysgenesis causes reduced aqueous outflow
- Typically diagnosed within first year of life but not usually at birth
- 2% chance of affected parent having affected child if no FHx of PCG
- Bilateral in 70% and more common in males
- PCG (CYP1B1 gene): first 3 years of age
- Primary juvenile glaucoma (MYOC gene): 4–16 years of age

9.4.2 Investigations

- HVF: early: paracentral defect, nasal step (IT or ST rim thinning), temporal wedge (nasal disc thinning) / late: arcuate defect, double arcuate defect, central vision only

9.4.3 Treatment

- If IOP raised/glaucoma
  - Medical treatment to lower IOP acutely
  - Surgical treatment options:
    - Goniotomy
    - Trabeculotomy
    - Trabeculectomy
    - GDI
    - Cyclodiode
- Corneal opacification
  - PK

9.5 Aphakic Glaucoma (Fig. 9.7)

9.5.1 Causes of Aphakia

- Removal of congenital cataracts without subsequent IOL implantation
- Complicated cataract surgery without IOL implantation
- Dislocated lens: trauma or connective tissue disorders
- Previous ICCE with spectacle rehabilitation
- Primary congenital aphakia

9.5.2 Mechanism of IOP Elevation in Aphakia

- Distortion of AC angle
- PAS: flat AC post-op, inflammation
- Pigment dispersion post cataract surgery

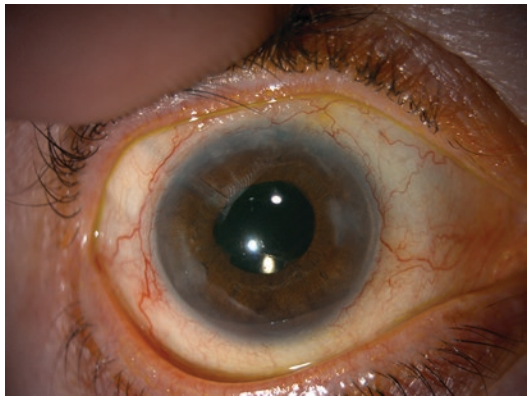

Fig. 9.7 Anterior segment image showing a GDI implant in an aphakic eye

- Pupil block (post ICCE): adherence between the iris and anterior vitreous face after a transient flat AC secondary to a wound leak

9.5.3 Complications of Aphakia

- Glaucoma
- Retinal detachment (RD): vitreous traction on retina (complicated surgery)

9.5.4 Examination

- Aphakic
- Check IOP
- Perform gonioscopy: open angle, PAS
- Examine the optic disc for signs of glaucoma
  - Generalised signs: CDR 0.7 or more, asymmetry of CDR of 0.2 or more, progressive enlargement of cup
  - Focal signs: rim thinning/notching (ISNT rule), regional pallor, NFL haemorrhage, NFL loss
- Perform a dilated fundus examination to look for a RD

9.5.5 Investigations

- HVF: early: paracentral defect, nasal step (IT or ST rim thinning), temporal wedge (nasal disc thinning)/late: arcuate defect, double arcuate defect, central vision only

9.5.6 Treatment

- Medical
- Surgical options
  - GDI's (initial surgical intervention)
  - Trabeculectomy

9.6 Sturge-Weber Syndrome (Encephalotrigeminal Angiomatosis)

(Fig. 9.8 and Table 9.5)

9.6.1 Examination

- Naevus flammeus of the face (port-wine stain) along distribution of CN V (see Fig. 9.8)
- Dilated and tortuous episcleral and conjunctival vessels
- Check IOP
- Perform gonioscopy: open angle or lack of anatomical landmarks
- Examine the optic disc for signs of glaucoma
  - Generalised signs: CDR 0.7 or more, asymmetry of CDR of 0.2 or more, progressive enlargement of cup
  - Focal signs: rim thinning/notching (ISNT rule), regional pallor, NFL haemorrhage, NFL loss
- Perform a dilated fundus examination to look for a diffuse (tomato ketchup red appearing fundus) or circumscribed choroidal haemangioma (see Fig. 9.9)

9.6.2 Investigations

- HVF: early: paracentral defect, nasal step (IT or ST rim thinning), temporal wedge (nasal disc thinning)/late: arcuate defect, double arcuate defect, central vision only
- MRI head: look for CNS haemangiomas

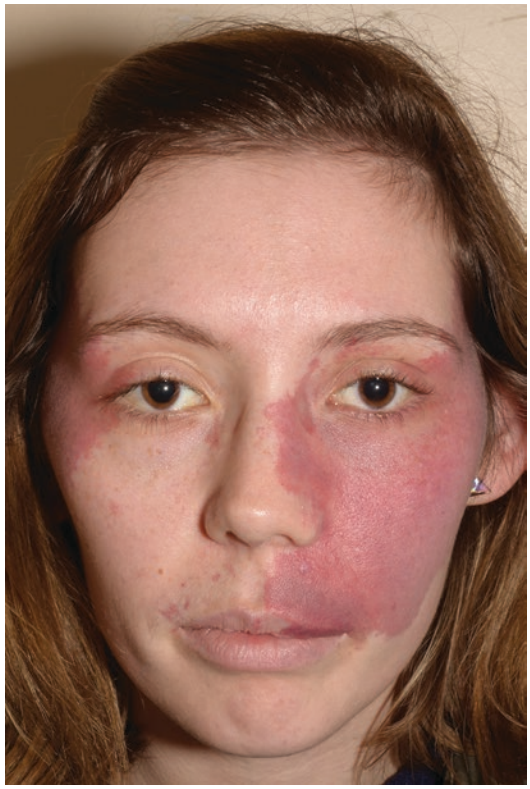

Fig. 9.8 Facial photograph of a patient with Sturge-Weber syndrome with a naevus flammeus (port-wine stain) of the face

Table 9.5 Key facts about Sturge-Weber syndrome

- Type of phakomatosis (group of disorders characterised by hamartomas: congenital tumours arising from tissue that is normally found in the involved area) that occurs sporadically (no inheritance pattern)
- No race or sex predilection
- Tumours are present at birth
- Mechanism of glaucoma: developmental anomaly AC angle before the first decade of life, elevated episcleral venous pressure after the first decade of life

9.6.3 Treatment

- If IOP high
  - Medical treatment: topical medications
  - Surgical treatment if medical treatment fails:

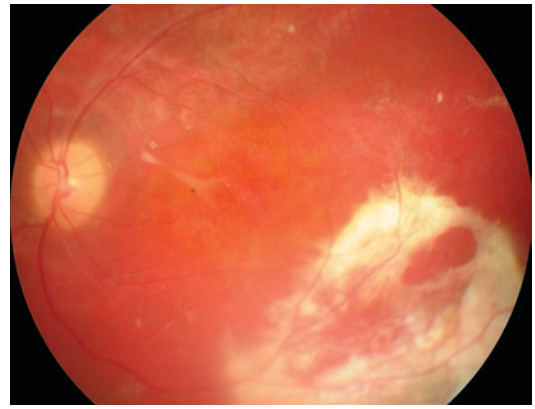

Fig. 9.9 Colour fundus image of the patient in Fig. 9.8 showing an area of chorioretinal scarring from previous external beam radiotherapy treatment for a circumscribed choroidal haemangioma

    Trabeculotomy
    Goniotomy
    Trabeculectomy (associated with intraoperative choroidal effusion ± expulsive haemorrhage) with prior prophylactic posterior sclerostomies
    GDI
    Cyclodiode
- Treat choroidal haemangiomas if associated with a secondary exudative RD: options include PDT or external beam radiotherapy
- Cosmetic appearance of the naevus flammeus of the face can be improved by laser photocoagulation in infancy or late cosmetics to cover the defect

9.7 Congenital Aniridia (Fig. 9.10 and Table 9.6)

9.7.1 History

- Positive family history of aniridia (AD inheritance)
- Always ask about family history as if case is sporadic there is a risk of WAGR syndrome (Wilms tumour — nephroblastoma, aniridia, GU abnormalities, reduced IQ)

9.7.2 Examination

- Nystagmus
- Corneal opacification with subepithelial fibrosis and peripheral pannus — LESC deficiency
- Iris hypoplasia (rudimentary iris stump)
- Cataracts
- Check IOP

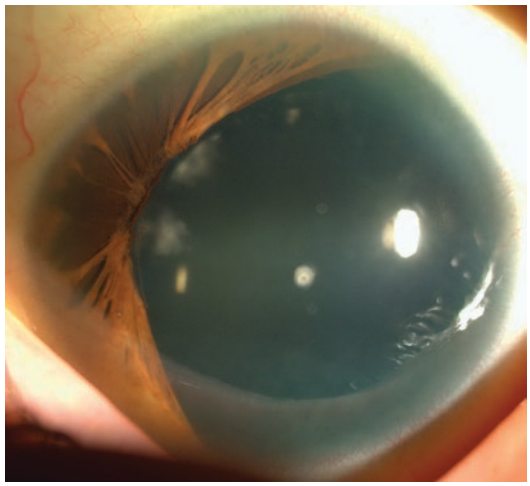

Fig. 9.10 Anterior segment image of a patient with congenital aniridia

Table 9.6 Useful information about congenital aniridia

• Congenital aniridia is a bilateral disease with complete or partial absence of iris as well as other ocular abnormalities
• AD with variable expressivity in two-thirds and sporadic in one-third
• Caused by mutations in PAX6 gene

- Examine optic nerve
  - Look for optic nerve hypoplasia
  - Look for signs of glaucoma:
    Generalised signs: CDR 0.7 or more, asymmetry of CDR of 0.2 or more, progressive enlargement of cup
    Focal signs: rim thinning/notching (ISNT rule), regional pallor, NFL haemorrhage, NFL loss
- Perform gonioscopy to look for chronic angle closure caused by blockage of TM by rudimentary iris stump rotating forward

9.7.3 Investigations

- OCT: foveal hypoplasia (see Fig. 9.11)
- Renal US: nephroblastoma
- HVF: early: paracentral defect, nasal step — IT or ST rim thinning, temporal wedge — nasal disc thinning/late: arcuate defect, double arcuate defect, central vision only

9.7.4 Treatment

- If IOP raised/glaucoma: topical medication, goniotomy (if clear cornea), trabeculotomy (if cornea cloudy), trabeculectomy — usually first surgical procedure in cases of aniridic glaucoma refractory to medical treatment, GDI's, cyclodiode in cases refractory to trabeculectomy or GDI

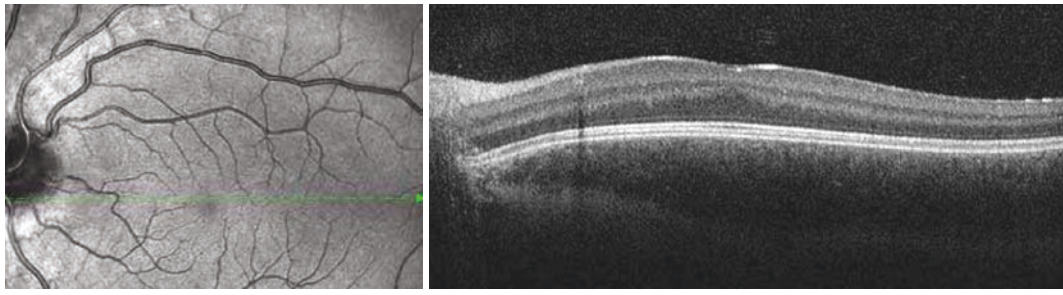

Fig. 9.11 OCT image of a patient with congenital aniridia showing foveal hypoplasia

- Keratopathy: Scleral CL, keratolimbal allograft (KLAL), Boston keratoprosthesis (KPro) for severe aniridia associated keratopathy
- Dry eye: lubricants, ointments, punctal occlusion
- Cataract extraction for visually significant cataracts — beware of fragile anterior capsule
- If patient has significant glare or photophobia (from iris atrophy, polycoria, corectopia): painted or tinted CL

9.7.5 Other Diagnoses to Consider

- Trauma: post-surgical or non-surgical
- Rieger syndrome (see Sect. 9.8)
- ICE syndrome (findings are unilateral)
  - Essential iris atrophy: corectopia, iris atrophy with polycoria (iris hole formation), guttata (fine hammered silver appearance) ± corneal oedema, ectropion uveae, gonioscopy shows broad based PAS extending to and beyond Schwalbe line
  - Cogan-Reese syndrome: unilateral multiple diffuse brown nodules on anterior surface of iris, guttata (fine hammered silver appearance) ± corneal oedema, ectropion uveae, iridocorneal adhesions, pupil distortion ± corectopia, gonioscopy shows broad based PAS extending to and beyond Schwalbe line
- Gillespie syndrome: AR, ataxia

9.8 Rieger Syndrome (Fig. 9.12)

- Anterior segment dysgenesis (failure of the normal development of the anterior segment of the eye)

9.8.1 History

- Positive family history (AD)

9.8.2 Examination

- Findings tend to be bilateral
- Posterior embryotoxin (see Fig. 9.12)

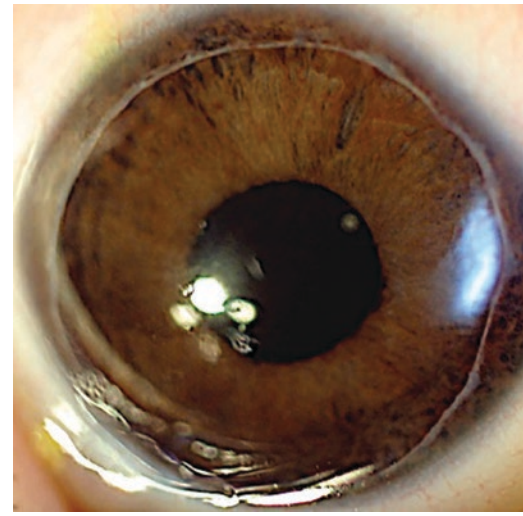

Fig. 9.12 Anterior segment image of a patient with Rieger syndrome showing a posterior embryotoxin and iris atrophy

- Iris atrophy/iris hypoplasia
- Corectopia
- Polycoria (multiple holes in the iris)
- Visible pupil sphincter against the hypoplastic iris stroma
- Check IOP
- Perform gonioscopy: prominent Schwalbe line, iris strands bridging the AC angle from the peripheral iris to the prominent ridge
- Examine the optic disc for signs of glaucoma
- Systemic examination to look for redundant periumbilical skin, microdontia, oligodontia

9.8.3 Investigations

- HVF: early: paracentral defect, nasal step — IT or ST rim thinning, temporal wedge — nasal disc thinning/late: arcuate defect, double arcuate defect, central vision only

9.8.4 Treatment

- If IOP raised/glaucoma: medical, surgical — goniotomy, trabeculotomy, trabeculectomy, GDI, cyclodiode

- If patient has significant glare or photophobia (from iris atrophy, polycoria, corectopia): painted or tinted CL

9.8.5 Other Diagnoses to Consider

- ICE syndrome: unilateral, guttata, lack of systemic abnormalities, manifestation in middle age, female predominance
- Peters anomaly: central corneal opacity with absence of DM and endothelium, iridocorneal adhesions

9.9 Trabeculectomy (Fig. 9.13 and Table 9.7)

9.9.1 Indications

- Failure to control IOP with MTMT
- Patient intolerant of topical medications
- Patient wishes to be drop free

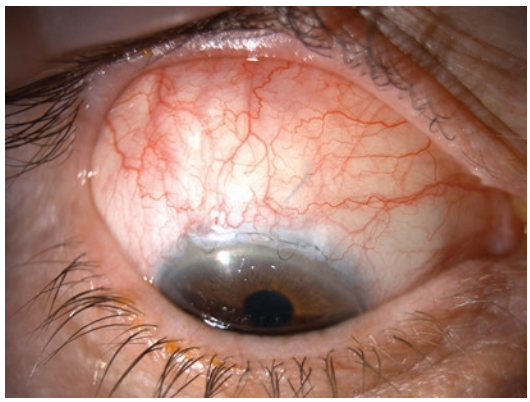

Fig. 9.13 Anterior segment image of a patient with a trabeculectomy

Table 9.7 Useful information about trabeculectomies

• A filtering surgical procedure that creates an opening, or fistula, at the limbus, which allows a direct communication between the AC and subconjunctival space, with the subsequent formation of a filtering bleb (elevation of conjunctiva at the surgical site)
• Fistula bypasses the TM, Schlemm canal, and collecting channels
• First line treatment if patient has advanced disease and needs lower IOP's or if patient is at high risk of progression

9.9.2 Description of Bleb Morphology

- Area
  - Diffuse: thin-walled blebs with large surface area and low elevation
  - Flat: blebs showing no important signs of bleb development such as elevation or microcysts
- Vascularity
  - Avascular
  - Similar to adjacent conjunctiva
  - Increased
  - Massive
- Corkscrew vessels
  - None
  - In one third
  - In two thirds
  - Entire bleb
- Microcysts
  - None
  - Over the scleral flap
  - Lateral or medial aspect of the scleral flap
  - Entire bleb
- Encapsulation (thick-walled blebs with cystic appearance, high elevation and a well demarcated area — see Fig. 9.14)
  - None
  - In one-third
  - In two-thirds
  - Entire bleb

9.9.3 Complications and its treatment

- Intraoperative: tearing or buttonholing of the conjunctival flap, haemorrhage (episcleral, choroidal), choroidal effusion, vitreous loss, lens injury, tearing of scleral flap from its limbal hinge
- Early postoperative
  - Hypotony (IOP <6 mmHg) and flat/shallow AC:

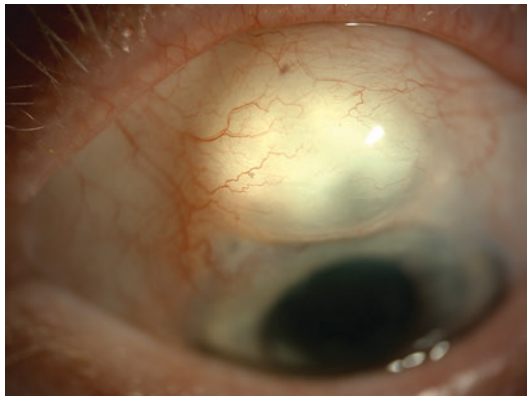

Fig. 9.14 Anterior segment image of a patient with an encapsulated bleb

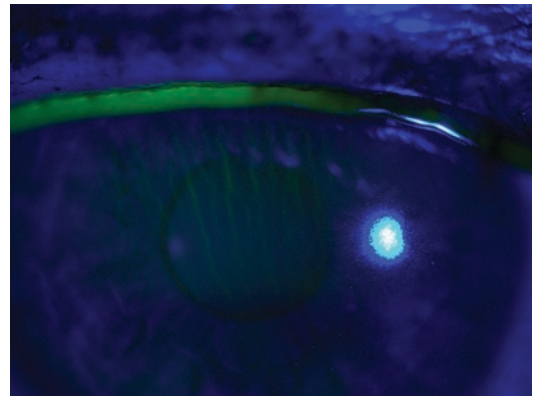

Fig. 9.15 Anterior segment image of a patient with hypotony post trabeculectomy. Fluorescein staining shows Bowman's folds, an early sign of ocular hypotony

Conjunctival defect/leak (flat bleb) — pressure patching (check leak again in 1–2 h post patching), temporarily tapering topical steroids, BCL, cyanoacrylate tissue adhesive or autologous fibrin glue, injection of autologous blood inside or around a bleb, surgical re-suturing

Excessive filtration (extensive bleb) — decreasing the frequency of postoperative topical steroids, reform AC with viscoelastic, resuturing of scleral flap if choroidal detachments present with maculopathy

Ciliary body shutdown (flat bleb) — reform AC with viscoelastic, treat excessive inflammation with topical steroids

– Elevated IOP and flat/shallow AC

Suprachoroidal haemorrhage — surgical drainage (anterior sclerostomies 7–10 days post haemorrhage to enable clot to liquefy) indicated if RD and 360° suprachoroidal haemorrhage, kissing choroidal detachments, vitreous incarceration, vitreoretinal adhesions

Malignant glaucoma (shallow central and peripheral AC) — atropine, disruption of anterior hyaloid face with Yag Laser or vitrectomy

Incomplete iridectomy with pupil block — perform new Yag PI followed by topical steroids and atropine

– Elevated IOP and deep AC:

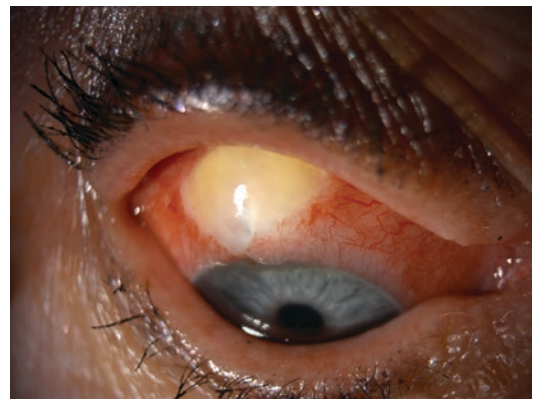

Fig. 9.16 Anterior segment image of a patient with a blebitis

Inadequate filtration (tight scleral flap or obstruction of fistula by iris, ciliary processes, lens, blood, or vitreous): laser suture lysis or release of suture, Yag laser to remove obstructing iris or ciliary processes from ostium, revision of filter

– Loss of vision ("wipe out") — risk factors include older age, preoperative macular splitting in the VF, hypotony (Fig. 9.15)
– Bleb-related infections — blebitis (milky bleb — see Fig. 9.16): intensive topical antibiotics and systemic antibiotics (ciprofloxacin 750 mg BD) / bleb-related endophthalmitis (BRE): intravitreal tap + injection of antibiotics, systemic antibiotics (ciprofloxacin 750 mg BD)

- Late postoperative
  - Late filtration failure — bleb encapsulation (highly elevated, smooth dome-shaped bleb with large vessels but intervening avascular spaces and no microcysts): resume topical medications, digital pressure, bleb needling + 5-FU
  - Leaking bleb (risk factors: blebs with large avascular area) — aqueous suppressants, BCL, cyanoacrylate glue or autologous fibrin glue, autologous blood, bleb revision surgery
  - Bleb-related infections
  - Loss of vision — cataract
  - Eyelid changes — upper eyelid retraction (adrenergic effect of aqueous humour on Muller muscle), ptosis (trauma to levator)

9.10 Glaucoma Drainage Implants (GDI's) (Fig. 9.17 and Table 9.8)

9.10.1 Types of GDI

- Valved: Ahmed implant
- Non-valved: Baerveldt implant, Molteno implant

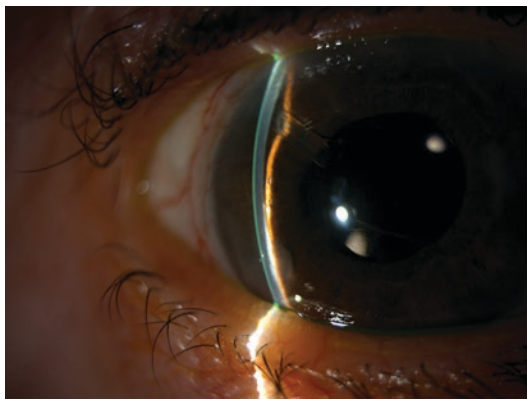

Fig. 9.17 Anterior segment image of a patient with a GDI

Table 9.8 Useful information about GDIs

- Basic design: silicone tube that extends from the AC to a plate, disc, or encircling element beneath the conjunctiva and Tenon capsule
- Successful outcome of a GDI is most dependent on size of the plate

9.10.2 Mechanism of action

- Fibrous capsule forms (after 6–8 weeks) a filtering bleb around the external portion of the draining device

9.10.3 Indications

- Classically performed for conditions where a filtering surgery would have a high likelihood of failure
  - Conjunctival scarring (from previous VR surgeries or glaucoma from chemical burns)
  - Uveitic glaucoma
  - Neovascular glaucoma
  - Aphakic glaucoma
  - Angle recession glaucoma
  - Childhood glaucomas (e.g. Sturge Weber syndrome)
  - Previous failed trabeculectomy

9.10.4 Complications and its treatment

- Intraoperative
  - avulsion of rectus muscles: resuture muscles to insertion sites
  - globe perforation while suturing the plate to the sclera: repair globe
- Post-operative
  - Hypotony with flat AC: injection of dense viscoelastic into AC, removal of tube from AC with subsequent repositioning of tube, permanent ligation of tube
  - Elevated IOP: medical tx initially, if encapsulated drainage implant from thick fibrous capsule — needling beneath conjunctiva required
  - Tube migration, implant extrusion, and erosion of silicone tube through the overlying conjunctiva
  - Endophthalmitis: removal of GDI, intravitreal tap and injection of antibiotics
  - Visual loss

  - Corneal decompensation: tube-cornea touch
  - Diplopia: acquired Brown syndrome, SO palsy

9.11 Minimally Invasive Glaucoma Surgery (MIGS) (Fig. 9.18)

9.11.1 Types of MIGS and Their Mechanisms of Action

- Increasing trabecular outflow by bypassing the TM, e.g. iStent, Hydrus micro-stent
- Increasing uveoscleral outflow via suprachoroidal pathways, e.g. CyPass micro-stent
- Creating a subconjunctival drainage pathway, e.g. XEN implant, InnFocus Microshunt

9.11.2 Indications

- There is currently little robust high-quality RCT evidence comparing the efficacy and safety of one MIGS technique over another for OAG
- At present there is no guidelines on the use of MIGS in clinical practice
- Possible indications
  - Patients with OAG (POAG, PXF glaucoma, pigmentary glaucoma) that is manageable with drops but who have poor drop compliance
  - Patients with OAG and a clinically significant cataract, as surgery may be performed simultaneously (Phaco-Plus)

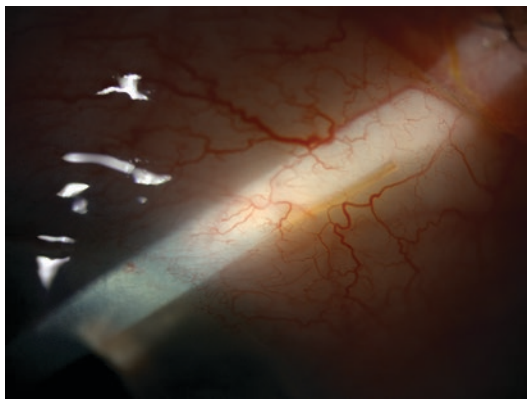

Fig. 9.18 Anterior segment image of a patient with a XEN implant in the superonasal subconjunctival space

9.12 Lid Examination Sequence

- Introduce
- Sit in front of patient with patient's eyes at your eye level
- Quick inspection for any obvious ptosis, brow ptosis, frontalis overaction, eyelid scars from previous surgeries, eyelid malpositions (e.g. ectropion's or entropions), CN VII palsy
- Ask patient to look straight ahead at a distance target and measure the palpebral aperture (PA): distance from the upper lid margin to the lower lid margin (normal range 9–11 mm)
- Shine a penlight at the patient's eye and measure the marginal reflex distance 1 (MRD1): distance from central corneal light reflex to the upper lid margin (normal range 4–5 mm)
- Ask patient to look down and measure the upper eyelid skin crease height: distance from lid margin to skin crease (normal range 6–8 mm for men and 8–10 mm for women)
- Measure levator function (LF): block action of patient's brow with your thumb and measure excursion of the upper lid from extreme downgaze to extreme upgaze (normal range 13–16 mm)
- Check for the presence of any lagophthalmos by asking patient to close their eyes
- Check orbicularis function by asking patient to squeeze their eyes shut without letting you open their eyes
- Hold a pen above the patient's eye level and check for fatiguability by asking a patient to look up at your pen for at least 30–60 s (ask examiner if they want you to do this in the exam): if fatiguability is present the eyelid will slowly drop as the patient stares at your pen
- Check for lid lag by asking a patient to follow your pen from upgaze to downgaze

- Hold a pen below the patient's eye level and check for a Cogan's lid twitch by asking the patient to look down at your pen for 20 s before asking them to look straight ahead: a positive Cogan's twitch is present if the upper eyelid overshoots following the sudden return of the eye to the primary position
- Ask patient to open and close the mouth and move the jaw around to check for a Marcus-Gunn jaw winking ptosis (see Sect. 9.21)
- Check ocular motility and pupils

9.13 Ectropion (Fig. 9.19 and Table 9.9)

9.13.1 Classification

- Lower eyelid
  - Involutional (see Fig. 9.19): horizontal lid laxity
  - Paralytic: loss of orbicularis muscle support of the lower eyelid, associated with lower facial paralysis and brow ptosis (CN VII palsy)
  - Cicatricial (see Fig. 9.20): shortening of the anterior lamella from trauma or skin changes

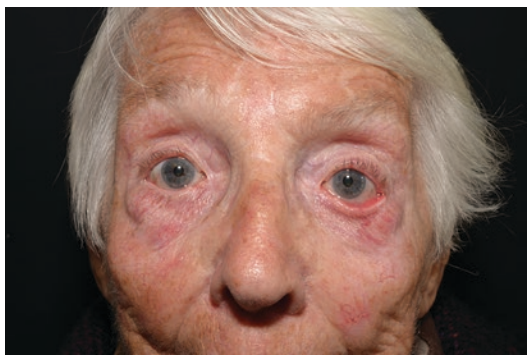

Fig. 9.19 Facial photo of a patient with an involutional ectropion

Table 9.9 Useful information about ectropion's

• Ectropion occurs when the lid margin everts or turns away from the eyeball
• Any type of ectropion may cause tearing as a result of reflex tearing, punctal eversion, or inadequate lacrimal pump

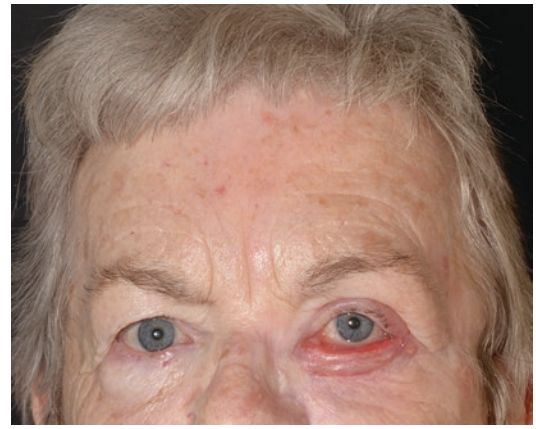

Fig. 9.20 Facial photo of a patient with a left cicatricial ectropion, with visible scar tissue in the lower eyelid resulting from a previous full thickness skin graft procedure

- Upper eyelid
  - Cicatricial
  - There is no upper eyelid equivalent for paralytic or involutional ectropion

9.13.2 History

- History of trauma or cicatrising skin disease — ichthyosis (anterior lamellar shortening)
- History of previous excision of skin cancer or repair of laceration in the periocular area (anterior lamellar shortening)
- History of CN VII palsy

9.13.3 Examination

- Location — medial lid, lateral lid, entire lid, punctal eversion only
- Examine for scarring of the periocular area: indicate previous accidental or surgical trauma as a cause for cicatricial ectropion
- Examine for generalised tightness of the skin: indicates skin shrinkage as a cause for cicatricial ectropion
- Examine for CN VII palsy suggesting paralytic ectropion: facial asymmetry, flattening of nasolabial folds, co-existing brow ptosis, corneal exposure

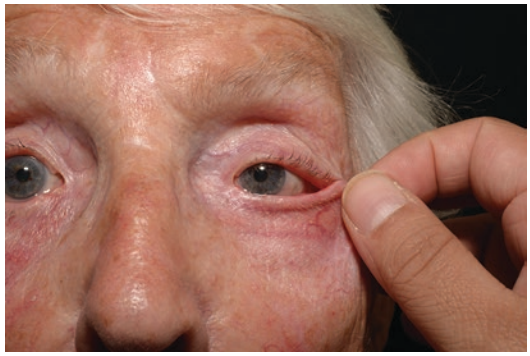

Fig. 9.21 Facial photo of the same patient in Fig. 9.19 showing the presence of horizontal lid laxity

- Examine for horizontal eyelid laxity (see Fig. 9.21): eyelid distraction test (manually pull lower eyelid away from eyeball, the lower lid should not move more than 6 mm off the eyeball), eyelid snap test (pulling lower eyelid inferiorly toward the inferior orbital rim, an eyelid without lower eyelid laxity will spring back into position without a blink)
- Examine for medial canthal tendon laxity: if lateral traction of lower eyelid displaces the punctum to or beyond the limbus, then medial canthal tendon laxity exists

9.13.4 Treatment

- Horizontal lid shortening procedures
  - Lateral tarsal strip (LTS): prepare the patient (inject LA), perform a lateral canthotomy, perform a lateral cantholysis, form the strip (splitting the anterior and posterior lamella, cut along inferior margin of tarsus, remove skin and conjunctiva from the strip), shorten the strip, reattach the strip, trim redundant anterior lamella, close the canthotomy
  - Pentagonal wedge resection: choice of procedure for upper eyelid with floppy eyelid syndrome
  - Kuhnt-Szymanowski: wedge resection and lower lid blepharoplasty
- Vertical lid shortening procedures
  - Medial spindle procedure (excision of a diamond of conjunctiva inferior to the lower puntum and closure with a suture): procedure for punctal ectropion alone or combined with LTS if lid laxity present (perform medial spindle procedure before eyelid is tightened with a LTS).
- Combined lid shortening procedures
  - Lazy T: diamond excision (medial spindle procedure) and wedge resection
- Involutional ectropion: lid shortening procedures
- Paralytic ectropion: correction of corneal exposure with lubricants and ointments, lid shortening procedures
- Cicatricial ectropion: lengthening of anterior lamella with full-thickness skin graft (preauricular, post-auricular, supraclavicular area, inner upper arm, inguinal area)

9.14 Entropion (Fig. 9.22 and Table 9.10)

9.14.1 Classification

- Lower eyelid
  - Involutional: disinsertion or laxity of the lower eyelid retractors (primary cause of involutional entropion as it allows the inferior edge of the tarsus to rotate away from the eye), horizontal lid laxity, overriding preseptal orbicularis muscle
  - Cicatricial: (see Fig. 9.22) shortening of the posterior lamella (pulls eyelid margin inwards) from scarring of the conjunctiva

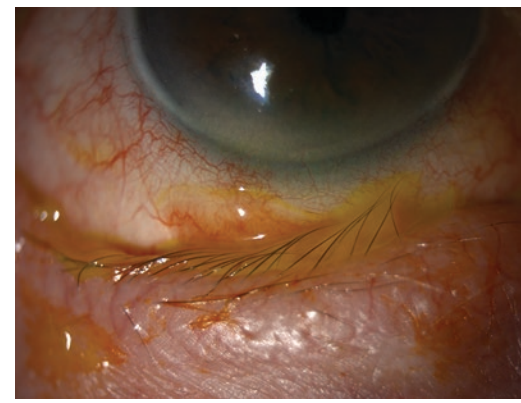

Fig. 9.22 Anterior segment image of a patient with a cicatricial entropion from OCP

Table 9.10 Useful information about entropions

- Lid margin inverts or turns against the eyeball
- Keratinised skin of the eyelid margin and eyelashes rub against the cornea and conjunctiva, causing irritation

(e.g. alkali burns, surgical or accidental trauma, OCP, SJS, trachoma)
  - Spastic: squeezing of the lids in association with ocular pain or inflammation, entropion resolves once discomfort disappears, occurs in patients who have predisposing factors to involutional entropion such as horizontal lid laxity and lax lower lid retractors
  - Congenital
- Upper eyelid
  - Cicatricial

9.14.2 History

- Intermittent symptoms of irritation: suggest an involutional cause
- Constant symptoms of irritation: suggests a cicatricial cause
- Hx of previous surgical or accidental trauma
- Hx of chemical injuries, OCP, SJS, trachoma

9.14.3 Examination

- For subtle entropions, look for a slightly rolled appearance of the posterior angle of the lid margin (should be a flat platform with well-defined right-angled anterior and posterior edges). For intermittent entropions not seen on examination initially, ask patient to squeeze eyes to elicit entropion
- Examine to determine if entropion is cicatricial: with your finger, return the inverted lid to its normal position. If cicatricial changes are present, there is resistance to placing the lid in the normal position and after you release the lid it will immediately return to its inverted position, examine the conjunctiva for signs of fornix shortening or scarring
- Examine the degree of conjunctival scarring: identify the position of the meibomian gland orifices in the least inverted part and follow to most inverted part, in severe scarring the meibomian gland openings may be on the posterior surface of tarsus
- If not cicatricial, the entropion must be involutional: lid returns to normal position with your finger and it will remain there for a blink or two. If entropion does not recur with a few blinks, ask the patient to squeeze the lids closed for a moment, lower eyelid may ride above the lower limbus suggesting some laxity of the lower eyelid retractors
- Examine for horizontal lid laxity if involutional entropion present: eyelid distraction test (manually pull lower eyelid away from eyeball, the lower lid should not move more than 6 mm off the eyeball), eyelid snap test (pulling lower eyelid inferiorly toward the inferior orbital rim, an eyelid without lower eyelid laxity will spring back into position without a blink)

9.14.4 Treatment

- Involutional (aim is to restore the normal tension of the lower lid retractors and to correct any co-existing horizontal lid laxity)
  - Retractor reinsertion procedure: Jones procedure — lower lid subciliary incision, identify lower lid retractors (landmark is the preaponeurotic fat), dissect retractors from anterior fat and posterior conjunctiva, advance lower lid retractors onto the tarsus, skin closure
  - Horizontal lid shortening procedure: LTS, wedge excision, Kuhnt-Szymanowski
- Cicatricial (aim is to restore normal length of the posterior lamella using either incisions alone or incisions with mucous membrane grafts)
  - Tarsal fracture (tarsotomy — requires a contact lens post op for a few weeks to avoid irritation of cut tarsus) if mild-moderate cicatricial changes,
  - Terminal tarsal rotation operation for upper eyelid entropion
  - Mucous membrane grafts if severe cicatricial changes
- Spastic
  - Treat cause of underlying irritation causing spasm

– If not possible to eliminate the cause of irritation:
Quickert sutures: topical and local anaesthetic, load a double armed suture, pass the arms of the suture thought the lid from deep in the fornix passing anteriorly and superiorly to emerge from the skin just below the eyelashes, repeat so that there are medial, central, and lateral sutures in position, tie the sutures so that there is a slight overcorrection

9.15 Facial Nerve (CN VII) Palsy (Fig. 9.23)

9.15.1 Causes of CN VII palsy

- Bell's palsy (diagnosis of exclusion)
- Acoustic neuroma (cerebellopontine angle tumour)

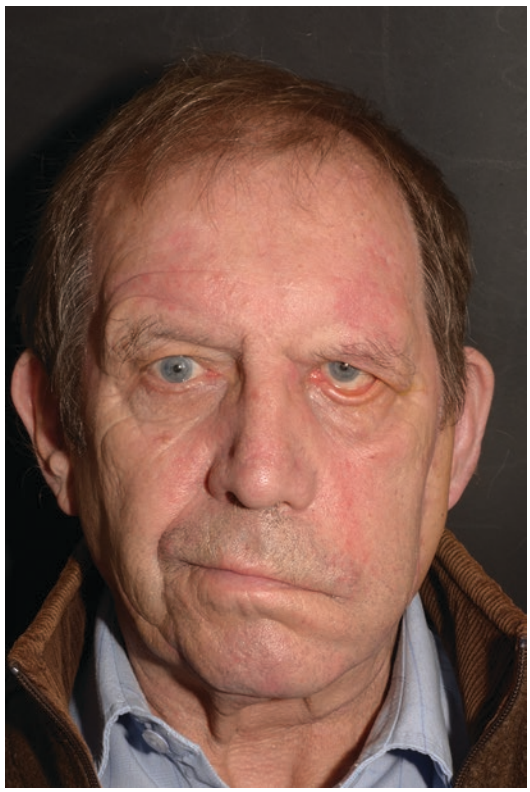

Fig. 9.23 Facial photo of a patient with a left-sided lower motor neurone facial nerve palsy with a brow ptosis and a paralytic ectropion

- Facial tumour (parotid gland mass)
- Trauma
- Ramsay-Hunt syndrome (VZV): otalgia, vesicular rash on ear canal, tympanic membrane
- Sarcoidosis (CN VII palsy tends to be bilateral)
- Lyme disease (CN VII palsy tends to be bilateral)

9.15.2 History

- History of otalgia, hearing loss, or vestibular complaints (if present patient needs scanning)
- Find out likelihood of recovery from ENT colleagues — perhaps tumour resection required cutting the facial nerve, meaning there is no chance of recovery

9.15.3 Examination

- Look for incomplete blink
- Look for brow ptosis
- Look for lower eyelid ectropion
- Look for lagophthalmos with corneal exposure
- Examine for Bell's phenomenon: if good, patients may have little or no corneal exposure despite incomplete closure
- Examine for aberrant regeneration: narrowing of palpebral fissure on pursing of lips/showing of teeth
- Examine corneal sensation: may be reduced if CN VII palsy is due to acoustic neuroma resection (resection may compromise CN V as CN V, VII, VIII leave the brainstem in close proximity) — reduced corneal sensation makes corneal exposure more difficult to manage

9.15.4 Investigations

- ENT referral to establish cause for all new-onset CN VII palsy
- MRI for UMN facial palsy, recurrent CN VII palsy or patients with otalgia, vestibular symp-

toms, or hearing loss to exclude inflammatory or neoplastic (cerebellopontine angle) causes

9.15.5 Treatment

- Treatment depends on how permanent the palsy is likely to be, the degree of anatomic dysfunction (Bells phenomenon), and the patient's needs
- Corneal exposure
  - Medical treatment:
    Hourly artificial tears or ointments
    Eyeglasses outdoors to protect the eye from the wind
    Avoidance of moving air from fans or heating vents indoors
    Taping lid closed at night
  - Surgical treatment (if corneal exposure cannot be managed medically or the facial paralysis is likely to be long term, e.g. no improvement in 18 months):
    Static procedures (narrow the palpebral aperture a fixed amount):
    - Tarsorrhaphy: temporary (see Table 9.11) or permanent
    - Elevation of lower eyelid (retractor disinsertion ± graft)

    Dynamic procedures (improve lid closure):
    - Botox:
      - Technique: 25G needle passed through central aspect of upper lid immediately inferior to the superior orbital rim, needle passed against orbital roof for 1–2 cm, 5–10 units are injected, after 48 h the upper lid rests closed
      - Side-effects: ocular surface dryness (temporary paralysis of orbicularis and decreased blinking), upper eyelid ptosis and diplopia (botox induced paresis of the levator muscle or extraocular muscles) — may last for 6 weeks
    - Upper eyelid gold weight implantation
- Ectropion — LTS ± medial spindle procedure
- Brow ptosis — browplasty
- Aberrant regeneration: treat if narrowing of palpebral fissure affects vision. Options include Botox and levator aponeurosis advancement
- For Bell's palsy — oral prednisolone (25 mg BD) for 10 days starting within 72 h after the onset of symptoms has increased complete recovery rates from 64% to 83% at 3 months and from 82% to 94% at 9 months

Table 9.11 Surgical technique for a temporary suture tarsorrhaphy

- Can be placed anywhere along the lid margins. The nylon suture can be left in place for 2 weeks
- Topical anaesthetic and inject local anaesthetic into the eyelids
- Cut two 5 mm pieces of a narrow red rubber catheter to use as bolster material
- Pass one arm of a double ended 5/0 nylon suture through the bolster material, then into the lower lid skin 5 mm below the lid margin, emerging out the lid margin through the meibomian glands, into the opposite lid margin, out the skin 5 mm above the upper eyelid margin, and through the second bolster
- Repeat this procedure with the other arm of the suture
- Tie a slip knot over the bolster on the upper eyelid

9.16 Simple Congenital Ptosis (Fig. 9.24)

9.16.1 History

- Present at birth with no associated ocular or systemic problems
- For a child: Is the lid above the pupil? How many times is lid above the pupil?
- History of previous ptosis surgery ± secondary lagophthalmos
- History of CN VII palsy
- History of dry eye/use of topical lubricants

9.16.2 Examination

- Reduced/poor levator function
- Absent or weak upper eyelid crease
- Lid lag on downgaze ± lagophthalmos
- Examine for amblyopia (astigmatism or deprivation) in a child
- Examine for risk factors that would increase the chance of post-operative corneal

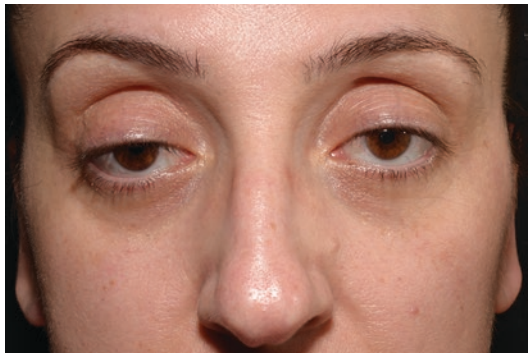

Fig. 9.24 Facial photo of a patient with a simple congenital ptosis

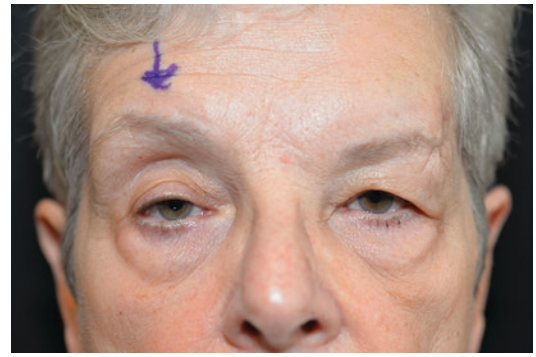

Fig. 9.25 Facial photo of a patient with a right involutional ptosis

exposure: poor Bell's phenomenon, lagophthalmos
- Examine anterior segment for dry eye: assess tear lake height, fluorescein staining of cornea, Schirmer's I test, TBUT
- Normal ocular motility (or SR weakness alone in 5%) and pupil examination

9.16.3 Treatment

- If levator function <4 mm, a frontalis sling procedure is appropriate
- If levator function ≥4 mm, a levator aponeurosis advancement is appropriate

9.17 Involutional Ptosis (Fig. 9.25)

9.17.1 History

- Indefinite onset
- Gradual progression
- No associated ocular or systemic problems
- Ptosis usually about the same severity throughout the day
- History of previous ptosis surgery ± secondary lagophthalmos
- History of CN VII palsy
- History of dry eye/use of topical lubricants

9.17.2 Examination

- Normal (13–16 mm) or near normal (12 mm) levator function
- High skin crease (8–10 mm in women, 6–8 mm in men)
- Lid drop on downgaze (lid margin remains low throughout downgaze)
- Examine for dermatochalasis or brow ptosis: combined surgery with levator aponeurosis advancement may be required
- Examine for risk factors that would increase the chance of post-operative corneal exposure: poor Bell's phenomenon, lagophthalmos
- Examine anterior segment for dry eye: assess tear lake height, fluorescein staining of cornea, Schirmer's I test, TBUT
- Normal ocular motility and pupil examination

9.17.3 Treatment

- Levator aponeurosis advancement procedure ± brow plasty ± blepharoplasty

9.18 Chronic Progressive External Ophthalmoplegia (CPEO) (Fig. 9.26)

9.18.1 History

- Ask about family history to rule out myotonic dystrophy and oculopharyngeal dystrophy

9.18.2 Examination

- Bilateral progressive symmetrical ptosis with poor levator function (CPEO), good levator

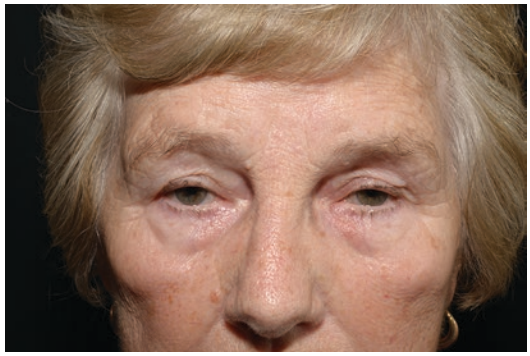

Fig. 9.26 Facial photo of a patient with CPEO showing bilateral symmetrical ptosis

function initially with oculopharyngeal dystrophy
- CN VII weakness especially orbicularis weakness (CPEO)
- Test fatigability (MG): ask patient to look up for 30–60 s and upper eyelid will fatigue and slowly drop
- Look for Cogan's eyelid twitch (MG): ask patient to look down for 20 s and then at object in the primary position — positive if lid overshoots
- Progressive symmetrical advanced loss of ocular motility (eyes virtually immobile with secondary fibrotic changes in advanced stages) — reduced pursuits and always reduced (hypometric) saccadic velocities (CPEO), check for improvement in ocular motility with Dolls head testing (Supranuclear gaze palsy), normal saccadic velocities in MG, down and out eye in complete CN III palsy
- Normal pupil reactions and accommodation (CPEO), mydriasis with poor reactions (CN III palsy)
- Examine for X-mas tree cataract, frontal balding, slow release grip (myotonic dystrophy)
- Fundus exam: pigmentary retinopathy (Kearns-Sayre syndrome/myotonic dystrophy)
- Ask patient to drink glass of water quickly (oculopharyngeal dystrophy)

9.18.3 Investigations

- ECG (Kearns-Sayre syndrome/myotonic dystrophy): heart conduction defects
- Fields of uniocular fixation (CPEO)
- Tensilon test (MG): ensure IV atropine, resuscitation equipment, and trained staff is on hand, cardiac monitoring (ECG) essential. Give 2 mg edrophonium IV and if no ill effects at 30s, give further 8 mg edrophonium IV. Compare pre- and post-test ptosis or motility disorder
- Ice pack test (MG): measure ptosis, ice cubes in rubber glove with patient holding it over their eyelid for 2 min, re-measure ptosis: positive if ≥2 mm improvement
- Serum antibodies (MG): anti-Ach receptor antibodies (50% ocular myasthenia, 95% generalised myasthenia)
- Single fiber EMG (MG); reduction in action potential amplitude
- Hess chart (CN III palsy)
- Skeletal muscle biopsy: ragged red fibers with peripheral concentration of mitochondria (CPEO)
- Bloods: Mitochondrial DNA mutations (CPEO), expanded CTG repeat in the dystrophica myotonica protein kinase (DMPK) gene (myotonic dystrophy), expanded GCG repeat (oculopharyngeal dystrophy)

9.18.4 Treatment

- Prisms if diplopia present (CPEO)
- Strabismus surgery if eyes in grossly eccentric position (CPEO)
- Ptosis props (CPEO)
- Ptosis surgery: risk of causing serious exposure keratitis due to the associated poor orbicularis function and absent Bell's phenomenon (CPEO)

9.18.5 Other Diagnoses to Consider

- Myasthenia gravis
- Myotonic dystrophy
- Oculopharyngeal dystrophy
- CN III palsy
- Supranuclear gaze palsy

9.19 Floppy Eyelid Syndrome (Fig. 9.27)

9.19.1 History

- Unilateral/bilateral ocular injection and irritation (nocturnal eversion of the extremely lax upper eyelid rubbing on the pillow)
- History of obstructive sleep apnoea (OSA) ± wearing a CPAP mask at night
- If no history of OSA ask about snoring, sleepless nights, daytime fatigue

9.19.2 Examination

- Papillary conjunctivitis
- Upper eyelid laxity, eyelid can be folded on itself and easily turned inside out

9.19.3 Investigations

- If patient symptomatic from OSA, refer to sleep specialist

9.19.4 Treatment

- Protecting eye with an eye shield at night (trial for a few weeks is a good test to see if lid tightening will improve the irritation)
- Horizontal lid tightening of the upper eyelid (usually pentagonal wedge resection)

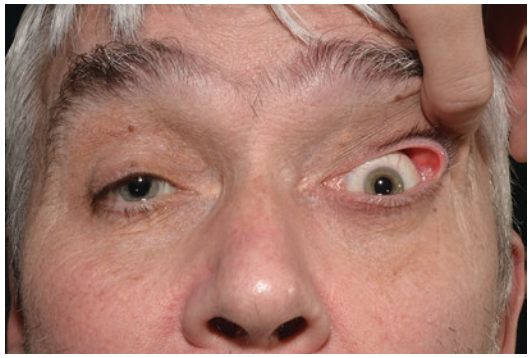

Fig. 9.27 Facial photo of a patient with floppy eyelid syndrome

9.20 Dermatochalasis (Fig. 9.28 and Table 9.12)

9.20.1 History

- History of dry eye (sensitivity to moving air, from ceiling fans, air vents, or windshield defrosters) and use of artificial tears: relative contraindication for blepharoplasty procedures — less skin and muscle removal required
- History of CN VII palsy
- History of previous blepharoplasty: any remaining ptosis is likely from brow ptosis

9.20.2 Examination

- Examine height and contour of brow (normal male brow is at the rim and relatively flat; the normal female brow is above the rim and arched temporally). Judge height by palpating brow between your index finger and thumb relative to the orbital rim. (Look for ptotic brow hanging over the superior orbital rim); is there a generalised ptosis of the brow or is there more of a mild temporal droop? Brow furrows indicate that the patient is trying to see by using the brows to elevate the lids

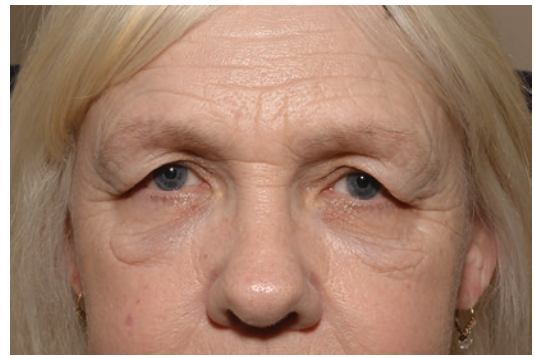

Fig. 9.28 Facial photo of a patient with dermatochalasis

Table 9.12 Causes of a pseudo-ptosis

- Excessive skin: brow ptosis, dermatochalasis
- Inadequate globe size: microphthalmos, phthisis bulbi, prosthesis
- Incorrect globe position: enophthalmos, hypotropia
- Contralateral lid retraction
- Contralateral large globe
- Contralateral proptosis

- Examine for extra-tissues in the upper skin fold: estimate the amount of redundant skin and muscle in the skin fold by lifting the brow into the normal position at or above the rim, if you lift the brow higher you can see any fullness of sulcus if there is prolapsed orbital fat present (central or nasal fat)
- Examine the upper eyelid height: determine MRD1 (normal MRD1 as redundant upper eyelid skin does not change the eyelid position) by elevating the upper skin fold slightly to check the position of the upper eyelid margin, record levator function (not necessary if ptosis repair is not being considered)
- Examine the lower eyelid: look for prolapsed orbital fat (medially/laterally), look for redundant skin and muscle (any lower eyelid malar bags or festoons), estimate lower lid laxity (lid distraction test — normally the eyelid should not pull more than 6 mm away from eyeball, snap test with lower eyelid pulled down and released — normally lid returns to position without a blink or with one blink)
- Examine anterior segment: Look at size of tear lake and the presence of any corneal staining

9.20.3 Investigations

- 24-2 HVF: performed with eyelids in relaxed ptotic position and with the eyelids taped open. An improvement in the superior visual field defect of at least 12° is required

9.20.4 Treatment

- Browplasty: entire brow, temporal brow
- Upper lid blepharoplasty (removes redundant skin and muscle from the upper skin fold with variable amounts of fat excised depending on the amount of fat prolapse)
  - Indications:
    Functional (vision blocked by redundant skin fold)
    Cosmetic
  - Surgical technique: skin marking (skin crease, upper limit of skin excision — should leave between 10 and 15 mm of skin between the eyebrow hairs and the skin crease), anaesthesia, skin incision, skin and muscle excision, fat excision, closure
  - Complications:
    Postoperative: asymmetry, reoperation, scarring, corneal exposure, lagophthalmos, blindness (retrobulbar haemorrhage — requires opening of surgical wound)
- Lower lid blepharoplasty

9.21 Marcus-Gunn Jaw Winking Syndrome (Fig. 9.29)

9.21.1 Definition

- A congenital miswiring of the CN V (pterygoid muscles) gets misdirected to CN III (levator muscle)

Fig. 9.29 Facial photos of a patient with Marcus-Gunn jaw winking phenomenon

9.21.2 History

- Ptosis onset from birth
- History of amblyopia

9.21.3 Examination

- Partial ptosis (mild to severe) in primary position
- Poor levator function in majority of patients. A few patients will have good levator function
- Elevation of ptotic lid with movements of the mouth

9.21.4 Treatment

- If poor levator function and significant synkinesis: extirpation of the levator to eliminate the abnormal movements and a frontalis sling operation to elevate the upper lid
- If good levator function and minimal synkinesis: levator aponeurosis advancement

9.22 Myasthenia Gravis (Fig. 9.30)

9.22.1 History

- Variable ptosis and diplopia (worse towards the evening/with exercise)
- Any breathlessness, swallowing problems or choking episodes

9.22.2 Examination

- Unilateral ptosis ± contralateral pseudo-lid retraction (consequence of Hering's law) or bilateral ptosis
- Ocular motility disturbance (any pattern) with always normal saccadic velocities (see Fig. 9.31)
- Fatigability: ask patient to look up for 30–60 s and upper eyelid will fatigue and slowly drop (see Fig. 9.30)
- Cogan's eyelid twitch: patient to look down for 20 s and then at object in the primary position — positive if lid overshoots
- Normal pupil exam

9.22.3 Investigations

- Tensilon test
  - Pretreatment requirements — ensure IV atropine, resuscitation equipment, and trained staff is on hand, cardiac monitoring (ECG) essential
  - Technique — give 2 mg edrophonium IV and if no ill effects at 30 s, give further 8 mg edrophonium IV. Compare pre- and post-test ptosis or motility disorder (Hess)
  - Possible side-effects — increased salivation, sweating, bronchospasm, hypotension, bradycardia, arrhythmia
- Ice pack test — measure ptosis, ice cubes in rubber glove with patient holding it over their

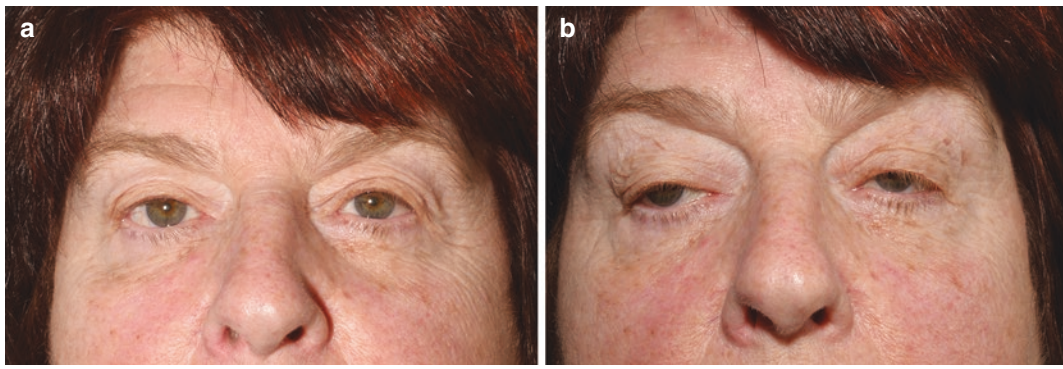

Fig. 9.30 Facial photos of a patient with myasthenia gravis showing minimal ptosis initially (**a**) and fatiguability of the upper eyelids after prolonged upgaze (**b**)

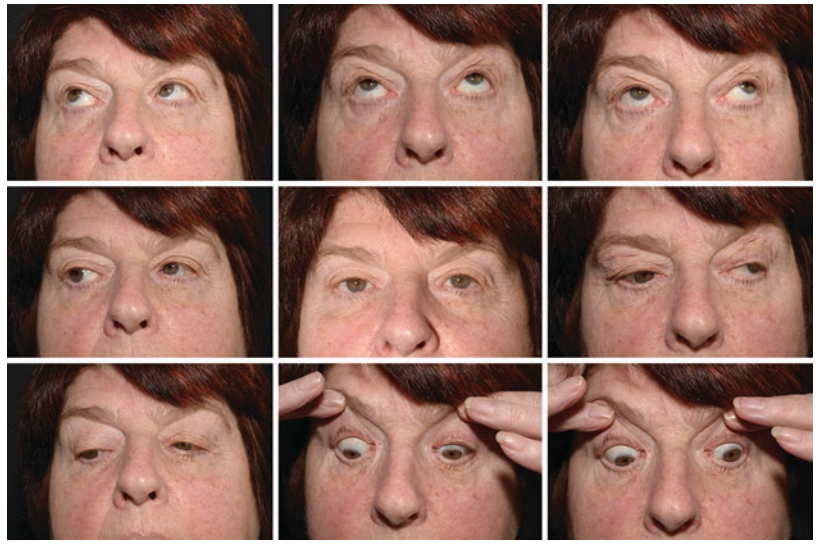

Fig. 9.31 Nine positions of gaze for the same patient as shown in Fig. 9.30 showing a limitation of adduction in the right eye

eyelid for 2 min, re-measure ptosis: positive if ≥2 mm improvement
- Serum antibodies — anti-Ach receptor antibodies (50% ocular myasthenia, 95% generalised myasthenia) — negative test does not rule out MG
- Single fiber EMG — reduction in action potential amplitude
- Bloods — TFT (MG associated with Graves disease in 4–10%)
- CT chest — thymoma

9.22.4 Treatment

- Co-manage with a neurologist
- Ocular manifestations: Lid crutches for ptosis, surgical ptosis correction if medical treatment unsuccessful although variability remains, prisms for diplopia
- Systemic manifestations:
  - Medical treatment — pyridostigmine (anti-acetylcholinesterase), immunosuppression (oral prednisolone to reduce dose of pyridostigmine, azathioprine, AZT, plasmapheresis and IV immunoglobulin for myasthenic crisis)
  - Surgical treatment — thymectomy

9.23 Basal Cell Carcinoma (BCC) (Fig. 9.32)

9.23.1 Classification of BCC

- Nodular
- Morpheaform: sclerotic plaques or papules, border not defined
- Superficial: scaly patches or papules (mimics eczema or psoriasis)
- Pigmented: areas of brown and black pigment seen in lesion along with signs similar to nodular

9.23.2 History

- History of sun exposure
- Positive family history of BCC: Gorlin's syndrome (basal cell naevus syndrome) — AD, predisposes patients to multiple BCCs, associated with jaw cysts, palmar pits, skeletal

abnormalities (syndactyly of the digits, sprengel deformity — scapula displacement and limitation of shoulder movement)
- History of xeroderma pigmentosum

9.23.3 Examination (Table 9.13)

- Firm nodule with pearly borders with telangiectasia ± central ulceration (lesions are not tender and not painful to touch)
- Destruction of normal lid margin architecture when the lesion involves the lid margin — lashes are often lost
- Examine for signs of actinic skin damage: skin appears thin with deep wrinkles and furrows, changes in pigmentation include diffuse mottling or brownish patches known as solar lentigo, vessels of the dermis are visible due to loss of surrounding collagen in elastic tissue, tight skin with no wrinkles despite advancing age

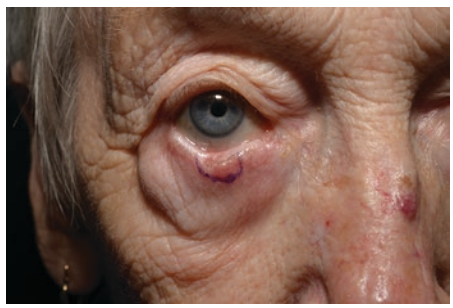

Fig. 9.32 Facial photo of a patient with a lower eyelid nodular BCC

Table 9.13 Characteristics suggestive of eyelid skin malignancy

- Ulceration: often associated with bleeding, malignant lesions do not tend to be painful, nor are they tender to touch
- Induration: all malignancies tend to be firm or indurated
- Irregularity: irregular margins and asymmetric shapes
- Pearly borders and telangiectasia (dilated and irregular vessels): pathognomonic of BCC, heaped up edges often surround an area of central ulceration
- Loss of eyelid margin architecture: malignancy may destroy the normal architecture of the lid margin, suspect malignancy when an area of lash loss or lid margin destruction is present

- BCCs most commonly present in the lower lid, then the medial canthus, then the upper lid and then the lateral canthus

9.23.4 Investigations

- Incisional biopsy (only portion of lesion is removed): used to sample a lesion for diagnosis — best place to sample the tumour is at the periphery of the lesion and include areas of normal tissue, centre of lesion should not be sampled, especially if there is central ulceration — histopathological interpretation may yield only necrotic tissue
- Genetic testing: mutations in PTCH1 and SUFU genes (Gorlin's syndrome)

9.23.5 Treatment

- Topical imiquimod 5% cream for small superficial BCCs
- Wide local excision using Moh's micrographic tumour excision technique followed by eyelid reconstruction (see Table 9.14): after removal of a debulking layer, narrow margins of surrounding tissue including the sides and the base of the tumour bed are removed for frozen section analysis, the frozen section are interpreted by the excising surgeon, if any tumour remains the surgeon goes back to the exact site and removes more tissue, the process is repeated with small areas of excision until all tumour tissue has been excised

9.23.6 Referrals of BCCs into Secondary Care (NICE Guidance [NG12])

- Consider routine referral for people if they have a skin lesion that raises the suspicion of a BCC
- Only consider a suspected cancer pathway referral (for an appointment within 2 weeks) for people with a skin lesion that raises the suspicion of a BCC if there is particular concern that a delay may have a significant impact, because of factors such as lesion site or size

Table 9.14 Eyelid reconstruction

Repair of full-thickness eyelid defects up to 25%:

Primary/direct eyelid margin repair:

- The primary eyelid margin repair begins with identifying the appropriate anatomic landmarks of the eyelid, especially the landmarks of the lid margin.
- The strength of the closure is in sutures placed in the tarsal plate
- Eyelid wound margin eversion is necessary to prevent lid notching
- Steps of eyelid margin repair are:
  - Inject local anaesthetic
  - Align the lid margin (7/0 vicryl vertical mattress suture passed through the meibomian gland orifices to align and evert the lid margin)
  - Suture the tarsal plate (use 2–3 interrupted 5/0 vicryl sutures passed in a lamellar fashion to align the tarsal plate)
  - Suture the lid margin (place a 7/0 vicryl vertical mattress suture anterior to the gray line — this suture should align the eyelashes and provide eversion of the lid margin)
  - Close the skin (5/0 vicryl interrupted sutures)
- If the closure is under too much tension or the lower lid retracts inferiorly under the globe do a lateral canthotomy and cantholysis — if there is still too much tension
- Perform a Tenzel flap procedure, advancing tissue from the temple to form a new lid margin
- If the defect involves most of the lower eyelid, you should start with a Hughes flap procedure
- If the defect involves most of the upper eyelid, you should start with a Cutler Beard procedure

Repair of full-thickness eyelid defects of 25–50%:

Canthotomy, cantholysis, and eyelid margin closure:

- The canthotomy (angle canthotomy incision slightly superiorly for lower eyelid and angle canthotomy incision slightly inferiorly for upper eyelid) and cantholysis are used to release the lateral aspect of the lid to allow the lid margin to be closed under less tension
- Perform a primary lid margin repair and close the canthotomy

Repair of lid defects of 50–75%:

The Tenzel semi-circular flap:

- Steps of the Tenzel procedure are:
  - Inject local anaesthetic: draw an arched line extending superiorly (lower lid) or inferiorly (upper lid) from the lateral canthus in a curve
  - Perform lateral canthotomy and cantholysis: angle canthotomy superiorly as the canthotomy incision will continue as the Tenzel flap.
  - Form and mobilise the Tenzel flap: dissect a myocutaneous flap posterior to the orbicularis muscle in the preseptal plane
  - Perform a primary lid margin repair and close the flap

Repair of lower lid defects of 75% or greater:

(a) The Hughes procedure:

- Used to reconstruct the posterior lamella of a full thickness lower eyelid defect that is too wide for the use of a Tenzel flap (no lashes on lower eyelid)
- Procedure provides a flap of tarsus and conjunctiva from the upper eyelid, which is sewn into the lower eyelid. This tarsoconjunctival flap carries its own blood supply because it remains attached to the upper eyelid for 4 weeks
- An anterior lamella is provided using a myocutaneous advancement flap or FTSG
- Steps of the Hughes procedure:
  - Inject local anaesthetic
  - Measure the lower eyelid defect
  - Form the tarsoconjunctival flap: leave 3 mm of intact superior lid margin to prevent upper lid entropion, make a horizontal cut parallel to the lid margin full thickness through the tarsus, dissect tarsus off the underlying orbicularis muscle and levator aponeurosis superiorly to the top edge of the tarsus, dissect a tissue plane between Muller's muscle and the conjunctiva up to the superior fornix, make vertical cuts in the conjunctiva to bring down the tarsal flap
  - Suture the flap into the lower eyelid defect
  - Complete the anterior lamellar repair
  - 4 weeks later, open the eyelids by excising the flap. Cut slightly above the lower lid margin

(b) Free tarsal graft:

- Harvested from the contralateral upper lid to be used as a posterior lamellar replacement for lower eyelid defects
- Advantage is that it is a one staged procedure
- Disadvantage is that it does not have a blood supply, so it must be covered with a myocutaneous advancement flap

Repair of upper lid defects of 50% or greater:

(a) The Cutler Beard procedure:

- Used to repair large full thickness defects of the upper lid.
- Two-stage lid sharing procedure
- A width of full thickness lower eyelid below the tarsal plate is used to reconstruct the upper eyelid defect
- The eyelids are sewn closed for several weeks before the second stage procedure (6–8 weeks later) to open the eyelids is performed

(b) Free tarsal graft and bipedicle flap:

- Use a free tarsal graft from contralateral upper lid to fill the posterior lamellar defect
- Make a horizontal incision in the upper lid anterior lamella and advance a bipedicle flap of skin and muscle inferiorly to vascularise the free tarsal graft
- Place a free skin graft over the defect where you borrowed the tissue for the bipedicle flap.

9.24 Actinic Keratosis (Fig. 9.33 and Table 9.15)

9.24.1 Examination

- Multiple flesh coloured, yellowish, or brownish macules or papules ± cutaneous horn, depending on the degree of hyperkeratosis, which are rough to touch
- Upper lid is rarely a site of actinic keratosis because of shading of the skin by the prominence of the superior brow

9.24.2 Investigations

- Perform an incision biopsy if there is any doubt of the underlying diagnosis
- If a keratin horn is present, perform a deep excision biopsy including the base of the horn to determine the diagnosis

9.24.3 Treatment

- Monitor for formation of squamous cell carcinoma (see Fig. 9.34)
- Treatment options: excision, topical application of imiquimod or 5-FU, cryotherapy

Fig. 9.33 Facial photo of a patient with an upper eyelid keratin horn

Table 9.15 Useful information about actinic keratosis

- Premalignant skin lesion, the precursor to squamous cell carcinoma
- Lesions appear in the context of sun damaged skin on the face, hands, bald scalp, and ears

9.25 Melanocytic Naevus (Fig. 9.35 and Table 9.16)

9.25.1 History

- Presentation age: at birth — congenital naevus, teenaged child — junctional or compound naevus, older adult — intradermal naevus

9.25.2 Examination (Tables 9.17 and 9.18)

- Junctional naevus: brown flat lesion
- Compound naevus: darker dome-shaped lesion
- Intradermal naevus: elevated non-pigmented lesion

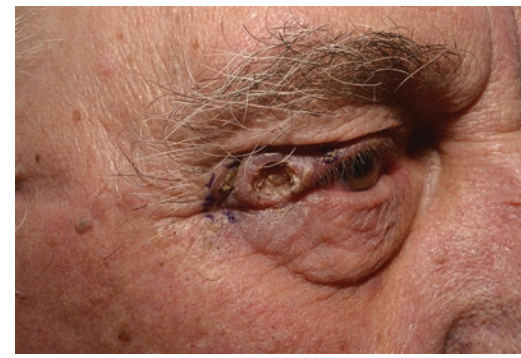

Fig. 9.34 Facial photo of a patient with a right upper lateral lid squamous cell carcinoma

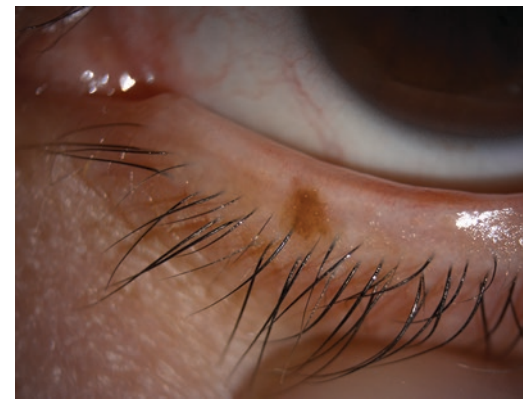

Fig. 9.35 Anterior segment photo of a patient with an eyelid melanocytic naevus

Table 9.16 Life cycle of a melanocytic naevus

- Junctional naevus: flat small oval or round light to dark brown macules — at border of epidermis and dermis
- Compound naevus: raised and dome shaped — extending from epidermis into dermis
- Intradermal naevus: raised with loss of colour returning to light brown or flesh colour — within dermis

Table 9.17 Characteristics of benign pigment cell tumours (e.g. naevus)

- Uniform in colour (small variations from light brown to brown are normal)
- Regular smooth borders (smooth edges)
- Symmetric shape (lesion can be folded on itself)

Table 9.18 Characteristics of malignant pigment cell tumours (e.g. melanoma)

- Recent onset of pigmented lesion
- Change in existing pigmented lesion (shape, size, colour)
- Irregular margins
- Asymmetric shape (lesion cannot be folded on itself)
- Large size greater than 6 mm in diameter
- Colour change or presence of multiple colours

9.25.3 Investigations

- Punch biopsy (incisional biopsy technique where a disposable skin dermatome, like a corneal trephine, is used to "core" out a sample of the lesion) should be performed if a naevus shows a dramatic change in colour or shape

9.25.4 Treatment

- No treatment required for majority of naevi
- For intradermal naevus (elevated nonpigmented naevus) causing irritation or disfigurement: shave biopsy (incisional biopsy technique with lesion shaved off flush with the lid margin)

Reference

National Institute for Health and Care Excellence. Suspected cancer: recognition and referral [NG12]. [Online]. London: NICE; 2015. https://www.nice.org.uk/guidance/ng12. Accessed 15 Dec 2019.

Posterior Segment

10

Timothy H. M. Fung and Winfried M. K. Amoaku

10.1 Posterior Segment Examination Sequence

10.1.1 Indirect Slit-Lamp Biomicroscopy

- Introduce yourself to the patient
- Set patient up on the slit-lamp
- Focus and center a slit beam (use the brightest light intensity that the patient can easily tolerate) in the center of the corneal surface and hold a condensing lens (e.g. +90 D) stationary between your thumb and index finger approximately 5–10 mm from the patient's cornea
- Keeping the slit beam centered on both the patient's cornea and the condensing lens, pull the slit-lamp joystick with your freehand away from the patient until the patient's red reflex becomes a focused fundus image
- Ask the patient to look at your ear or shoulder to begin examining the optic disc. Proceed temporally circumferentially around the posterior pole and ending at the fovea. Examine different aspects of the peripheral retina by asking the patient to look in different directions of gaze

10.1.2 Indirect Ophthalmoscopy

- For the exam the patients will likely be lying flat on a bed with the pupils dilated
- Introduce yourself to the patient
- Ask for room lights to be dimmed (if not already dimmed)
- Begin by asking the patient to stare at a distance target on the ceiling just above and beyond your shoulder (your right shoulder when examining the patient's right eye and your left shoulder when examining the patient's left eye)
- Examine each eye in turn. Direct the indirect ophthalmoscopes light source into the center of the patient's pupil. Hold the condensing lens, and position it just in front of the patient's eye and center the pupil in it. Pull the lens slowly away from the patient's eye by flexing your wrists and by bending your fingers holding the lens until you see a focused image of the fundus
- Shift the field of view to different areas of the eye by walking around the patient and by asking the patient to look in different directions of gaze

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- Remember that the image of the patient's fundus is reversed and inverted

10.2 Stargardt Disease (Fig. 10.1 and Table 10.1)

10.2.1 Examination

- Bilateral symmetrical changes often confined to the posterior pole
- Yellowish white flecks (differ from drusen in that they are more elongated than round and they often contact each other at angles that create a branching or net-like appearance) at the level of the RPE — pisciform flecks (two adjacent flecks form an obtuse angle)
- Relative sparing of the peripapillary retina and RPE
- Circular area of RPE atrophy centered at the fovea with a metallic sheen (crystalline deposits overlying this atrophy) ± clumps of dark pigment within the atrophic lesion
- Vermillion or light-brown colour to the fundus with complete obscuration of the underlying choroidal vessels
- Bull's eye maculopathy (see Fig. 10.2 and Table 10.2): ring of atrophic RPE surrounding the fovea

10.2.2 Investigations

- FAF: loss of autofluorescence in areas of atrophy (including the atrophic fovea and bull's eye maculopathy)
- FFA: dark choroid (see Fig. 10.3) — masking of the choroidal circulation with dye filled retinal vessels lying upon a completely hypofluorescent background ± hyperfluorescence of flecks and areas of atrophy
- OCT: RPE atrophy and outer retinal loss (loss of ellipsoid zone)

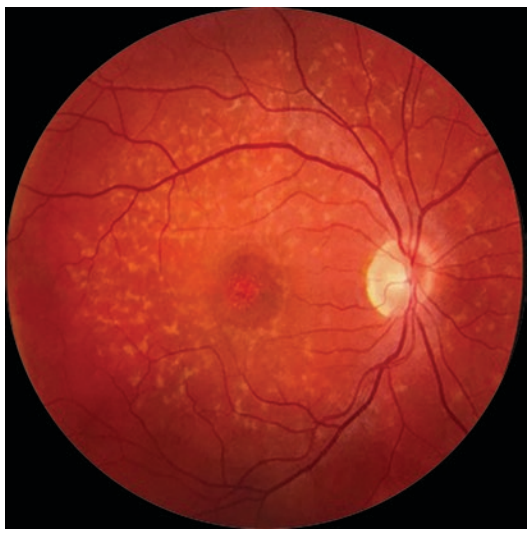

Fig. 10.1 Colour fundus image of a patient with Stargardt disease showing the typical yellowish-white flecks in the posterior pole

Table 10.1 Key facts about Stargardt disease

• AR macular dystrophy (onset in childhood)
• Mildest of the ABCA4 phenotypes

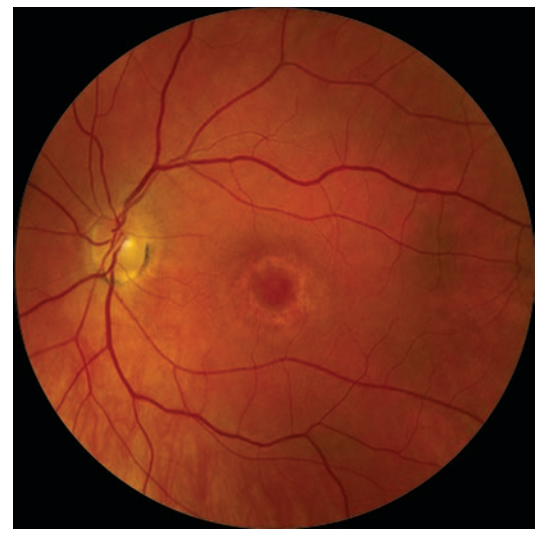

Fig. 10.2 Colour fundus image of a patient with Stargardt disease with a typical bull's eye maculopathy

Table 10.2 Causes of Bulls eye maculopathy

• Stargardt disease
• Hydroxychloroquine toxicity
• Cone dystrophy/Cone-rod dystrophy
• Batten disease (neuronal ceroid lipofuscinosis — ERG severely reduced or extinguished before age of 10 years)

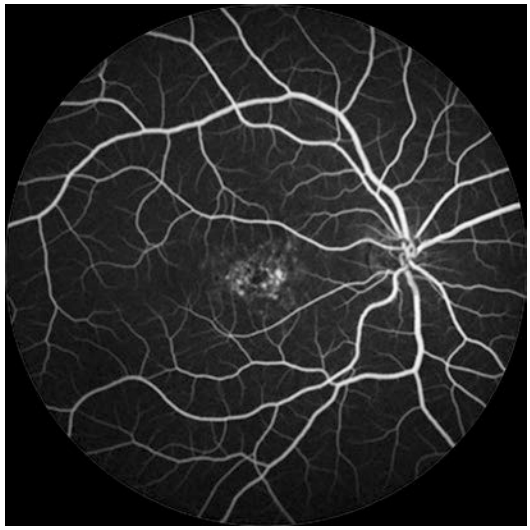

Fig. 10.3 Fundus fluorescein angiogram of a patient with Stargardt disease showing a typical dark choroid with hyperfluorescence of flecks

- Molecular testing: ABCA4 gene
- EDTs: full field ERG - typically normal in Stargardt disease, pattern ERG (PERG) — group 1 (severe PERG abnormality with normal full field ERG), group 2 (additional loss of photopic function), group 3 (additional loss of both photopic and scotopic function)

10.2.3 Treatment

- There is currently no proven treatment for ABCA4 disease

10.2.4 Other Diagnosis to Consider

- Fundus flavimaculatus: AR, adult onset, pisciform flecks, peripapillary sparing, relative preservation of vision (no macular atrophy)
- Stargardt like autosomal dominant macular dystrophy (SLDMD): positive FHx, pisciform flecks, peripapillary sparing, macular atrophy, normal ERG
- Pattern dystrophy (group of inherited conditions characterised by changes at the level of the RPE) — reticular pattern: AD (positive FHx), gene testing for PRPH2 mutations, low risk of CVN development
- Cone dystrophy/Cone-rod dystrophy
- Central areolar choroidal dystrophy: AD (positive FHx), earliest change is a fine mottled depigmentation in the macula of both eyes and gradually evolves into symmetric, sharply outlined oval or round areas of GA of the RPE, normal full field ERG

10.3 Best's Macular Dystrophy (BMD) (Fig. 10.4 and Table 10.3)

10.3.1 History

- Positive FHx (autosomal dominant)

10.3.2 Examination

- Solitary round oval yellow slightly elevated lesion centered on the fovea (egg-yolk like

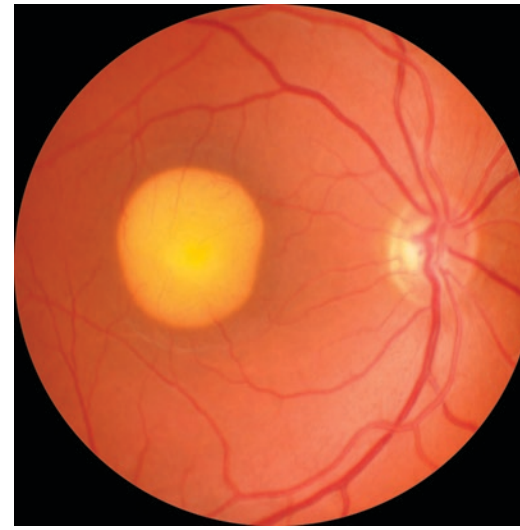

Fig. 10.4 Colour fundus image of a patient with BMD showing the typical egg-yolk like lesion

Table 10.3 Key facts about BMD

• AD macular dystrophy caused by mutations in BEST1 gene • Onset usually in childhood • BMD refers to the "classic" form of a single symmetric egg-yolk like lesion centered on the fovea of each eye

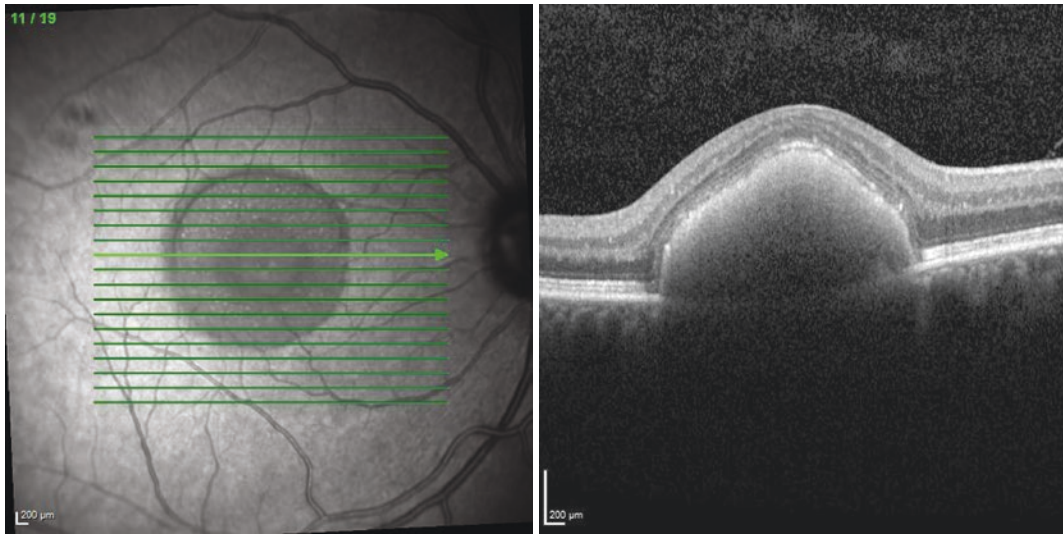

Fig. 10.5 OCT image of a patient with BMD showing the typical sub-RPE hyper-reflective lesion

lesion) ± pseudohypopyon (yellow material gravitates inferiorly in the subretinal space) ± subretinal fibrosis ± RPE atrophy ± RPE hyperpigmentation
- Subretinal haemorrhage in the macula — suggestive of a CNV membrane (20%)

10.3.3 Investigations

- OCT (see Fig. 10.5): sub-RPE hyper-reflective lesion
- FFA: look for leakage suggestive of a CNV membrane
- EDT: EOG — reduced Arden ratio (less than 1.5), ERG — normal full field ERG

10.3.4 Treatment

- Treatment of CNV with anti-VEGF therapy

10.3.5 Staging of BMD

- Stage 1: Pre-vitelliform — EOG findings only
- Stage 2: Vitelliform — yolk-like macular lesion
- Stage 3: Pseudohypopyon — partial absorption leaving level
- Stage 4: Vitellidisruptive — scrambled egg appearance with RPE atrophy + hyperpigmentation
- Stage 5: End-stage — geographic atrophy of the RPE

10.3.6 Other Diagnoses to Consider

- Adult-onset foveomacular vitelliform pattern dystrophy — smaller (less than 1/3 DD) vitelliform lesions than BMD, normal EOG

10.4 Sorsby Macular Dystrophy (Fig. 10.6 and Table 10.4)

10.4.1 History

- Positive FHx

10.4.2 Examination

- In the early stages, yellow-to-grey material (similar in appearance to drusen) is present at the level of Bruch's membrane

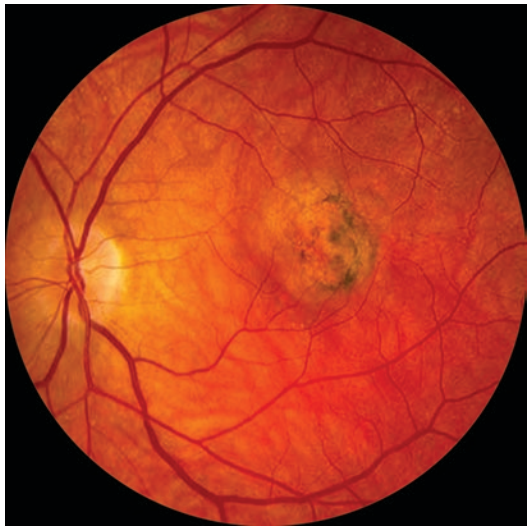

Fig. 10.6 Colour fundus image of a patient with Sorsby macular dystrophy showing subfoveal disciform scarring

Table 10.4 Key facts about Sorsby macular dystrophy

- AD condition caused by a mutation in the TIMP3 gene
- Progressive atrophy of the peripheral choroid and RPE is common
- Most commonly presents in the fourth or fifth decade of life

- Bilateral subfoveal CNV membranes with extensive disciform scarring, which can extend peripherally (unlike AMD which rarely extends beyond the temporal vascular arcades) in the late stages

10.4.3 Investigations

- Mutation in TIMP3 gene

10.4.4 Treatment

- CNV: anti-VEGF therapy

10.4.5 Other Diagnoses to Consider

- AMD

10.5 Retinitis Pigmentosa (RP) (Fig. 10.7 and Table 10.5)

10.5.1 Classification

- Based on inheritance (50% have no FHx): AD (later onset and less severe), AR, XL recessive (both AR and XL recessive RP have an earlier onset and more severe)

10.5.2 History

- Positive FHx
- Symptoms: nyctalopia, loss of peripheral visual field, loss of central vision, photopsias

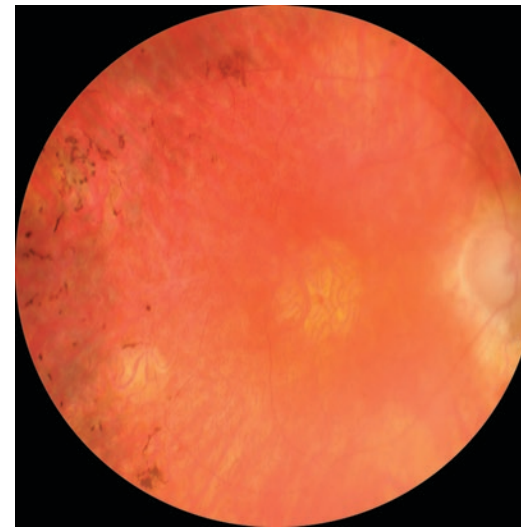

Fig. 10.7 Colour fundus image of a patient with RP showing disc pallor, attenuated retinal vessels, bone spicules and foveal and peripheral atrophy of the RPE and choriocapillaris

Table 10.5 Key facts about RP

- Term used for a group of disorders that are characterised by inherited, progressive dysfunction, cell loss, and eventual atrophy of retinal tissue
- Initial involvement of photoreceptors leads to subsequent damage to inner retinal cells. Eventually there is widespread atrophy of several, if not most, layers of the retina
- RP may be seen in isolation (typical RP) or in association with systemic disease in <25% of cases (syndromic RP)

10.5.3 Examination

- In typical RP, there is a high degree of symmetry of fundus abnormalities between the two eyes
- Bone spicule intraretinal pigmentation — represent RPE migration into the retina
- Optic nerve head pallor (from atrophy ± gliosis) ± optic disc drusen
- Attenuated retinal vessels
- Mottling and granularity of the RPE
- Atrophy of RPE and choriocapillaris with fundus pallor and visible large choroidal vessels in advanced disease
- Check IOP: RP patients at risk of open angle glaucoma
- Perform an anterior segment examination: look for cataracts (posterior subcapsular cataract) and keratoconus

10.5.4 Investigations

- Refraction: high myopia and astigmatism
- Kinetic VF: scotomas in the mid-periphery which coalesce to form a ring of VF loss (ring scotoma)
- EDT: scotopic ERG is more affected than photopic ERG, ERG extinguished in advanced RP, abnormal EOG
- OCT: CMO, ERM, decreased thickness of the ONL, loss of the ELM and IS/OS junction
- Genetic testing especially for RPE65 gene mutations

10.5.5 Treatment

- Refractive error correction
- Cataract extraction when indicated
- Treatment of CMO when present: topical/oral CAI's
- Visual impairment registration and referral for low vision aids
- Voretigene neparvovec if RPE65 gene mutations are present (NICE Guidance [HST11])

10.5.6 Syndromic RP

- Usher syndrome: AR sensorineural deafness (most commonly congenital), pigmentary retinopathy indistinguishable from typical RP, ERG is profoundly abnormal to undetectable — cochlear implantation
- Kearns-Sayre syndrome: mitochondrial DNA deletion syndrome, pigmentary retinopathy, CPEO, ptosis, cardiac conduction block, cerebellar ataxia — muscle biopsy shows red ragged fibers by light microscopy
- Refsum disease (infantile or adult-onset): AR, pigmentary retinopathy, peripheral neuropathy, ichthyosis, cardiac conduction defects, ERG responses are severely abnormal or unrecordable at all ages, high phytanic acid levels in blood and urine — restriction of dietary phytanic acid (dairy products) required
- Bardet-Biedl syndrome: AR, pigmentary retinopathy, polydactyly, congenital obesity, mental retardation, hypogonadism

10.6 Sector Retinitis Pigmentosa (Sector RP) (Fig. 10.8 and Table 10.6)

10.6.1 History

- Positive FHx

10.6.2 Examination

- Bone-spicule like pigmentary changes limited to one or two quadrants with minimal or no extension of the retinal area involved with time ± chorioretinal atrophy
- Retinal arteriolar attenuation in the affected quadrants only
- Cataract: posterior subcapsular lens opacity
- Sector RP can be differentiated from acquired pigmentation by its symmetry between the two eyes

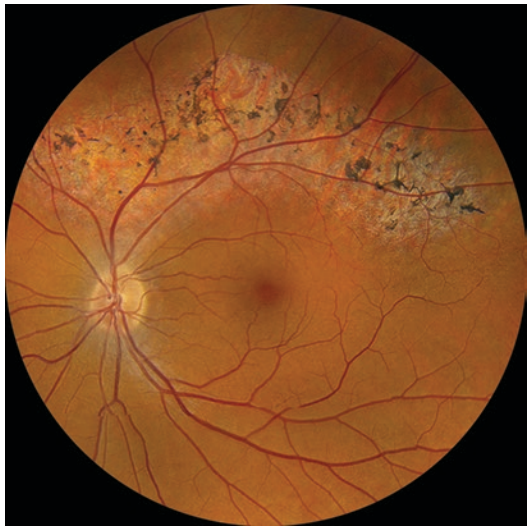

Fig. 10.8 Colour fundus image of a patient with superior sector RP

Table 10.6 Key facts about sector RP

• Specific subtype of RP: usually AD but can be AR
• Usually bilateral and symmetrical

10.6.3 Investigations

- Refraction
- VF: defects usually only in the regions of retinal pigmentation
- ERG: relatively good responses — relative preservation of amplitudes, with mild to moderate sub-abnormalities of both rod- and cone-mediated responses with normal implicit times
- Genetic testing
- OCT: look for CMO

10.6.4 Treatment

- Refractive error correction
- Cataract extraction when indicated
- Treatment of CMO when present: topical/oral CAI's
- Visual impairment registration and referral for low vision aids

10.6.5 Other Diagnoses to Consider

- Prior trauma (e.g. surgical such as a prior RD repair)
- Inflammation or infection: syphilis (congenital or acquired), congenital rubella (normal ERG, cataracts, hearing loss, no arteriolar attenuation), toxoplasmosis, DUSN
- Retinal toxicity: thioridazine, chlorpromazine, chloroquine, hydroxychloroquine, quinine
- Neoplasm (retinal or choroidal) and CAR (autoimmune paraneoplastic retinopathy)

10.7 Age-Related Macular Degeneration (AMD)

10.7.1 Classification of AMD

10.7.1.1 NICE Guidance [NG82]

- Early AMD
  - Low risk of progression
    - Medium drusen (63–124 μm)
    - Pigmentary abnormalities
  - Medium risk of progression
    - Large drusen (≥125 μm)
    - Reticular drusen
    - Medium drusen with pigmentary abnormalities
  - High risk of progression
    - Large drusen with pigmentary abnormalities
    - Reticular drusen with pigmentary abnormalities
    - Vitelliform lesion without significant visual loss (BCVA better than 6/18)
    - Atrophy smaller than 175 μm and not involving the fovea
- Late AMD (indeterminate)
  - RPE degeneration and dysfunction (presence of degenerative AMD changes with SRF or IRF in the absence of neovascularisation)
  - Serous PED without neovascularisation
- Late AMD (dry)
  - Geographic atrophy (in the absence of neovascular AMD)

  - Significant visual loss (6/18 or worse) associated with:
    Dense or confluent drusen
    Advanced pigmentary changes and/or atrophy
    Vitelliform lesion
- Late AMD (wet [neovascular] active)
  - Classic CNV
  - Occult (fibrovascular PED and serous PED with neovascularisation)
  - Mixed (predominantly or minimally classic CNV with occult CNV)
  - RAP
  - PCV
- Late AMD (wet [neovascular] inactive)
  - Fibrous scar
  - Subfoveal atrophy or fibrosis secondary to an RPE tear
  - Atrophy (absence or thinning of RPE and/or retina)
  - Cystic degeneration (persistent IRF or tabulations unresponsive to treatment)

10.7.1.2 The Age-Related Eye Disease Study (AREDS) Severity Scale

- Group 1 (No AMD): none or a few small drusen (<63 μm)
- Group 2 (Early AMD): any or all of the following — multiple small drusen; few intermediate drusen (63–124 μm); RPE abnormalities (increased pigmentation or depigmentation but not geographic atrophy)
- Group 3 (Intermediate AMD): any or all of the following — extensive intermediate drusen; at least one large drusen (≥125 μm, equivalent to the width of a major retinal vein at the optic disc edge), geographic atrophy that does not extend under the center of the macula
- Group 4 (Advanced AMD): presence of geographic atrophy extending under the center of the macula and/or presence of neovascular AMD

10.7.1.3 Rotterdam Classification System

- Grade 0 (no AMD): no signs of AMD at all **OR** hard drusen (<63 μm) only
- Grade 1 (preliminary early AMD): soft distinct drusen (≥63 μm) only **OR** pigmentary abnormalities only
- Grade 2 (early AMD): soft indistinct drusen (yellow lesions with indistinct borders and ≥125 μm in size)/reticular pseudodrusen only **OR** soft distinct drusen (≥63 μm) **AND** pigmentary abnormalities
- Grade 3 (early AMD): soft indistinct drusen (yellow lesions with indistinct borders and ≥125 μm in size)/reticular pseudodrusen **AND** pigmentary abnormalities
- Grade 4 (late AMD): atrophic, neovascular, or mixed AMD

10.7.2 History

- Ask about risk factors for AMD (NICE Guidance [NG82]):
  - Older age
  - Smoking
  - Positive FHx of AMD
  - HTN
  - Presence of AMD in other eye
  - BMI of 30 kg/m^2 or higher
  - Diet high in fat
  - Lack of exercise

10.7.3 Examination

- Non-neovascular (see Fig. 10.9): confluent pale yellow poorly defined soft drusen (intermediate 63–124 μm, large ≥125 μm [width of a retinal vein at the disc edge]) ± RPE focal hyperpigmentation (intraretinal pigment clumping from RPE migration associated with drusen) ± RPE hypopigmentation (associated with drusen) ± RPE atrophy (sharply delineated round or oval area of hypopigmentation or depigmentation with visible choroidal vessels)
- Neovascular (see Fig. 10.10): subretinal (red) or sub-RPE (grey) haemorrhage, subretinal or sub-RPE exudates, retinal or RPE detachment, subretinal fibrosis (disciform scar)

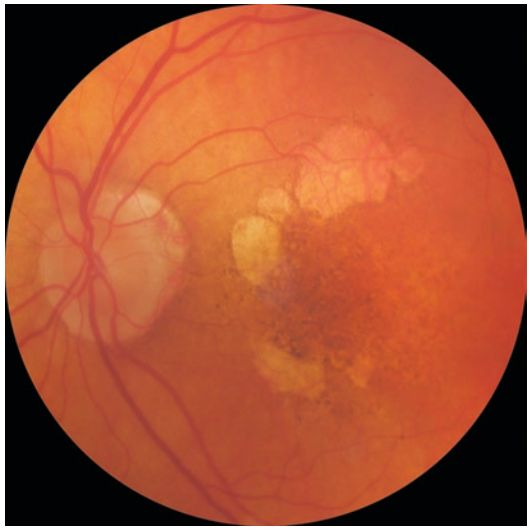

Fig. 10.9 Colour fundus image of a patient with late AMD (dry) showing the presence of geographic atrophy and advanced pigmentary changes

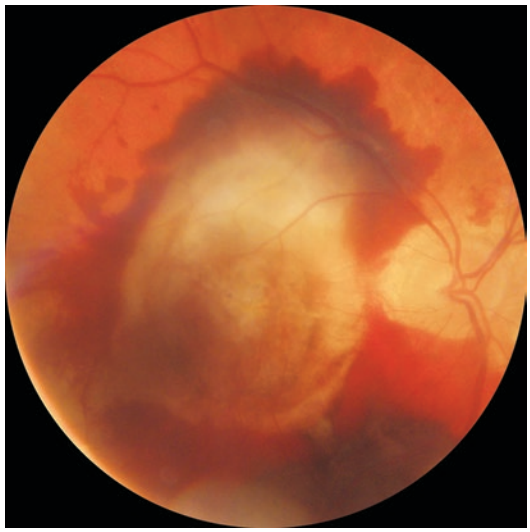

Fig. 10.10 Colour fundus image of a patient with late AMD (wet active) showing the presence of a subretinal haemorrhage with a disciform scar

10.7.4 Investigations

- OCT (see Sect. 2.1.3.5)
- FFA (see Sect. 2.3): perform if late AMD (wet active) suspected to confirm presence of CNV membrane
- ICG: branching vascular network (BVN) in PCV, "hot hyperfluorescent spot" in RAP

10.7.5 Treatment

- Non-neovascular
  - Visual impairment registration and referral to low vision aid service
  - Referral to support groups
  - Refraction with increased near add
  - Amsler grid: advise patients about new or progressive metamorphopsia
  - Lifestyle changes: smoking cessation, increased intake of food rich in macular carotenoids (spinach, broccoli, cabbage) and omega-3 fatty acids (oily fish such as salmon, mackerel, sardines), exercise
  - Vitamin supplementation (indications — advanced AMD in 1 eye, ≥1 large druse or extensive intermediate drusen in 1 or both eyes): AREDS 1 (vitamin C and E, β-carotene, zinc, copper) — 25% reduced risk of progression to advanced AMD at 5 years (The Age-Related Eye Disease Study Research Group 2001), AREDS 2 (vitamin C and E, zinc, copper, lutein, zeaxanthin) — 18% reduced risk of progression to advanced AMD at 5 years (The Age-Related Eye Disease Study 2 (AREDS2) Research Group)
  - Discharge from outpatient department
- Neovascular
  - Visual impairment registration and referral to low vision aid service
  - Referral to support groups
  - Refraction with increased near add
  - Amsler grid: advise patients about new or progressive metamorphopsia
  - Lifestyle changes: smoking cessation, increased intake of food rich in macular carotenoids (spinach, broccoli, cabbage) and omega-3 fatty acids (oily fish such as salmon, mackerel, sardines), exercise
  - Laser photocoagulation: extrafoveal or peripapillary CNV

– Anti-VEGF therapy:

Eligibility criteria (NICE Guidance [NG82]) in the UK:

- BCVA 6/12–6/96
- No permanent structural damage to the central fovea
- Greatest linear dimension of lesion size ≤12 DD
- Evidence of recent disease progression (recent VA changes or blood vessel growth on FFA)
- In eyes with BCVA worse than 6/96 consider anti-VEGF treatment for late AMD (wet active) only if a benefit in the person's overall visual function is expected (e.g. if the affected eye is the persons better seeing eye)

Ranibizumab (Lucentis, Novartis):

- Clinical trials:
  - **MARINA** (Rosenfeld et al. 2006): monthly Lucentis compared with sham injection for minimally classic or occult (see Sect. 5.4.2)
  - **ANCHOR** (Brown et al. 2006): monthly Lucentis compared with vPDT for predominantly classic CNV (see Sect. 5.4.1)
  - **PRONTO** (Fung et al. 2007; Lalwani et al. 2009): PRN dosing (see Sect. 5.4.3)
  - **PIER** (Regillo et al. 2008; Abraham et al. 2010): quarterly dosing (see Sect. 5.4.4)

Aflibercept (Eylea, Bayer):

- Clinical trials:
  - **VIEW 1** and **VIEW 2** (Heier et al. 2012): see Sect. 5.4.6

Bevacizumab (Avastin, Genentech/Roche):

- Clinical trials:
  - **CATT** (The CATT Research Group 2011): see Sect. 5.4.5
  - **IVAN** (Chakravarthy et al. 2013): see Sect. 5.4.7

Brolucizumab (Novartis)

- Not licensed by NICE at present
- Clinical trials:
  - **HAWK** and **HARRIER** (Dugel et al. 2020): see Sect. 5.4.8

10.7.6 Defining Risk for the Development of Advanced AMD

- The AREDS investigators devised a clinical scoring system defining risk categories for development of advanced AMD (The Age-Related Eye Disease Study Research Group 2005a)
- The scoring system tabulates a person score by assigning 1 risk factor to each eye of an individual for the presence of at least 1 large druse (within 2 DD of the foveal center) and 1 risk factor for the presence of any pigment abnormality (increased pigmentation thought to be attributed to AMD, RPE depigmentation, or areas of noncentral geographic atrophy)
- Risk factors are summed across both eyes on which the 5-year risk of developing advanced AMD in at least one eye can be approximated
- Risk of developing advanced AMD is as follows: total score 0, 0.5% risk; 1 factor, 3%; 2 factors, 12%; 3 factors, 25%, and 4 factors, 50%
- Modifications of the scale award persons without any large drusen 1 risk factor if medium sized drusen are present in both eyes and individuals with advanced AMD in their first eye receive a score of 2 for that eye when tabulating the person score to estimate the risk for their fellow eye

10.7.7 Other Diagnoses to Consider

- Polypoidal choroidal vasculopathy (PCV — see Fig. 10.11): black and asian populations, reddish-orange polypoidal lesions and is often associated with serosanguineous PEDs, branching vascular network (BVN) appear as a shallow elevation of the RPE, while the polypoidal lesions appear as sharper protuberances

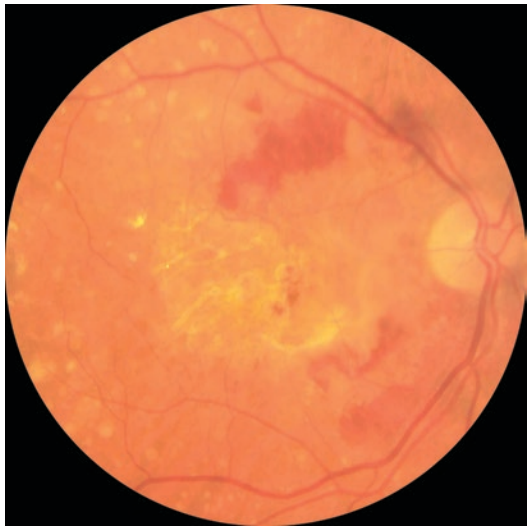

Fig. 10.11 Colour fundus image of a patient with PCV showing a peripapillary and macula subretinal haemorrhage

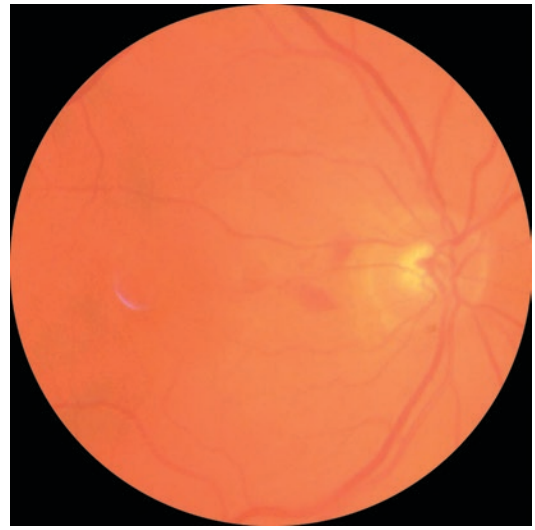

Fig. 10.12 Colour fundus image of a patient with a peripapillary CNV membrane

10.8 Peripapillary Choroidal Neovascular (CNV) Membrane (Fig. 10.12 and Table 10.7)

10.8.1 Causes of Peripapillary CNV Membrane

- Degenerative
  - AMD
  - Angioid streaks
  - Degenerative myopia
  - Laser photocoagulation scars
  - Traumatic choroidal ruptures
- Vascular
  - PCV
- Inflammatory
  - Birdshot chorioretinopathy
  - POHS
  - Sarcoidosis
  - Serpiginous choroiditis
- Optic nerve malformations
  - Optic disc drusen
  - Optic disc pits
  - Retinochoroidal colobomas
- Neoplastic
  - Choroidal naevi
  - Choroidal osteoma
- Idiopathic (up to 39% of cases)

Table 10.7 Key facts about peripapillary CNV membrane

- Peripapillary CNV membranes are defined as a collection of new choroidal blood vessels, any portion of which lies within 1 DD of the nerve head
- Account for 7–10% of all CNV membranes
- Clinical manifestations only occur if the membrane extends over the macula, if the vessels haemorrhage into the subretinal space, or fluid exudation occurs within the macula
- Two types of peripapillary CNV membranes: type 1 — CNV membrane is sub-RPE (e.g. AMD), type 2 — CNV membrane in the subretinal space (e.g. POHS)

10.8.2 Examination

- Peripapillary (within 1 DD) SRF ± subretinal haemorrhages
- Peripapillary fibrotic scar

10.8.3 Investigations

- OCT (see Fig. 10.13): look for presence of SRF
- FFA: look for leakage confirming presence of a CNV membrane
- ICG: look for PCV

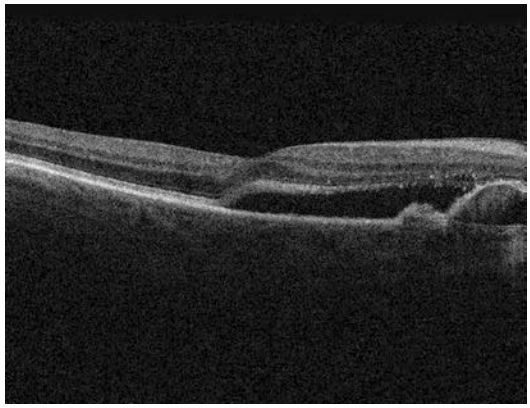

Fig. 10.13 OCT image of a patient with a peripapillary CNV membrane showing SRF tracking to the fovea

10.8.4 Treatment

- Indication: treat when fluid threatening or involving the fovea with reduction of vision
- Options:
  - Anti-VEGF agents: maintains the integrity of the papillomacular bundle
  - Laser photocoagulation: induce scar formation, thermal injury, vitreous haemorrhage, BRAO, damage to the papillomacular bundle

10.9 Myopic Macular Degeneration (Fig. 10.14, Tables 10.8 and 10.9)

10.9.1 Examination

- Tilted optic discs
- Peripapillary atrophy (predominantly temporal to optic disc)
- Patchy or diffuse chorioretinal atrophy: visibility of choroidal vessels
- Lacquer cracks (ruptures of Bruch's membrane): yellowish linear lesions
- Posterior staphyloma: outward protrusion of all layers of the posterior eye globe
- Macular CNV (macular haemorrhage) ± elevated pigmented forster fuchs spot

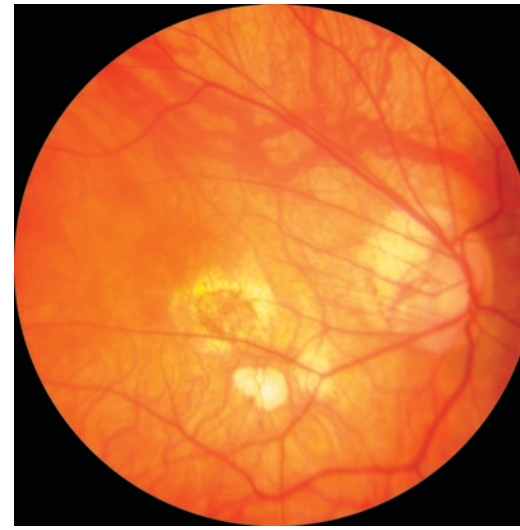

Fig. 10.14 Colour fundus image of a patient with myopic macular degeneration showing diffuse chorioretinal atrophy, tilted optic disc, peripapillary atrophy and a forster fuchs spot

Table 10.8 Myopia definitions

• High myopia is defined as myopia −6.00 D or more or an axial length ≥26.5 mm
• Pathologic myopia is defined as myopia over −8.00 D or an axial length >32.5 mm

Table 10.9 Associations of myopia

• Connective tissue disorders:
– Sticklers syndrome
– Marfan syndrome
– Ehlers-Danlos syndrome
• Infectious:
– Congenital rubella
• Chorioretinal dystrophies:
– Gyrate atrophy
• Others:
– Albinism
– Downs syndrome

10.9.2 Investigations

- Refraction
- B-scan US: posterior staphyloma
- OCT: posterior staphyloma, myopic foveoschisis (split layers have bridge columns between

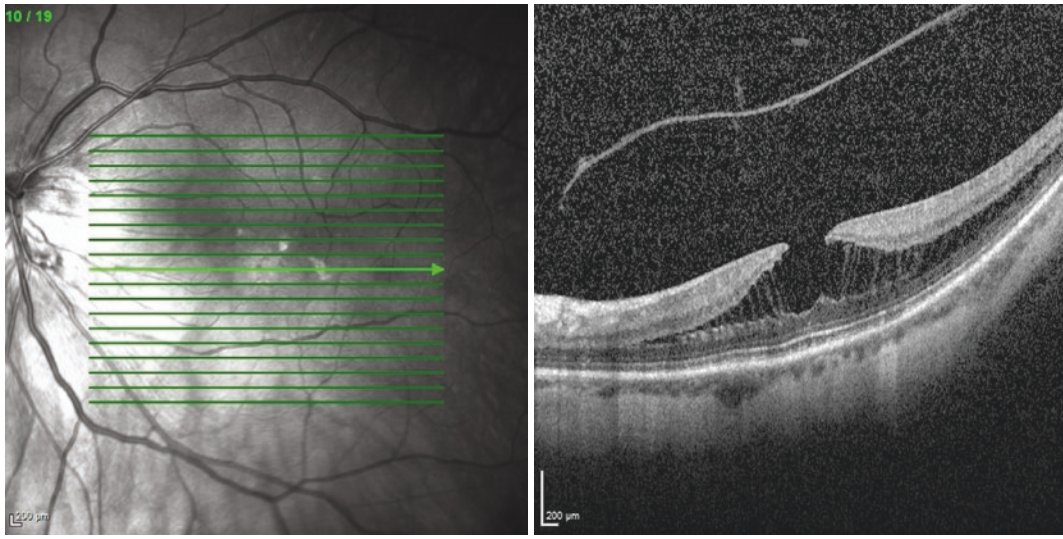

Fig. 10.15 OCT image of a patient with myopic foveoschisis

them, ILM detachment, well preserved IS/OS junction — see Fig. 10.15), macular hole
- FFA: classic CNV membrane

10.9.3 Treatment

- CNV
  - Laser photocoagulation for extrafoveal CNV
  - Anti-VEGF therapy for subfoveal CNV:
    Ranibizumab (Lucentis, Novartis):
    - NICE Guidance [TA298]: ranibizumab is recommended as an option for treating visual impairment due to choroidal neovascularisation secondary to pathological myopia
    - **RADIANCE** study (Wolf et al. 2014): comparison of vPDT and Lucentis — after 3 months of treatment Lucentis showed significantly greater gain in no. of ETDRS letters

    Aflibercept (Eylea, Bayer):
    - NICE Guidance [TA486]: aflibercept is an option treating visual impairment because of myopic choroidal neovascularisation in adults
    - **MYRROR** study (Ikuno et al. 2015): comparison of Eylea and sham injection — at week 24 a gain of 12.1 letters and loss of 2 letters was seen in the Eylea and sham group, respectively.
- Myopic foveoschisis
  - If foveal detachment is found on OCT images, macular hole formation is likely to start in the near future and surgery must be planned soon (1–2 months)
  - If retinoschisis present with no foveal retinal detachment — not an indication for surgery

10.10 Branch Retinal Vein Occlusion (BRVO) (Figs. 10.16, 10.17, and Table 10.10)

10.10.1 Risk Factors

- Arteriosclerosis: HTN, DM, smoking, hyperlipidaemia (including secondary to hypothyroidism)
- Glaucoma
- Ocular inflammatory disease: Behcet's disease, PAN, sarcoidosis, SLE
- Haematological: Protein C, protein S or anti-thrombin deficiency, activated protein C resistance, factor V Leiden, myeloma, Waldenstrom's macroglobulinaemia, antiphospholipid syndrome

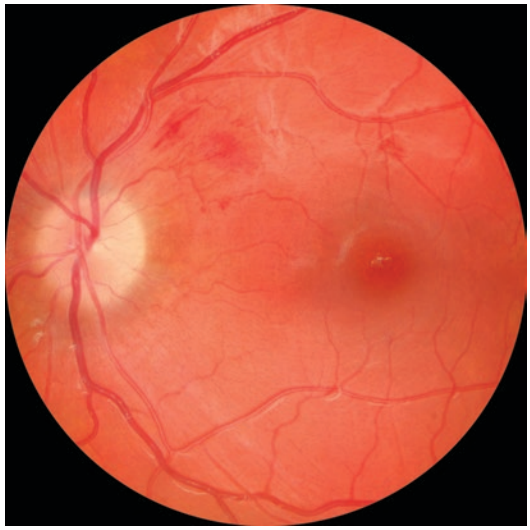

Fig. 10.16 Colour fundus image of a patient with a superior macular BRVO

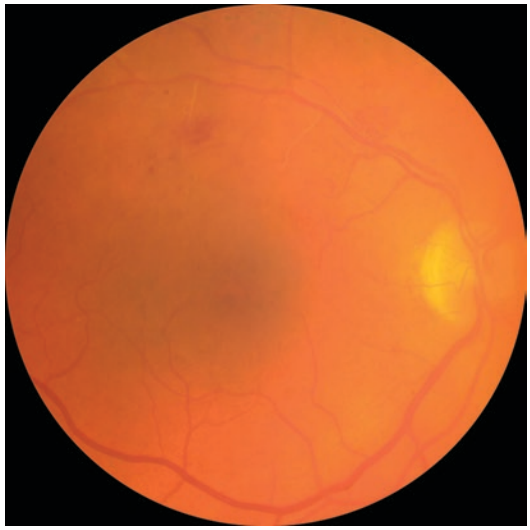

Fig. 10.17 Colour fundus image of a patient with a superotemporal BRVO with NVE

Table 10.10 Key facts about BRVO

- Mostly occurs at arteriovenous crossings
- Retinal artery and vein share a common adventitial sheath — lumen of vein compressed by arteriosclerotic artery at the crossing site
- Venous obstruction leads to elevation of venous pressure that may overload the collateral drainage capacity and lead to macular oedema and ischaemia

10.10.2 Examination

- Acute: wedge shaped segmental distribution of intraretinal haemorrhage in a quadrant of the fundus, narrowed branch retinal vein passing under a retinal artery, dilated and tortuous retinal vein, cotton wool spots
- Chronic: telangiectatic vessels (dilation of capillaries) forming collaterals that cross the horizontal raphe, microaneurysms, exudates, sclerosed retinal vein ± NVE > NVD > NVI
- Check for RAPD
- Check the IOP
- Look for NVI on anterior segment examination
- Perform gonioscopy for NVA

10.10.3 Investigations (RCOphth RVO July 2015 Guidelines)

RCOphth Retinal Vein Occlusion (RVO) Guidelines 2015:

- BP
- Bloods: FBC, ESR, glucose
- OCT: CMO
- FFA (if uncertain diagnosis): delayed filling of the occluded retinal vein, capillary non-perfusion — >5 DD is defined as an ischaemic BRVO (The Branch Vein Occlusion Study Group 1984, 1986), macular ischaemia, telangiectatic vessels forming collaterals that cross the horizontal raphe

10.10.4 Treatment

- Control of cardiovascular risk factors: HTN, hyperlipidaemia, smoking, DM
- Neovascularisation: sectoral PRP — branch vein occlusion study — BVOS (The Branch Vein Occlusion Study Group 1984, 1986) recommended that laser photocoagulation be applied only after NV is observed, which reduces the likelihood of vitreous haemorrhage from about 60% to 30%

- Macular oedema
  - Laser photocoagulation:

    BVOS (The Branch Vein Occlusion Study Group 1984, 1986):
    - An RCT that aimed to answer three questions: (1) can laser photocoagulation improve VA compared to observation in eyes with macular oedema from BRVO that reduces the vision to 6/12 or worse; (2) Can sectoral PRP prevent the development of NV; (3) Can sectoral PRP prevent vitreous haemorrhage
    - Wait for at least 3 months if VA 6/12 or worse before considering laser therapy to allow clearing of intraretinal haemorrhages to permit FFA and evaluation of macular oedema and macular ischaemia
    - If perfused macular oedema accounts for the visual loss, and vision continues to be 6/12 or worse without spontaneous improvement, consider grid macular photocoagulation (0.1 s duration, 100 μm spot size, power titrated to produce a "medium" white burn) to the leaking area demonstrated by FFA
    - After 3 years of follow-up, 65% of treated eyes gained 2 or more lines of vision compared to 37% of untreated eyes
  - Dexamethasone implant (Ozurdex, Allergan):

    NICE Guidance [TA 229]: recommend as an option for treatment of macular oedema due to a BRVO when treatment with laser photocoagulation has not been beneficial or treatment with laser photocoagulation is not considered suitable because of the extent of retinal haemorrhages

    GENEVA study (Haller et al. 2010): A RCT that evaluated the effects of a single dexamethasone implant compared to sham injection for the treatment of macular oedema secondary to BRVO and CRVO. Increase in BCVA of ≥15 ETDRS letters was achieved in 30% of the Ozurdex 0.7 mg group, 26% of the Ozurdex 0.35 mg group, and 13% of the sham group 60 days after injection (peak response) and was maintained through day 90 in BRVO patients. There was no difference between either of Ozurdex groups and the sham group at day 180.
  - Ranibizumab (Lucentis, Novartis):

    NICE Guidance [TA283]: recommend as an option for treatment of macular oedema due to a BRVO when treatment with laser photocoagulation has not been beneficial or treatment with laser photocoagulation is not considered suitable because of the extent of retinal haemorrhages

    BRAVO study (Campochiaro et al. 2010): A RCT to evaluate the efficacy and safety of Lucentis in the treatment of macular oedema from BRVO. Patients were randomised into 3 groups: (1) sham injection; (2) 0.3 mg Lucentis; and (3) 0.5 mg Lucentis. In the first 6 months, injections were given monthly. At 6 months, both Lucentis groups gained +16.6 and +18.3 ETDRS letters (0.3 mg and 0.5 mg groups, respectively) compared with a gain of +7.3 letters in the control group. At 6 months, 55.2% and 61.1% of patients receiving Lucentis 0.3 mg and 0.5 mg gained ≥3 ETDRS lines compared to 28.8% in the sham injection group
  - Aflibercept (Eylea, Bayer):

    NICE Guidance [TA305]: recommend as an option for treatment of visual impairment caused by macular oedema following BRVO

    VIBRANT study (Campochiaro et al. 2015): A RCT that evaluated the efficacy and safety of Eylea compared to macular grid laser in the treatment of macular oedema from BRVO or HRVO. After 6 months of treatment, 26.7% of the laser group gained ≥3 ETDRS lines compared to 52.7% in the

Eylea group. Mean change in letters from baseline was +6.9 letters in the laser group compared to +17.0 letters in the Eylea group.

10.10.5 Prognosis

- BVOS (The Branch Vein Occlusion Study Group 1984, 1986)
  - Only eyes with ischaemic BRVO (>5 DD of retinal capillary non-perfusion) are at risk of developing NV — 40% of these eyes develop NV, and of these 40%, 60% will experience periodic vitreous haemorrhage
  - Retinal or disc NV, or both, may develop at any time within the first 3 years after an occlusion but are most likely to appear within the first 6–12 months after the occlusion
  - Up to 10% of patients with BRVO in one eye will develop any type of RVO in the fellow eye

10.10.6 Other Diagnoses to Consider

- Macular telangiectasia
- Susac syndrome: BRAO, sensorineural hearing loss, subacute encephalopathy, hyperintense lesions in the corpus callosum on T2 MRI
- Diabetic retinopathy
- Radiation retinopathy
- Retinal inflammation: Sarcoidosis, Behcet's disease

10.11 Central Retinal Vein Occlusion (CRVO) (Fig. 10.18)

10.11.1 Risk Factors

- Arteriosclerosis: HTN, DM, smoking, hyperlipidaemia (including secondary to hypothyroidism)
- Glaucoma
- Ocular inflammatory disease: Behcet's disease, PAN, sarcoidosis, SLE

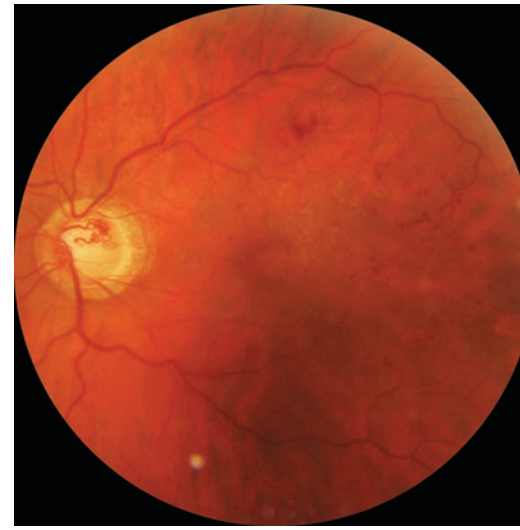

Fig. 10.18 Colour fundus image of a patient with a chronic CRVO showing the presence of telangiectatic vessels and optociliary shunt vessels

- Haematological: Protein C, protein S or antithrombin deficiency, activated protein C resistance, factor V Leiden, myeloma, Waldenstrom's macroglobulinaemia, antiphospholipid syndrome
- Pharmacological: oral contraceptive pill

10.11.2 Examination

- Acute: retinal haemorrhages (flame shaped and deep blot type) in all four quadrants of the fundus with a dilated tortuous retinal venous system, cotton wool spots, optic disc swelling, CMO
- Chronic: optociliary shunt vessels (collateral vessels connecting the choroidal and the retinal vasculature — do not leak on FFA - see Fig. 10.19 and Table 10.11), telangiectatic capillary bed, persistent dilatation and tortuosity, perivenous sheathing, NVI > NVD > NVE, CMO, glaucomatous optic neuropathy
- Check for a RAPD
- Check the IOP
- Look for NVI on anterior segment examination
- Perform gonioscopy for NVA

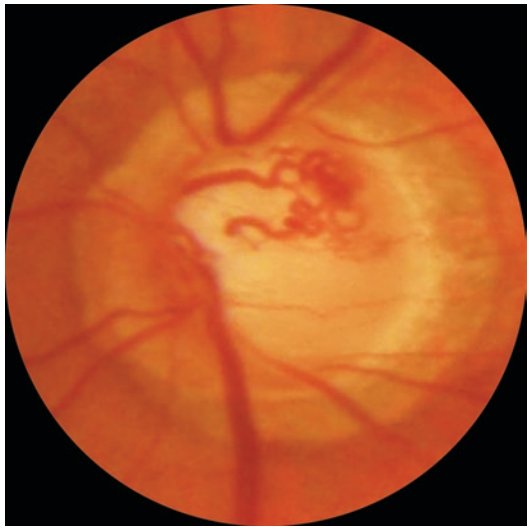

Fig. 10.19 Colour fundus image of a patient with optociliary shunt vessels from a chronic CRVO

Table 10.11 Causes of optociliary shunt vessels

• CRVO
• Chronic glaucoma
• Chronic papilloedema
• Optic nerve sheath meningioma

10.11.3 Investigations

RCOphth RVO Guidelines 2015:

- BP
- Bloods — FBC (leukaemia), ESR (myeloma), glucose
- OCT — CMO
- FFA (uncertain diagnosis) — delayed filling of the occluded retinal vein, capillary non-perfusion, macular ischaemia, telangiectatic vessels forming collaterals that cross the horizontal raphe

10.11.4 Treatment

- Control of cardiovascular risk factors: HTN, hyperlipidaemia, smoking cessation, DM
- RCOphth RVO guideline 2015 recommends that oestrogen containing HRT and OCP should not be commenced in women with history of RVO. However, the continued use in a patient who develops RVO does not appear to be associated with a higher rate of recurrence
- Neovascularisation:
  - Full scatter PRP — central vein occlusion study — **CVOS** (The Central Vein Occlusion Study Group 1997) recommended that laser photocoagulation be applied only after NV is observed, with greater resolution of NVI/NVA by 1 month after PRP in 56% of no early treatment eyes (no NVI or NVA present) compared with 22% of early treatment eyes (NVI or NVA present)
- Macular oedema
  - Dexamethasone Implant (Ozurdex, Allergan):

    NICE Guidance [TA229]: recommend as an option for the treatment of macular oedema following CRVO

    GENEVA study (Haller et al. 2010): A RCT that evaluated the effects of a single dexamethasone implant compared to sham injection for the treatment of macular oedema secondary to BRVO and CRVO. Increase in BCVA of ≥15 ETDRS letters was achieved in 29% of the Ozurdex 0.7 mg group and 9% of the sham group 60 days after injection but not at 90 or 180 days.
  - Ranibizumab (Lucentis, Novartis):

    NICE Guidance [TA283]: recommend as an option for treatment of visual impairment caused by macular oedema following CRVO

    CRUISE study (Brown et al. 2010): A RCT to evaluate the efficacy and safety of Lucentis in the treatment of macular oedema from CRVO. Patients were randomised into 3 groups: (1) sham injection; (2) 0.3 mg Lucentis; and (3) 0.5 mg Lucentis. In the first 6/12, injections were given monthly. At 6/12, both Lucentis groups gained +12.7 and +14.9 ETDRS letters (0.3 mg and 0.5 mg groups, respectively) compared with a gain of +0.8 letters in the control group. At 6 months, 46.2% and 47.7% of patients receiving Lucentis 0.3 mg and 0.5 mg gained ≥3 ETDRS lines compared to 16.9% in the sham injection group
  - Bevacizumab (Avastin, Roche/Genetech):

    Off license treatment, where licensed treatments are not available

  - Aflibercept (Eylea, Bayer):
    NICE Guidance [TA305]: recommend as an option for treatment of visual impairment caused by macular oedema following CRVO
    CORPERNICUS study (Boyer et al. 2012): comparison of Eylea and sham injection — the proportion of patients who gained ≥15 letters from baseline in the Eylea and sham groups was 56.1% and 12.3% at week 24, respectively
    GALILEO study (Holz et al. 2013): comparison of Eylea and sham injection — the proportion of patients who gained ≥15 letters from baseline in the Eylea and sham groups was 60.2% and 22.1% at week 24, respectively
- Delay in initiating treatment up to 6 months results in fewer visual gains compared to immediate initiation of treatment. Therefore, treatment should be initiated as soon as the diagnosis is established (RCOphth RVO Guidelines 2015)
- Careful consideration should be given to further therapy in such eyes that do not improve in terms of snellen VA or OCT central subfield thickness after three loading injections at monthly intervals and treatment with anti-VEGF is not recommended if no response occurs after six injections (RCOphth RVO Guidelines 2015)
- No robust data on outcomes of switching steroid to an anti-VEGF agent or switching between anti-VEGF agents or combining steroids with anti-VEGF agents for macular oedema due to CRVO (RCOphth RVO Guidelines 2015). However, eyes with suboptimal response to steroids may be switched to anti-VEGF therapy or vice versa.

10.11.5 Follow up

- Non-ischaemic CRVO (may resolve completely without any complications): initial follow up every 3 months for 6 months, follow up for at least 2 years but the development of disc collaterals and the resolution of macular oedema for at least 6 months should allow the discharge of the patient from clinical supervision (RCOphth RVO Guidelines 2015)
- Ischaemic CRVO (see Table 10.12): follow up after 6 months should be every 3 months for 1 year (RCOphth RVO Guidelines 2015)
- RCOphth RVO guidelines 2015 recommends that oestrogen containing HRT and OCP should not be commenced in women with history of RVO. However, the continued use in a patient who develops RVO does not appear to be associated with a higher rate of recurrence

Table 10.12 Features suggestive of an ischaemic CRVO

- Poor VA (CVOS — 44% of eyes with vision of <6/60 develop rubeosis)
- RAPD
- Presence of multiple dark deep intraretinal haemorrhages
- Presence of multiple cotton wool spots
- Degree of venous dilation and tortuosity
- FFA showing greater than 10-disc areas of capillary non-perfusion on 7 field FFA (CVOS)
- ERG: reduced b wave amplitude, reduced b:a ratio (negative ERG) and prolonged b-wave implicit time

10.11.6 Prognosis

- At 3 years, there was a 45% chance of developing neovascular glaucoma after onset of ischaemic CRVO — highest risk if VA <6/60 or >10 DD of non-perfusion on FFA (The Central Vein Occlusion Study Group 1997)
- Overall, 34% of initially perfused eyes converted to non-perfused status after 3 years (The Central Vein Occlusion Study Group 1997)
- Risk of CRVO in contralateral eye is 5% by 1 year (RCOphth RVO Guidelines 2015)

10.12 Central Retinal Artery Occlusion (CRAO) (Fig. 10.20)

10.12.1 Risk Factors

- Arteriosclerosis: HTN (60%), DM (25%), smoking, hyperlipidaemia
- Embolic sources: carotid artery disease, aortic disease (dissection), cardiac valve vegetations

(infective endocarditis), cardiac tumours (atrial myxoma), arrhythmias, cardiac septal defects
- Inflammatory disease: GCA, PAN, GPA, SLE
- Haematological: antiphospholipid syndrome, leukaemia, lymphoma,

10.12.2 Examination

- Acute — retinal whitening in the posterior pole (ischaemic damage to the inner half of the retina), cherry red spot (normal appearing retina and is observed in high contrast against the surrounding opacified retina), box carring of retinal arteries, retinal emboli (Hollenhorst plaque — yellow refractile cholesterol embolus frequently found at bifurcation sites, calcific emboli — white, non-refractile, proximal to optic disc, platelet-fibrin clot — elongated), optic disc oedema
- Chronic (fundus may appear featureless) — optic atrophy, retinal arterial attenuation, cilioretinal collaterals, macular RPE changes, cotton wool spots, NVD (2%), NVE, NVI (18%)
- Check for a RAPD
- Check the IOP
- Look for NVI on anterior segment examination

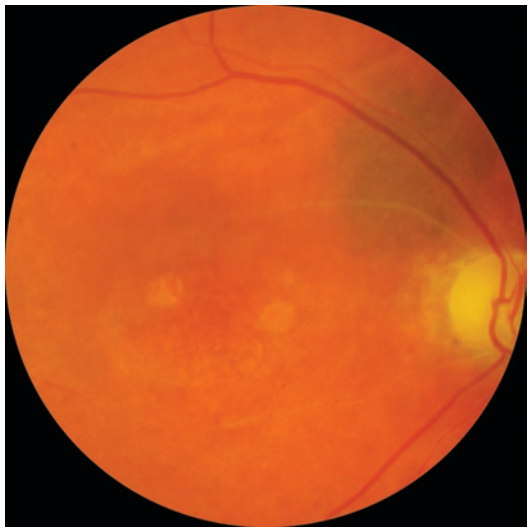

Fig. 10.20 Colour fundus image of a patient with a long standing CRAO

10.12.3 Investigations

- BP
- Glucose
- FBC, CRP, ESR ± temporal artery biopsy (TAB): rule out GCA if patient age >50 years
- OCT: inner retinal oedema in acute CRAO, inner retinal atrophy with outer retinal preservation in long standing CRAO (see Fig. 10.21)
- FFA: delayed filling of the retinal arteries (see Fig. 10.22)
- HVF: altitudinal defect
- ERG: negative ERG with the scotopic white stimulus

10.12.4 Treatment

- If within 4 h of onset: reduce IOP with 500 mg IV diamox, ocular massage (dislodge emboli), AC paracentesis (all treatment options described here have limited evidence for its effectiveness)

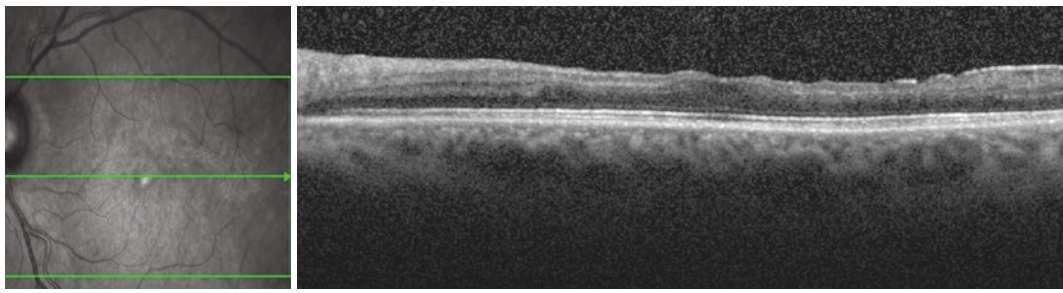

Fig. 10.21 OCT image of a patient with a chronic CRAO with inner retinal atrophy

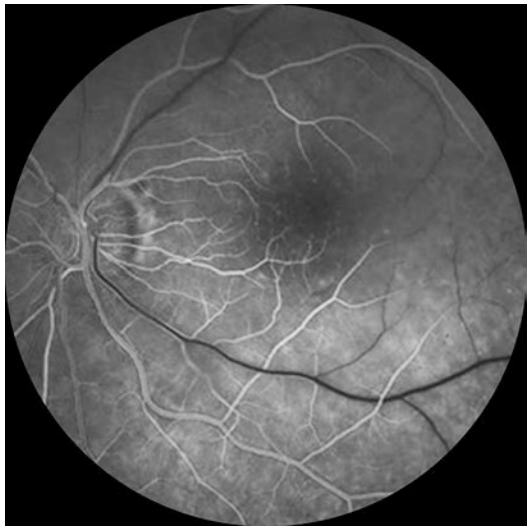

Fig. 10.22 Fundus fluorescein angiogram of a patient with CRAO showing delayed filling of the retinal arteries

- If GCA suspected: start steroids and arrange TAB
- If embolic, refer to stroke (TIA) clinic for carotid doppler ± echocardiography
- Treat NV: PRP

10.13 Diabetic Retinopathy (DR) (Fig. 10.23)

10.13.1 Proposed International Clinical Diabetic Retinopathy and Diabetic Macular Edema Severity Scales 2003

- Mild Non-proliferative DR (NPDR)
  - Microaneurysms (MAs) only
- Moderate NPDR
  - More than just MA's but less than severe NPDR
- Severe NPDR (4-2-1 rule)
  - One or more of the following:
    - More than 20 intraretinal haemorrhages in each of 4 quadrants
    - Definite venous beading in 2 or more quadrants
    - Prominent intraretinal microvascular abnormalities (IRMA) in 1 or more quadrants
- Very severe NPDR
  - Two or more features of severe NPDR present
- Proliferative DR (PDR)
  - One or more of the following:
    - Extraretinal neovascularisation
    - Vitreous or preretinal haemorrhage
- Mild DMO
  - Some retinal thickening or hard exudates in the posterior pole, distant from the center of the macula
- Moderate DMO:
  - Retinal thickening or hard exudates near the center of the macula but not involving the center
- Severe DMO:
  - Retinal thickening or hard exudates involving the center of the macula

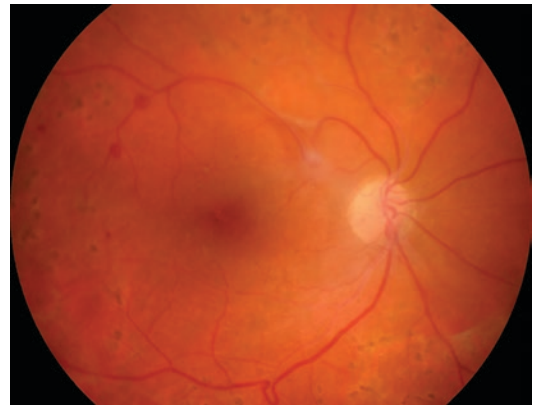

Fig. 10.23 Colour fundus image of a patient with active PDR; PRP commenced but incomplete

10.13.2 High-Risk PDR

- Defined by the Diabetic Retinopathy Study (The Diabetic Retinopathy Study Research Group 1981) with patients at higher risk of visual loss and requires prompt PRP treatment
  - Neovascularisation of the disc (NVD — new vessels on or within 1DD of the optic

disc): NVD ≥¼ disc area or any size NVD with vitreous and/or preretinal haemorrhage
- Neovascularisation elsewhere in the retina (NVE): NVE ≥½ disc area with vitreous and/or preretinal haemorrhage

10.13.3 Clinically Significant Macular Oedema (CSMO)

- Defined by the Early Treatment of Diabetic Retinopathy Study (Early Treatment Diabetic Retinopathy Study Research Group. ETDRS Report number 9. 1991a):
  - Retinal thickening at or within 500 μm of the centre of the macula and/or
  - Hard exudates at or within 500 μm of the centre of the macula, if associated with thickening of the adjacent retina and/or
  - Zone or zones of retinal thickening 1-disc area or larger, any part of which is within 1 DD of the center of the macula

10.13.4 Examination

- NPDR
  - MAs (small red dots)
  - Intraretinal haemorrhages: dot and blot haemorrhages, flame haemorrhages (located in NFL)
  - Hard exudates: sharply demarcated yellow-white deposits within the retina
  - Cotton wool spots (CWS — patches of relative ischaemia affecting the NFL of the retina): small white patches with wispy borders situated in the inner retina
  - Venous beading: localised areas of change in vessel calibre with alternating regions of relative dilation and constriction
  - Venous loops
  - IRMA (see Fig. 10.24): segments of dilated and tortuous retinal vasculature without crossing both arterioles or veins in the underlying retina
  - Subretinal fibrosis
- PDR

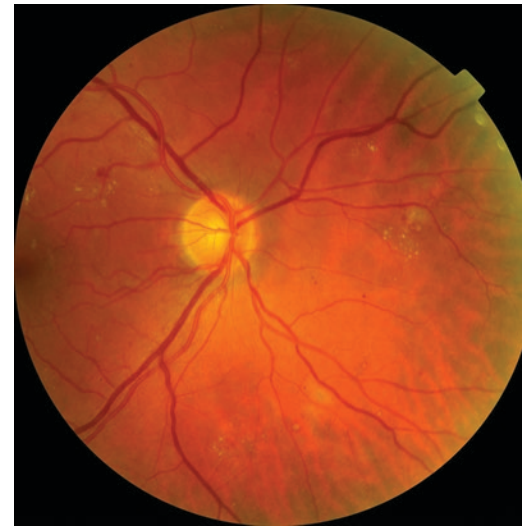

Fig. 10.24 Colour fundus image of a patient with severe NPDR showing the presence of IRMA

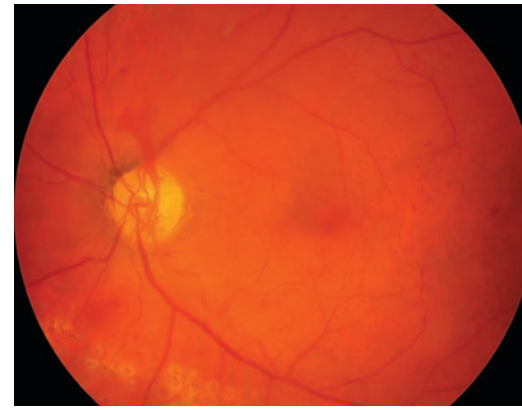

Fig. 10.25 Colour fundus image of a patient with PDR with active NVD, and incomplete PRP

  - NVD (see Fig. 10.25): wheel like network of vessels on or within 1 DD of the disc
  - NVE (see Fig. 10.26): superficial location lying over retinal veins, formation of wheel-like networks, cross both arterioles and veins in the underlying retina, regressing new vessels appear to become sheathed
  - NVI/NVA
  - Concave tractional RD (see Fig. 10.27) ± distortion or displacement (dragging) of the macula

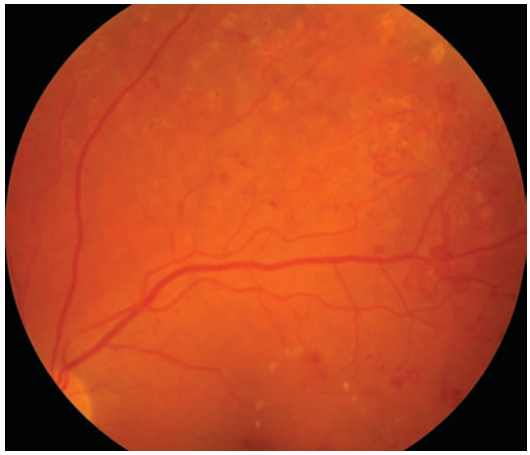

Fig. 10.26 Colour fundus image of a patient with PDR with active NVE (PRP commenced)

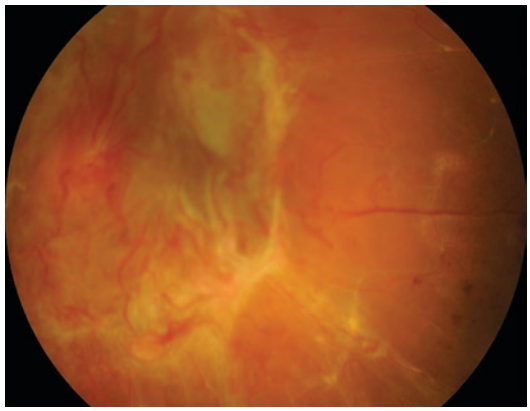

Fig. 10.27 Colour fundus image of a patient with PDR with a tractional RD involving the fovea

10.13.5 Investigations

- Venous fasting glucose ≥7.0 mmol/L ± oral glucose tolerance test (75 g anhydrous glucose) with a 2-h value ≥11.1 mmol/L ± random venous glucose ≥11.1 mmol/L
- OCT
  - Hard exudates appear as hyperreflective foci within the retina
  - Macular oedema
  - Traction from ERM or VMT causing underlying macular oedema in the absence of retinal vascular leakage demonstrable by FFA
- FFA
  - MAs appear as hyperfluorescent dots visible during the arteriovenous transit phase
  - Intraretinal haemorrhages appear hypofluorescent blocking normal fluorescence from the underlying choroid
  - Hard exudates appear hypofluorescent
  - CWS appear hypofluorescent
  - IRMA appear hyperfluorescent during the arteriovenous transit phase and are often situated at the borders of areas of capillary non-perfusion
  - Macular oedema: petaloid pattern of leakage
  - NVD/NVE: leakage

10.13.6 Treatment

- NPDR
  - Modification of life-style:
    Smoking cessation
    Weight loss
    Exercise
  - Modification of systemic risk factors:
    Hyperglycaemia control:
    - **DCCT** (Diabetes Control and Complications Trial Research Group 1995): type 1 DM — tight control of HbA1C at mean of 7.2% was associated with 76% reduction in onset of retinopathy and slowed progression of DR by 54%, 60% reduction in onset of neuropathy, and 54% reduction in onset of nephropathy at 6.5 years
    - **UKPDS** (UK Prospective Diabetes Study Group 1998): type 2 DM — tight control of HbA1C at mean of 7% was associated with a 25% reduction in the onset of microvascular disease
    - **ACCORD** (The ACCORD Study Group and ACCORD Eye Study Group 2010): type 2 DM — intensive control of HbA1C reduced progression of DR by 42% and reduced development of PDR from 10.2% to

6.5%: avoid Pioglitazone in the presence of macular oedema, personalized HbA1c target should be set, usually between 48–58 mmol/mol (6.5–7.5%)

BP control:

- **UKPDS** (UK Prospective Diabetes Study Group 1998): type 2 DM — tight control of BP at mean of 144/82 was associated with a 37% reduction in the onset of microvascular disease and 32% reduction in diabetes related deaths

Lipid control:

- **ACCORD** (The ACCORD Study Group and ACCORD Eye Study Group 2010): type 2 DM — 40% reduction in the odds of having progression of DR over 4 years in patients allocated to fenofibrate in combination with a statin, compared to simvastatin alone): consider adding fenofibrate to a statin for NPDR in type 2 DM, avoid statins in pregnancy

- CSMO
  - Focal/grid laser:

    ETDRS (Early Treatment Diabetic Retinopathy Study Research Group. ETDRS Report number 9. 1991a): focal/grid laser reduced the risk of moderate vision loss (loss of ≥15 letters from baseline) by 50% at 3 years in eyes with mild or moderate NPDR with CSMO

    Indicated if CMT <400 μm and CSMO is not center involving (RCOphth Diabetic Retinopathy Guidelines 2012)
  - Anti-VEGF therapy:

    Aflibercept (Eylea, Bayer):
    - NICE Guidance [TA346]: option for treatment of DMO if CMT ≥400 μm at the start of treatment
    - Regimen: a single injection every month for five consecutive months, followed by one injection every 2 months with no requirement for monitoring between visits for the first 12 months
    - Clinical trials:
      - **VISTA** study (Brown et al. 2015)
      - **VIVID** study (Brown et al. 2015)

    Ranibizumab (Lucentis, Novartis):
    - NICE Guidance [TA274]: option for treatment of DMO if CMT ≥400 μm at the start of treatment
    - Regimen: given monthly and continued until maximum VA is reached (VA stable for three consecutive months):
    - Clinical trials:
      - **RISE** study (Nguyen et al. 2012; Brown et al. 2013)
      - **RIDE** study (Nguyen et al. 2012; Brown et al. 2013)
      - **RESTORE** study (Mitchell et al. 2011)

    Off license bevacizumab
  - Corticosteroids:

    Dexamethasone implant (Ozurdex, Allergan):
    - NICE Guidance [TA349]: option for treatment of DMO if eye is pseudophakic and CSMO does not respond to non-corticosteroid treatment or such treatment is unsuitable
    - Regimen: A single implant is injected into the vitreous and remains in the vitreous for up to 270 days before fully dissolving
    - Clinical trials:
      - **MEAD** study (Boyer et al. 2014)
      - **BEVORDEX** study (Gillies et al. 2014)
      - **PLACID** study (Callanan et al. 2013)

    Fluocinolone implant (Iluvien, Alimera):
    - NICE Guidance [TA301]: option for the treatment of chronic CSMO that is insufficiently responsive to available therapies if an eye is pseudophakic
    - Regimen: A single 190 μm of Fluocinolone Acetonide implant is injected with daily release of 0.2 μg/day for 36 months

- Clinical trials:
  - **FAME** study (Cunha-Vaz et al. 2014)

- PDR
  - Modification of life-style:
    Smoking cessation
    Weight loss
    Exercise
  - Modification of systemic risk factors (same as for NPDR)
  - Pan-retinal photocoagulation (PRP):
    Indications (The Royal College of Ophthalmologists Diabetic Retinopathy Guideline 2012): presence of NVD/NVE/NVI/NVA — PRP performed on same day or within 2 weeks of diagnosis, consider PRP for severe/very severe NPDR in older patients with type 2 DM, where retinal view is difficult, prior to cataract surgery, in only eye where first eye lost to PDR, where regular clinic attendance is likely to be poor, difficult to examine patient for other reasons
    Prognosis (The Diabetic Retinopathy Study Research Group 1981): PRP reduces severe vision loss (<5/200 at two consecutive visits) from high risk PDR by 50% at 2 years
  - Vitrectomy:
    Indications (The Royal College of Ophthalmologists Diabetic Retinopathy Guideline 2012): non-clearing (within 3 months for type 2 diabetic and 1 month for a type 1 diabetic) severe vitreous haemorrhage (confirmation of attached retina not possible with ophthalmoscopic examination), significant recurrent vitreous haemorrhage despite maximal PRP, tractional RD involving or threatening the fovea, combined tractional rhegmatogenous RD which involves or threatens to involve the fovea, diffuse CSMO associated with posterior hyaloidal traction
    Prognosis (The Diabetic Retinopathy Vitrectomy Study Research Group 1988): early vitrectomy (for those with severe vitreous haemorrhage with VA 5/200 or worse) increased chance of 20/40 vision from 12% to 36% in type 1 diabetics

10.13.7 Diabetic Retinopathy in the Context of Cataract Surgery

- Coexisting PDR should be treated with laser PRP preoperatively where possible if visualisation is allowed otherwise indirect laser treatment may be performed at the conclusion of the cataract surgery

10.13.8 Diabetic Maculopathy in the Context of Cataract Surgery

- Maculopathy should ideally be fully treated (macular laser treatment or anti-VEGF treatment) with resolution of oedema prior to cataract surgery
- For cases in which macular oedema persists despite treatment at the time of cataract surgery, it is reasonable to consider adjunctive treatment with intravitreal triamcinolone injected at the completion of cataract surgery

10.14 Von Hippel Lindau (VHL) Syndrome (Fig. 10.28 and Table 10.13)

10.14.1 History

- Positive FHx (AD)

10.14.2 Examination

- Peripheral capillary haemangioblastoma (red nodular lesion) with the majority located in the ST midperipheral retina ± optic nerve capillary haemangioblastoma
- Normal to dilated and tortuous afferent and efferent vessels (paired retinal arteriole and venule) that may extend all the way posterior to the disc

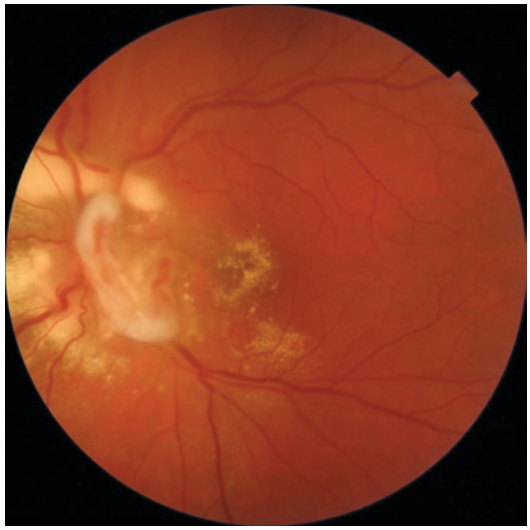

Fig. 10.28 Colour fundus image of a patient with VHL syndrome with an optic nerve capillary haemangioblastoma with subsequent intraretinal and subretinal exudation

Table 10.13 Key facts about VHL syndrome

- Retinal capillary haemangioblastomas are benign hamartomas of the retinal (or optic disc) vasculature, consisting of capillary-like vessels — may be isolated or may be multiple and bilateral as part of a systemic disease (VHL syndrome)
- VHL is an AD, multisystem, familial cancer syndrome caused by germline mutations in the VHL tumour suppressor gene
- VHL is characterised by ocular retinal capillary haemangioblastomas as well as systemic tumours such as cerebellar or spinal cord haemangioblastomas, renal cell carcinoma, phaechromocytomas, and islet cell carcinoma
- Diagnosis of VHL can be made in an individual with multiple tumours or isolated tumours with a positive FHx

- Intraretinal and subretinal exudation: formation of circinate retinopathy and exudative RD — exudates may accumulate preferentially in the macula (centripetal flow of subretinal fluid)

10.14.3 Investigations

- Standard colour fundus photography: assist with follow up to confirm growth, stability or regression following treatment
- FFA: rapid sequential filling of artery, haemangioma, and vein with diffuse leakage of fluorescein in the mid and late frames
- BP: HTN from phaechromocytomas
- 24 hour urine collection: vanillylmandelic acid (VMA) and metanephrines
- Abdominal US scan: renal cell carcinoma, islet cell carcinoma
- MRI brain/spinal cord: cerebellar or spinal cord haemangioblastomas

10.14.4 Treatment

- Refer to geneticist, physician or oncologist for systemic evaluation
- Laser photocoagulation (most suited for small tumours <1 DD): burns of large size (>500 μm), low intensity, and long duration (0.2–0.5 s) are applied directly to surface of the angioma ± feeder vessels
- Trans-scleral cryotherapy (for larger lesions, when media clarity poor, tumours located to anterior equator): 2–3 freeze-thaw cycles
- Radiotherapy

10.14.5 Other Diagnoses to Consider

- Retinal vascular disorders: acquired vasoproliferative retinal tumours, Coats disease, retinal artery macroaneurysm, racemose haemangioma, retinal cavernous haemangioma
- Tumours: retinal astrocytoma, retinoblastoma, malignant melanoma
- Inflammatory disorders: toxoplasmosis, toxocariasis

10.15 Angioid Streaks (Fig. 10.29 and Table 10.14)

10.15.1 Causes of Angioid Streaks

- Pseudoxanthoma elasticum (PXE or Gronbald-Strandberg syndrome — AR connective tissue disorder, optic disc drusen)
- Ehlers-Danlos syndrome
- Paget's disease
- Sickle cell retinopathy/β-thalassaemia
- Idiopathic
- Acromegaly

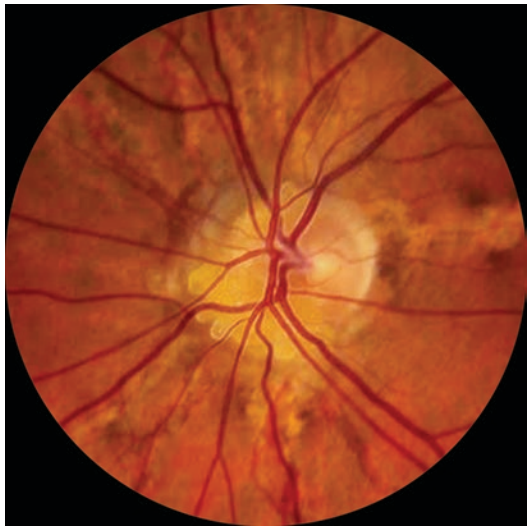

Fig. 10.29 Colour fundus image of a patient with angioid streaks radiating from the optic disc as well as optic disc drusen

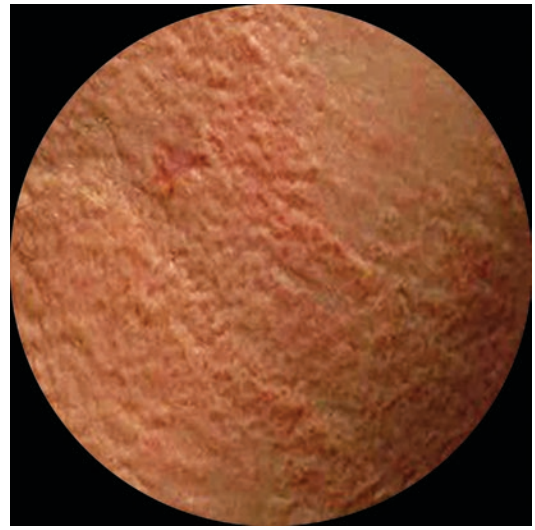

Fig. 10.30 Colour photo of the neck of a patient with PXE showing the typical papular skin lesions

Table 10.14 Key facts about angioid streaks

• Angioid streaks are breaks in an abnormally thickened and calcified Bruch's membrane

10.15.2 Examination

- Irregular reddish brown subretinal lines of varying widths that radiate out from the optic nerve to the retinal periphery
- CNV membrane ± subfoveal haemorrhage ± choroidal rupture (after minor trauma)
- Optic disc drusen
- Perform a systemic examination to look for papular skin lesions and skin laxity of the neck (see Fig. 10.30), axilla, and antecubital fossa

10.15.3 Investigations

- FFA: look for leakage for CNV membrane, hyperfluorescence of angioid streaks in the early phase with late staining

10.15.4 Treatment

- Avoid contact sports
- CNV: subfoveal — anti-VEGF therapy, extrafoveal — laser photocoagulation

10.16 Optic Disc Pits (Fig. 10.31 and Table 10.15)

10.16.1 Examination

- Small hypopigmented yellow or whitish oval or round excavated defect, most often within the inferior temporal portion of the optic cup

10.16.2 Investigations

- OCT: serous macular detachment

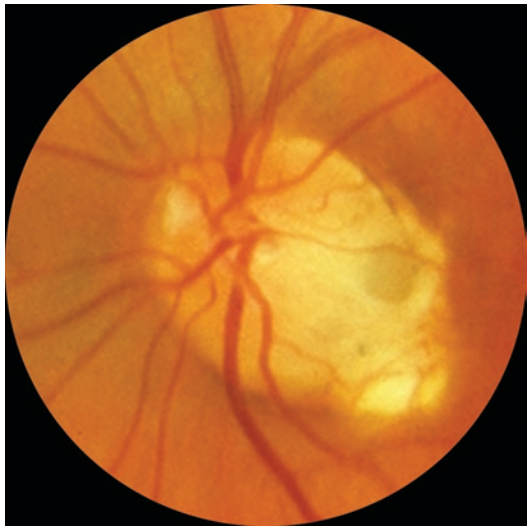

Fig. 10.31 Colour fundus image of a patient with an optic disc pit

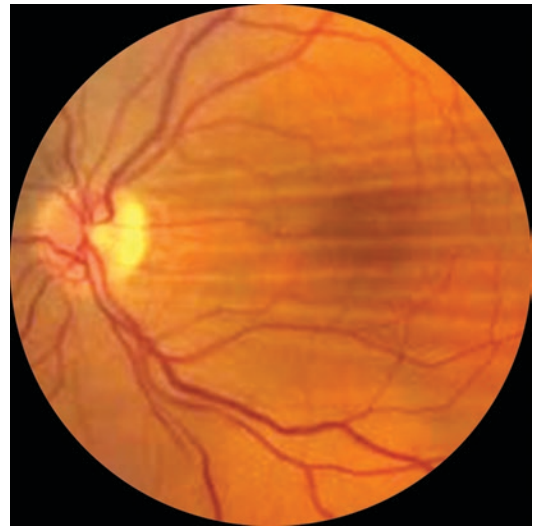

Fig. 10.32 Colour fundus image of a patient with choroidal folds

Table 10.15 Key facts about optic disc pits

• 40–60% of patients with optic disc pits develop non-rhegmatogenous serous macular detachments

10.16.3 Treatment

- Serous macular detachment:
  - Conservative: observation — 25% of optic disc pit maculopathies resolve spontaneously
  - Laser photocoagulation along temporal disc margin
  - Surgical: PPV ± ILM peeling ± Endolaser + long acting gas tamponade

10.17 Choroidal Folds (Fig. 10.32)

10.17.1 Causes of Choroidal Folds

- Ocular
  - Hypotony
  - Posterior scleritis
  - Uveitis
  - Choroidal lesions — tumours, disciform scars
- Orbit
  - TED
  - Retrobulbar mass
  - Idiopathic orbital inflammatory disease
- Intracranial:
  - Raised ICP
- Idiopathic:
  - Hypermetropia — bilateral in asymptomatic individuals

10.17.2 Examination

- Parallel alternating yellow and dark bands on the posterior pole

10.17.3 Investigations

- OCT (see Fig. 10.33)

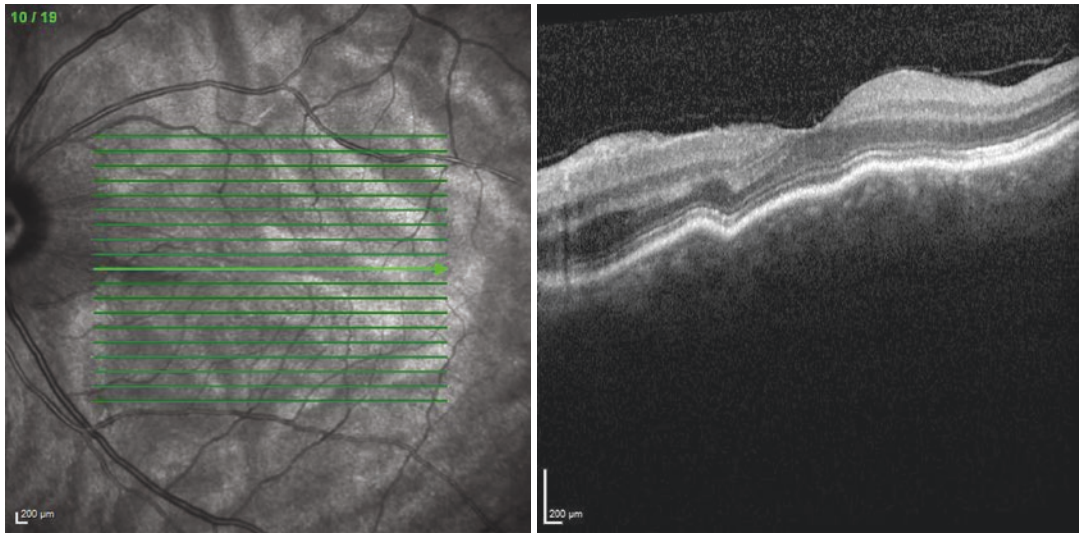

Fig. 10.33 OCT image of a patient with choroidal folds

10.17.4 Treatment

- Treat underlying cause

10.18 Choroideraemia (Fig. 10.34 and Table 10.16)

10.18.1 Examination

- RPE and choroidal atrophy with exposure of bare sclera: may get preservation of the choroid and RPE in the macula
- Relative sparing of retinal vessels and optic disc

10.18.2 Investigations

- VF — constricted
- Genetic testing
- ERG — reduced or absent scotopic (affected first) and photopic responses

10.18.3 Treatment

- There is currently no licensed treatment available for choroideraemia

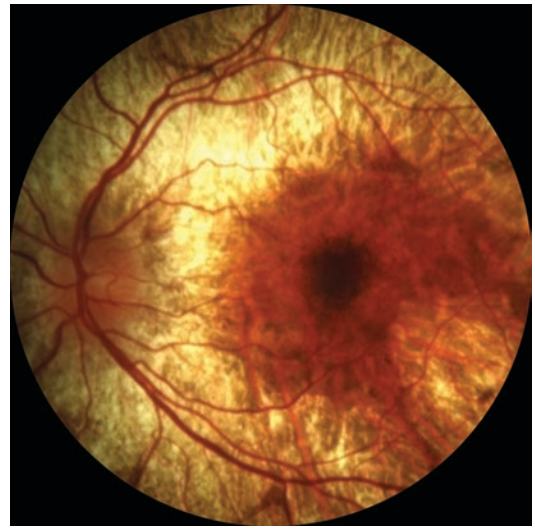

Fig. 10.34 Colour fundus image of a patient with choroideremia showing diffuse chorioretinal atrophy of the peripheral retina with preservation at the central macula

Table 10.16 Key facts about Choroideraemia

• X-linked recessive condition characterised by generalised degeneration of the retina and choroid

10.19 X-Linked Retinoschisis (Fig. 10.35 and Table 10.17)

10.19.1 History

- Positive FHx — X-linked recessive inheritance

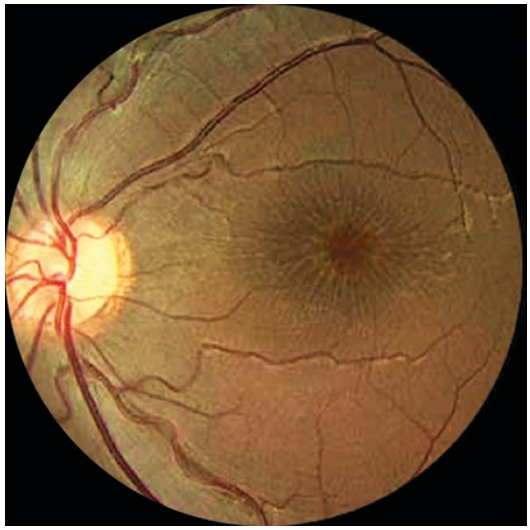

Fig. 10.35 Colour fundus image of a patient with X-linked retinoschisis showing the typical spokewheel pattern of folds radiating out from the fovea

Table 10.17 Key facts about X-linked retinoschisis

• Inherited retinal degenerative disease • Most common form of juvenile onset retinal degeneration in males

10.19.2 Examination

- Foveal schisis: spokewheel pattern of folds radiating out from the fovea
- Peripheral retinoschisis: often in the inferotemporal region

10.19.3 Investigations

- OCT — splitting of the foveal neurosensory retina in the NFL
- EDT — negative ERG — reduced b-wave amplitude with preservation of a-wave amplitude
- FFA — absence of leakage — differentiates foveal schisis from CMO

10.19.4 Treatment

- Genetic counselling
  - Carrier women have 50% chance of transmitting the mutation in each pregnancy
  - Males with the mutation will be affected and females with the mutation will be carriers
  - Affected males pass the disease-causing mutation to all of their daughters and none of their sons
- Medical — carbonic anhydrase inhibitors
- Surgical — if tractional or rhegmatogenous RD or vitreous haemorrhage present

10.19.5 Other Diagnosis to Consider

- CMO — late hyperfluorescence in a petaloid pattern
- Degenerative retinoschisis — bilateral, hypermetropes, smooth convex elevation, inferotemporal region, laser take up, absolute scotoma in schitic areas, split retina within OPL
- Goldmann Favre vitreoretinal degeneration — AD inheritance, foveal schisis, marked VF loss, pigmentary clumping, absence of vitreous veils, markedly reduced a-waves and b-waves

10.20 Macular Telangiectasia (MacTel) Type 2 (Fig. 10.36 and Table 10.18)

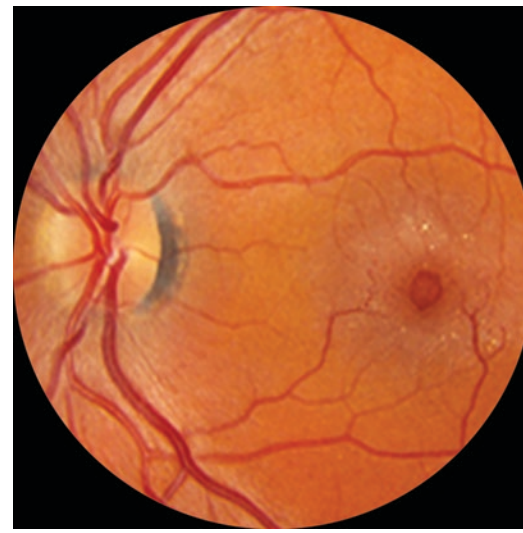

Fig. 10.36 Colour fundus image of a patient with MacTel type 2 showing dilation of capillaries in the temporal parafoveal region

Table 10.18 Key facts about MacTel type 2

- Disease characterised by telangiectatic vessels in the Juxtafoveal region, which tends to be bilateral but asymmetrical
- Middle aged and older persons
- All lesions begin temporal to the fovea but may subsequently involve the entire parafoveolar area
- Other diagnoses to consider:
  - MacTel type 1 — developmental or congenital, usually unilateral vascular anomaly (may be part of the larger spectrum of Coats disease)
  - Diabetic retinopathy
  - Vascular occlusion
  - Eales disease
  - Radiation retinopathy
  - ROP
  - Sickle cell retinopathy

10.20.1 Examination

- Subtle loss of retinal transparency in the perifoveal region, beginning temporally
- Dilation of the parafoveal capillaries in the temporal parafoveal area, which may extend to surround the fovea
- Crystalline deposits at the vitreoretinal interface
- Right angled venules ± RPE hyperplasia and intraretinal pigment migration
- CNV or associated sequelae — subretinal or intraretinal haemorrhage, intraretinal oedema, retinal hard exudates, fibrovascular disciform scar

10.20.2 Investigations

- OCT (see Fig. 10.37) — subfoveal cystoid cavities (retinal cavity formations) ± photoreceptor disruption (IS/OS junction) ± outer retinal atrophy
- FAF — loss of normal hypofluorescence at the fovea with abnormally increased autofluorescence at the fovea
- FFA — telangiectatic vessels starting predominantly temporal to the fovea with eventual involvement of entire parafoveal area with early hyperfluorescence and late leakage

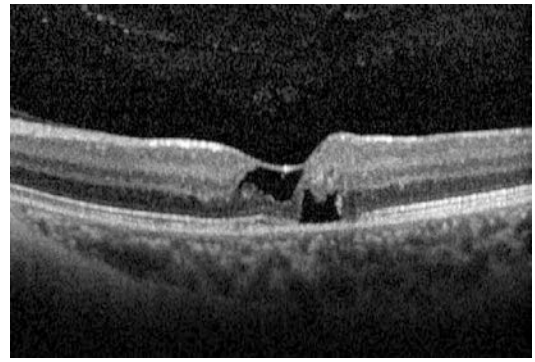

Fig. 10.37 OCT image of a patient with MacTel type 2 showing subfoveal cystoid cavities

10.20.3 Treatment

- CNV — anti-VEGF therapy

10.20.4 Other Diagnoses to Consider

- BRVO — segmental capillary changes, involves an area distal to an arteriolar-venular crossing, and does not cross the horizontal raphe unless there is already collateral formation
- Radiation retinopathy — involves larger area of retina, cotton wool spots, preretinal NV, hx of radiation to the eye, orbit or head
- Neovascular AMD — drusen, RPE changes, uncommon to have retinal capillary disease

10.21 Birdshot Chorioretinopathy (Fig. 10.38 and Table 10.19)

10.21.1 Examination

- Multiple small (1/4–1/2 DD) oval or round cream coloured lesions scattered around the optic disc that radiate out to the equator — lesions become atrophic but not pigmented
- Optic disc oedema leading to atrophy
- Vitritis (≤2+ vitreous haze)
- Retinal vasculitis (phlebitis)

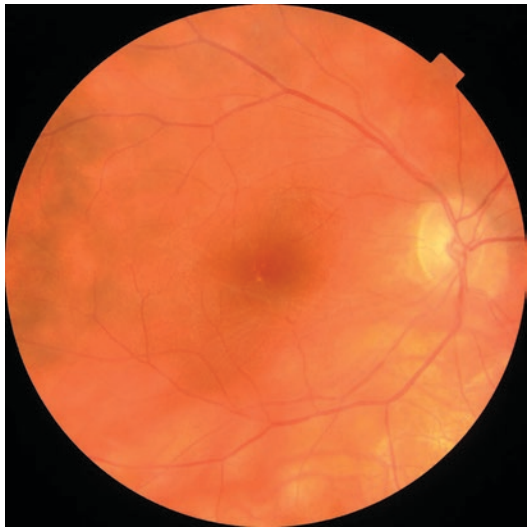

Fig. 10.38 Colour fundus image of a patient with birdshot chorioretinopathy with multiple scattered cream coloured oval lesions and an ERM

Table 10.19 Key facts about birdshot chorioretinopathy

• Bilateral condition • Middle aged Caucasian adults with a slight female preponderance • Chronic inflammation with natural course of 6–10 years

- CMO
- ERM
- CNV (5% of eyes)

10.21.2 Investigations

- OCT — CMO, ERM
- FFA — look for CNV and retinal vasculitis
- ICG — hypofluorescent (choroidal ischaemia or blockage from inflammatory infiltrates) birdshot lesions during active disease with diffuse late hyperfluorescence
- HLA-testing — positive HLA-A29
- VF — peripheral constriction, enlarged blind spot, central or paracentral scotomas
- ERG — negative ERG (reduced B wave amplitude and latency), delay in implicit time of 30 Hz flicker (to assess progression)

10.21.3 Treatment

- CMO — corticosteroids + long term immunosuppresants
- CNV — anti-VEGF therapy

10.21.4 Other Diagnoses to Consider

- Sarcoidosis
- Syphilitic chorioretinitis
- Multifocal choroiditis and panuveitis
- Sympathetic ophthalmia/VKH
- Intraocular B-cell lymphoma

10.22 Presumed Ocular Histoplasmosis Syndrome (POHS) (Fig. 10.39 and Table 10.20)

10.22.1 Examination

- Discrete focal atrophic (i.e. punched out) choroidal scars in the macula or periphery

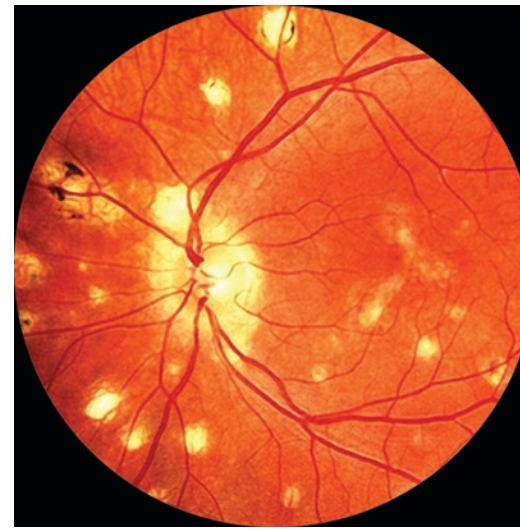

Fig. 10.39 Colour fundus image of a patient with POHS with multiple punched out atrophic chorioretinal spots and peripapillary atrophy

Table 10.20 Key facts about POHS

- An inflammatory disorder that has been postulated to result from systemic infection with the dimorphic fungi *Histoplasma capsulatum*
- Only presumed, not proven
- Histoplasma occurs mainly in Mississippi Valley; not identified in UK
- A clinical diagnosis is based on the presence of at least two of the following fundus lesions in one or both eyes in the absence of ocular inflammation

- Peripapillary chorioretinal scarring (i.e. peripapillary atrophy)
- CNV or associated sequelae — haemorrhagic RD, fibrovascular disciform scar
- Absence of anterior and posterior inflammation

10.22.2 Investigations

- FFA — look for leakage to confirm presence of a CNV

10.22.3 Treatment

- Steroid therapy if inflammation active, and vision threatening
- CNV — anti-VEGF therapy

10.22.4 Other Diagnoses to Consider

- Multifocal choroiditis with panuveitis: multiple chorioretinal scars, significant anterior and posterior inflammation present in the active phase ± CNV, bridging scars, subretinal fibrosis, clustering of lesions (e.g. macula, equator), narrow or sheathed vessels, progressive growth of lesions
- Sarcoidosis — usually accompanied by anterior and posterior inflammation, no peripapillary atrophy or CNV, elevated ACE, hilar adenopathy on CXR or CT chest
- Punctate inner choroidopathy (PIC) — predominantly seen in women, no anterior/posterior inflammation, no peripapillary atrophy, atrophic scars, CNV
- Myopic degeneration — peripapillary atrophy, CNV, small white focal areas of chorioretinal atrophy along with linear atrophic areas (e.g. lacquer cracks) in the posterior pole

10.23 Toxoplasmosis (Fig. 10.40 and Table 10.21)

10.23.1 Examination

- Acute lesions — intensely white focal lesions with overlying vitreous inflammatory haze adjacent ("headlight in the fog") to old hyperpigmented scars (satellite lesions), periphlebitis
- Chronic lesions — hyperpigmented scars with an atrophic center devoid of all retinal and

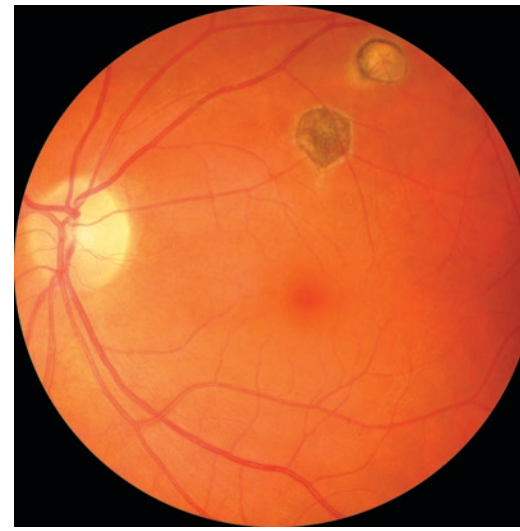

Fig. 10.40 Colour fundus image of a patient with congenital toxoplasmosis with multiple hyperpigmented scars

Table 10.21 Key facts about toxoplasmosis

- Caused by T. gondii
- Acquired from ingestion of oocyte from contaminated soil or the cyst form in undercooked infected meat — high risk of contamination from contact with cat faeces, litter boxes, or potentially contaminated outdoor sand and soil

choroidal elements — the underlying sclera gives the lesion its white center
- Check the IOP
- Perform an anterior segment examination to look for any visually significant cataract

10.23.2 Investigations

- VDRL — rule out syphilis
- ACE, CXR — rule out sarcoidosis
- HIV serology — rule out HIV

10.23.3 Treatment

- Inflammation
  - In immunocompetent patients, the disease is self-limiting and does not require treatment unless sight threatening
  - Indications for treatment:
    Lesions involving the disc, macula, or papillomacular bundle
    Lesions threatening a major vessel
    Marked vitritis
    Any lesion in an immunocompromised patients
  - No corticosteroids if patient is immunocompromised
  - Triple therapy: pyrimethamine, sulfadiazine, folinic acid, corticosteroids
  - Co-trimoxazole (trimethoprim + sulfamethoxazole) + corticosteroids
  - Intravitreal dexamethasone + clindamycin
  - Oral clindamycin
  - Spiramycin or atovaquone if maternal infection acquired during pregnancy (15% in the first trimester and 60% in the third trimester risk of fetal transmission if acquired during pregnancy)
- Cataract — extraction once uveitis is inactive for ≥3 months

10.23.4 Other Diagnoses to Consider

- Infectious — TB, syphilis, rubella, CMV retinitis, herpes simplex, toxocariasis
- Non-infectious — sarcoidosis

10.24 Multifocal Choroiditis and Panuveitis (MFC) (Fig. 10.41 and Table 10.22)

10.24.1 Examination

- Acute phase — yellow round or oval lesions in the posterior pole, peripapillary region and midperiphery ± subretinal fluid, vitritis ± anterior uveitis, periphlebitis
- Chronic phase — punched out atrophic scars with variable hyperpigmentation, peripapillary subretinal fibrosis, bridging subretinal fibrosis between atrophic scars, peripheral linear streak chorioretinal scars parallel to the ora, optic disc atrophy, CNV membrane (25–30%), CMO

10.24.2 Investigations

- OCT — CMO
- FFA — early hypofluorescence and late staining of lesions, leakage for CNV membrane
- ICG — hypofluorescent round spots with staining of edges

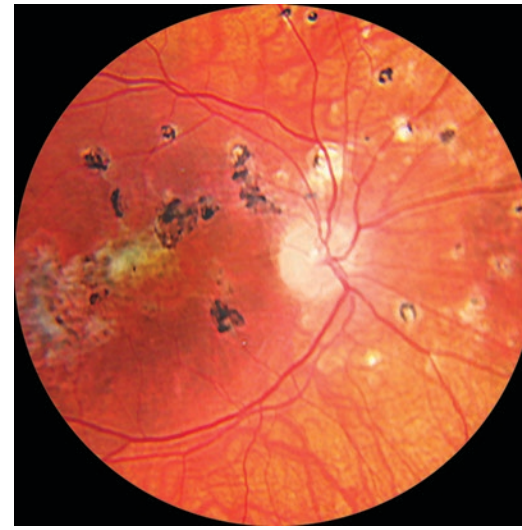

Fig. 10.41 Colour fundus image of a patient with MFC showing multiple hyperpigmented punched out atrophic scars in the posterior pole and peripapillary region

Table 10.22 Key facts about MFC

• Typically affects myopic caucasian women between the second and sixth decades of life (most affected patients are in their 30s)

10.24.3 Treatment

- CMO — topical, periocular, intraocular, and systemic corticosteroids
- CNV — anti-VEGF therapy

10.24.4 Other Diagnoses to Consider

- Inflammatory — POHS (no vitritis), PIC (posterior pole, no vitritis), Sarcoidosis, VKH syndrome/Sympathetic ophthalmia, Serpiginous choroidopathy, Birdshot chorioretinopathy
- Infectious — TB, syphilis
- Degenerative — Myopic degeneration maculopathy
- Neoplastic masquerading diseases — intraocular lymphoma

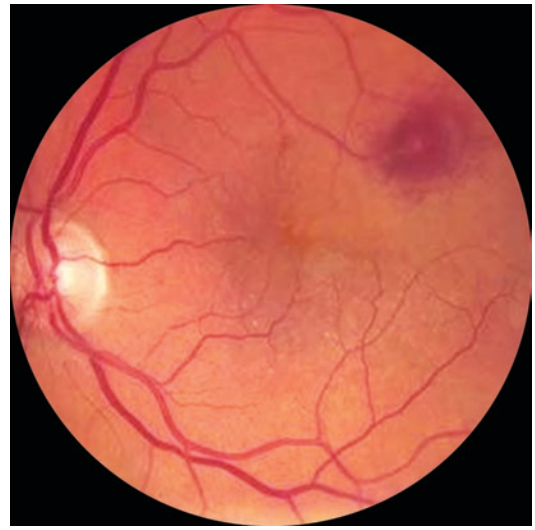

Fig. 10.42 Colour fundus image of a patient with a retinal arterial macroaneurysm

10.25 Retinal Arterial Macroaneurysm (Fig. 10.42)

10.25.1 Risk Factors

- HTN
- Diabetes

10.25.1.1 Examination

- Fusiform or round dilatations of the retinal arterioles that occur in the posterior fundus within the first three orders of arteriolar bifurcation
- Hourglass retinal haemorrhage (subretinal, intraretinal, sub-ILM, vitreous) ± retinal oedema ± retinal exudation

10.25.2 Investigations

- FFA — hyperfluorescence of macroaneurysm in the early arterial phase with leakage in the late stage

10.25.3 Treatment

- Conservative: most spontaneously thrombose and undergo involution with clearing of exudates
- Laser photocoagulation (if lipid exudation involves or threatens the fovea): treat around the macroaneurysm with a single confluent laser barrier — if leakage persists, repeat procedure with direct laser of the lesion
- Vitrectomy: non-clearing vitreous haemorrhage

10.25.4 Other Diagnoses to Consider

- Diabetic retinopathy
- Retinal telangiectasia
- Retinal capillary angioma
- Cavernous haemangioma
- Haemorrhagic PED of AMD

10.26 Choroidal Naevus (Fig. 10.43)

10.26.1 Examination

- Flat or minimally elevated slate-grey lesion with irregularly defined margins ± surface drusen

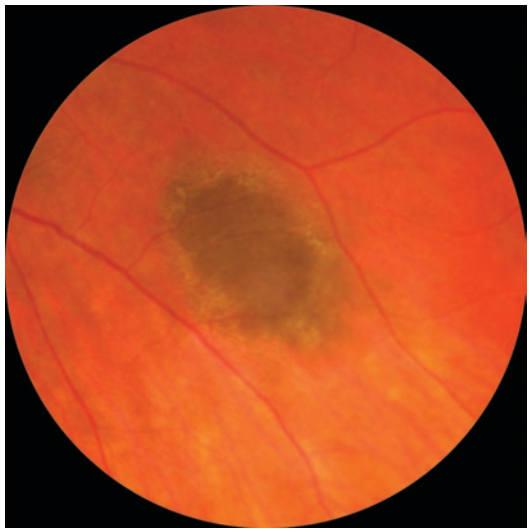

Fig. 10.43 Colour fundus image of a patient with a flat choroidal naevus with surface drusen

Table 10.23 When to refer a patient with a choroidal lesion (The RCOphth Clinical Guideline on Referral pathways for adult ocular tumours 2019)

Refer patients with a suspicious choroidal melanocytic tumour having:
- Any one of the following:
  (a) Thickness more than 2 mm
  (b) Collar stud configuration
  (c) Documented growth

OR
- Any two of the following:
  (a) Thickness more than 1.5 mm
  (b) Orange pigment
  (c) Symptoms
  (d) Serous RD

10.26.2 Investigations

- Colour fundus photography — documentation
- B-scan US — determine tumour thickness

10.26.3 Treatment

- If no suspicious features are present, these lesions do not require regular ophthalmic review. Naevus photographed and a copy is given to the patient to permit their own optometrist to monitor the lesion (e.g. annually) as part of their routine optometric review
- Refer patients if suspicious features are present in accordance with the RCOphth guidelines (see Table 10.23)

10.26.4 Other Diagnoses to Consider for a Pigmented Choroidal Lesion

- Choroidal melanoma (see Table 10.24) — more elevation, medium-low internal reflectivity on A-scan US, irregular elevated acoustically hollow choroidal mass on B-scan US

Table 10.24 Features suggestive of a choroidal melanoma (Shield et al. 2009)

"To Find Small Ocular Melanomas Using Helpful Hints Daily"
- **T**hickness: more than 2 mm
- **F**luid: presence of SRF (serous RD)
- **S**ymptoms: photopsias
- **O**range pigment: lipofuscin
- **M**argin: tumour margin within 3 mm of the optic disc
- **U**ltrasonography **H**ollowness
- **H**alo absence (in halo choroidal naevus the lesion is surrounded by a depigmented yellow ring)
- **D**rusen absence

Tumours that display a single factor have a 38% chance for transformation

Tumours with two or more factors show transformation in over 50% of cases at 5 years

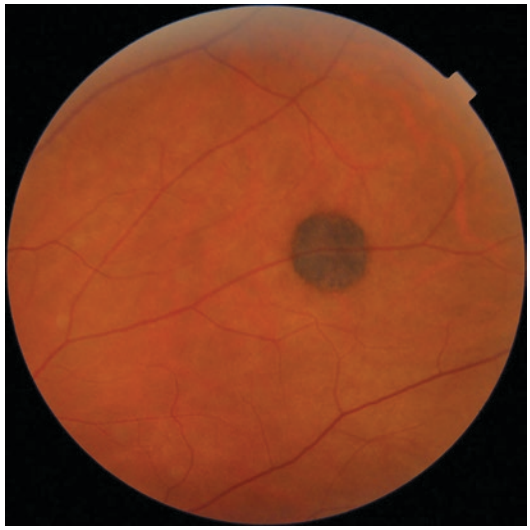

Fig. 10.44 Colour fundus image of a patient with a solitary CHRPE with intralesional lacunae (or loss of RPE hyperpigmentation)

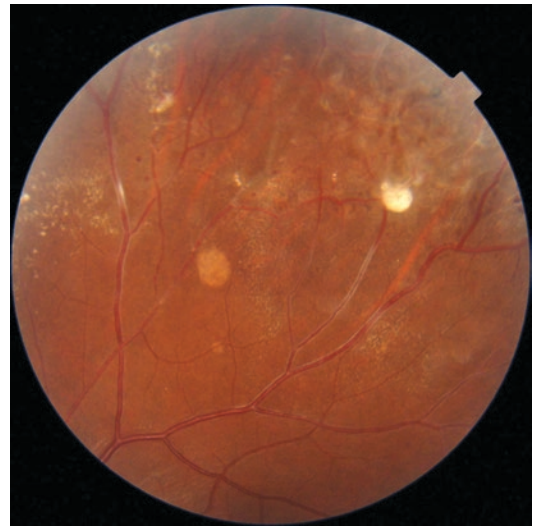

Fig. 10.45 Colour fundus image of a patient with Coats disease showing intraretinal and subretinal exudates, venous sheathing and arteriolar aneurysmal dilations

- Congenital hypertrophy of the RPE (CHRPE — see Fig. 10.44) — typically unilateral, solitary or grouped ("bear-track"), darkly pigmented, round, well circumscribed, flat lesions at the level of the RPE, intralesional lacunae, CHRPE-like lesions associated with FAP (Gardner syndrome — AD) are similar in appearance but are bilateral multiple and pisciform in shape
- Choroidal metastasis — indistinct or irregular margins, creamy-yellow colour, often associated with a serous RD out of proportion to size of tumour, B-scan US for an area of mild choroidal elevation with f A-scan, positive hx of prior malignancy, if no prior history of malignancy — CT chest (lung Ca) and breast imaging (breast Ca)

10.27 Coats Disease (Fig. 10.45 and Table 10.25)

Table 10.25 Key facts about Coat's disease

- Idiopathic condition characterised by telangiectatic and aneurysmal retinal vessels with intraretinal and subretinal exudation and fluid
- Disease affects males 3× as often as females
- Unilateral in 80–95% of cases

10.27.1 Examination

- Localised, yellow, intraretinal and subretinal exudation ± exudative RD associated with adjacent vascular anomalies, including venous sheathing and beading, telangiectasia (irregular dilation of the capillary bed), tortuosity, arteriolar aneurysmal dilatation ("light bulb" aneurysms) ± NVD ± NVE
- Check IOP (neovascular glaucoma)
- Perform an anterior segment examination to look for NVI and cataract

10.27.2 Investigations

- FFA — capillary non-perfusion between dilated telangiectatic vessels, leakage of dye from telangiectatic vessels and disc neovascularisation

10.27.3 Treatment

- Retinal telangiectasia present only: follow conservatively

- Subretinal exudation or fluid present: focal laser photocoagulation (first line treatment), or cryotherapy (if extensive subretinal exudation or RD) to areas of leaking telangiectatic vasculature and capillary non-perfusion ± adjuvant anti-VEGF injection (helps reduce subretinal fluid and macular exudation)
- Surgery for eyes with advanced exudative RD abutting the crystalline lens or those with a rhegmatogenous component to the detachment

10.27.4 Other Diagnoses to Consider

- BRVO
- Peripheral vasculitis (pars planitis)
- Eales disease
- Ocular toxocariasis
- FEVR — retinal dragging, positive FHx, bilateral
- Persistent fetal vasculature

10.28 Choroidal Osteoma (Fig. 10.46 and Table 10.26)

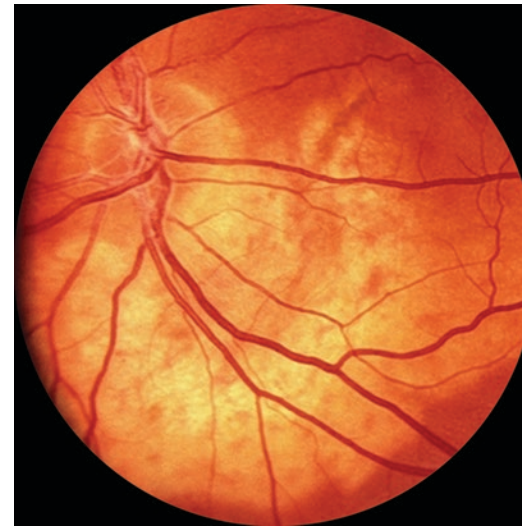

Fig. 10.46 Colour fundus image of a patient with a choroidal osteoma

Table 10.26 Key facts about a choroidal osteoma

• Benign tumour of the choroid composed of mature bone (mature bone replaces choroid with damage to overlying RPE and retina) • Typically found in healthy young females in the second or third decade of life • Tumour usually occurs as a sporadic trait and is usually unilateral

10.28.1 Examination

- Yellow-white well defined elevated or excavated oval or round geographic lesion located in the juxtapapillary or peripapillary area ± extension into the macula (rarely tumour is confined to the macular region only without involvement of the juxtapapillary area)
- Subretinal haemorrhages — suggestive of CNV
- Overlying retinal vasculature and optic disc is characteristically unaffected by the osseous tumour and there are no associated vitreous or anterior segment abnormalities

10.28.2 Investigations

- OCT — serous SRF ± retinal thinning over macular portion of the osteoma
- FFA (if SRF or haemorrhage present) — look for leakage suggestive of CNV membrane, osteoma produces a mild patchy hyperfluorescence of the tumour that evolves to a diffuse intense late staining
- A-scan US — high intensity echo spike from the inner surface of the tumour
- B-scan US — slightly elevated highly reflective choroidal mass with acoustic shadowing just posterior to the choroidal mass (gives appearance of a pseudo-optic nerve)

10.28.3 Treatment

- Treatment of CNV — extrafoveal (laser photocoagulation or PDT), subfoveal (anti-VEGF therapy)

- Induction of decalcification of tumour — if osteoma in extrafoveal region, argon laser photocoagulation or PDT to prevent growth of osteoma towards foveola (decalcified osteoma does not grow in the direction of the decalcification)

10.28.4 Other Diagnoses to Consider

- Amelanotic choroidal melanoma: less well-defined margin, more elevation, medium-low internal reflectivity on A-scan US, irregular elevated acoustically hollow choroidal mass on B-scan US
- Metastatic carcinoma to the choroid — indistinct or irregular margins, creamy-yellow colour, often associated with a serous RD out of proportion to size of tumour, B-scan US for an area of mild choroidal elevation with medium-high internal reflectivity on A-scan, positive hx of prior malignancy, if no prior hx of malignancy — CT chest (lung Ca) and breast imaging (breast Ca)
- Disciform macular degeneration — older patients with AMD, usually centered in the macula with AMD
- Circumscribed choroidal haemangioma — characteristically dome shaped with smooth regular margins with overlying serous SRF with cystoid degeneration of retina, orange-red in colour, high internal reflectivity on A-scan, acoustically full dome-shaped elevated mass
- Posterior scleritis — indistinct margins, US evidence of thickened sclera and choroid with retrobulbar oedema (T-sign)

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Strabismus and Orbit

11

Timothy H. M. Fung and Winfried M. K. Amoaku

11.1 Strabismus Examination Sequence

- Introduce yourself
- Ask the examiner for the patient's visual acuity: ensure that the patient can fixate on the distant target
- Ask the examiner if they would like you to perform the cover test (cover-uncover test and alternate cover test): move straight to ocular movements if not required
- Look for any obvious abnormal head postures
- Ask the patient to remove their glasses (if worn): quickly check the glasses to see if the patient is myopic or hyperopic and whether prisms are present in the glasses
- Perform the Hirschberg's test: ask the patient to fixate on light from a pentorch and ask the patient if they can see one or two images
- Ask the patient to look at a distant target (e.g. letter on a snellen chart or logMAR chart) and position yourself slightly to the side of the midline, facing the patient and at arm's length from the patient (do not obstruct patient's view of distance target):
  - Cover each eye in turn with an occluder to ensure the patient can visualise the distant target with each eye: if the patient has NPL vision then cover-uncover test and alternate cover test is not applicable
  - Perform a cover-uncover test to look for tropias:
    Swiftly cover the fixating eye with an occluder and observe the other eye for any movement. Carefully note its direction
    Uncover the eye and allow about 3 s for both eyes to be uncovered
    Swiftly cover the other eye and observe its fellow eye for any movement
  - Perform the alternate cover test to look for phorias:
    Rapidly shift the occluder from one eye to the other several times, not allowing any interval of binocularity
    Ensure that each eye fixes on the target after each movement of the cover
    Observe for any movement of the eyes
- Ask the patient to look at a near accommodative target and position yourself directly opposite the patient within arm's reach:
  - Cover each eye in turn with an occluder to ensure patient can visualise near accommodative target with each eye

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  - Perform a cover-uncover test to look for tropias:
  - Perform an alternate cover test to look for phorias:
- Repeat cover test with the patient wearing glasses (if patient wears glasses): ask the examiner if they would like you to perform this before going ahead
- Examine ocular movements (see table 11.1):
  - Sit facing the patient. Shine a light from a pentorch at eye level about 10–14 in. in front of the patient, with the patient looking in primary position
  - Ask the patient to inform you if they see double vision at any gaze position
  - Ask the patient to follow the light from your pentorch as you move it into the nine directions of gaze. Elevate the upper eyelid with a finger on your free hand to observe movements in downgaze: note any limitations of movement
  - Examine ductions if you see any limitations on version movements
  - Examine horizontal and vertical saccades: ask patient to look rapidly between targets (e.g. your hands) positioned at 30° on either side of the midline
- Perform a Parks-Bielschowsky three step test if hypertropia is present

11.2 Cranial Nerve III Palsy (Fig. 11.1)

11.2.1 Examination

- Nuclear lesion: If unilateral CN III palsy is nuclear in origin: bilateral ptosis, bilateral SR paresis (vertical gaze palsy with failure in voluntary upgaze — supranuclear in origin if eyes elevate with Doll's head manoeuvre, nuclear in origin if eyes do not elevate on Doll's head manoeuvre), unilateral MR, IR and IO paresis
- Fascicular lesion (associated damage to brainstem structures)
  - Webers syndrome (damage to cerebral peduncle + fascicular CN III): Ipsilateral CN III palsy + contralateral hemiparesis
  - Benedikt's syndrome (damage to red nucleus + fascicular CN III): Ipsilateral CN

Table 11.1 Useful information about neurogenic palsies and restrictive/mechanical disorders of ocular motility

Characteristics of neurogenic palsies
- The amount of ocular movement elicited is often greater on duction than on version.
- Ocular movement ceases gradually in the direction of limitation
- Maximal limitation of ocular movement is in the position of main action of the affected muscle
- Hess chart: field of affected eye will be smaller, proportional spacing between the inner and outer fields, both fields displaced according to the deviation

Characteristics of mechanical limited ocular movement
- A positive forced duction test (FDT)
- Normal saccadic velocity until the point of mechanical restriction is reached — this feature can differentiate a mechanical restriction from a neurogenic palsy
- Retraction of the globe, which strongly suggests mechanical limitation — occurs when gaze is directed away from the site of the leash and is best seen by viewing the affected eye from the side
- Equal limitation of version and duction
- Limited development of muscle sequelae, often confined to overaction of the contralateral synergist in the unaffected eye
- Hess chart: outer field of chart will be very close to the inner field in the direction of maximum limitation of movement, field of the affected eye will be very narrow either horizontally or vertically

General principles of management of mechanical disorders of ocular motility
- To centralise and if possible enlarge the field of binocular single vision, reducing the need for an abnormal head posture
- To reduce or eliminate anomalous ocular movements caused by mechanical restriction (e.g. up-shoot or down-shoot on attempted adduction)
- To correct the cosmetic defect (strabismus, enophthalmos, eyelid anomalies)

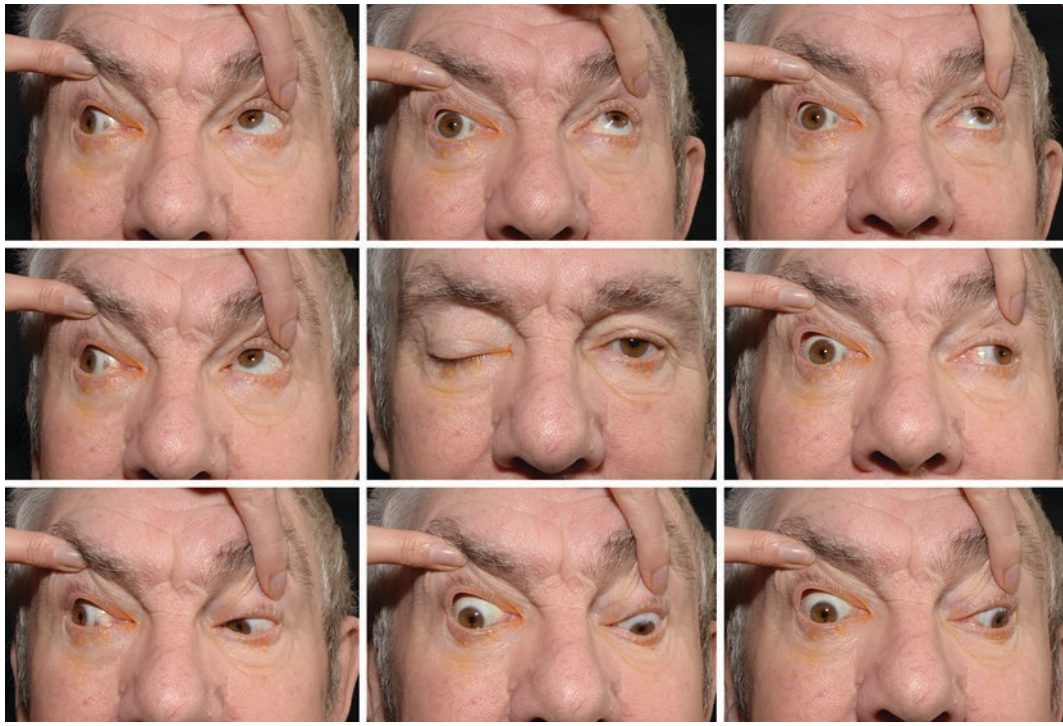

Fig. 11.1 Patient with a right CN III palsy

III palsy + contralateral ataxia with intention tremor
- Ptosis: partial or complete
- Pupil: involvement (dilated pupil) or non-involvement
- Ocular movements: all muscles affected (exotropia, hypotropia, intorsion), superior division (hypotropia), inferior division (exotropia, hypertropia, intorsion), single muscle palsy (IR, IO, SR, MR — most commonly IR followed by SR)
- Abnormal head posture: all muscles affected (face turn to unaffected side), superior division (head tilt, face turn to affected side and chin elevation), inferior division (head tilt to unaffected side, face turn to unaffected side)
- Aberrant regeneration (feature of compressive and traumatic CN III palsy, does not occur in microvascular lesions): its development without a history of trauma demands a CT/MRI to rule out SOL
- Examine the SO muscle (CN IV): instruct patient to abduct eye (patient unable to adduct eye in CN III palsy) and then look down — look for intorsion (look at iris landmark or conjunctival vessel) to determine CN IV not involved.
- Examine the LR muscle (CN VI): even when eye is exotropic, it is possible to demonstrate LR function by observing the saccadic velocity or performing a force generation test

11.2.2 Discussion Points (Tables 11.2 and 11.3)

11.2.2.1 Anatomy
- CN III nucleus lies in the midbrain, anterior to the periaqueductal grey matter, at the level of the superior colliculus
- CN III nucleus consists of a single central nucleus, innervating both LPS muscles, and separate subnuclei for each SR (contralateral

Table 11.2 Differentiating SR palsy and contralateral SO palsy

- Compare the amount of vertical deviation in extreme positions of gaze by use of the alternate cover test
- Deviation increasing on dextrodepression: indicates a left SO palsy
- Deviation increasing on dextroelevation: indicates a right SR palsy
- Excyclotorsion of globe seen objectively with a fundus photograph: more suggestive of SO palsy
- Comparison of the near and distance vertical deviation: hypertropia that increases for near fixation suggests a SO palsy
- Compensatory head posture: chin up in SR palsy, chin down in SO palsy
- Bielschowsky head tilt test

Table 11.3 Differentiating IO palsy and Brown's syndrome

- FDT: restricted in Brown's syndrome, passive movement in IO palsy
- A pattern occurs in IO palsy whereas Brown's syndrome shows a V pattern
- Incyclotropia usually present in IO palsy but not in Brown's syndrome
- Muscle sequelae (can be seen clearly on Hess chart) should develop as expected in IO palsy whereas development is confined to overaction of the contralateral SR in Brown's syndrome, field of the affected eye in IO palsy will be displaced down in IO palsy but that of a patient with Brown's syndrome will show little or no abnormality in the primary position or in the lower field

innervation), MR, IR, and IO (all ipsilateral innervation)

- CN III fasciculus travels anteriorly through the MLF, the red nucleus, and the cerebral peduncle. On leaving the midbrain, CN III peripheral nerve emerges within the interpeduncular fossa and passes anteriorly beneath the PCA, above the superior cerebellar artery, and lateral to the posterior communicating artery (PCoA)
- CN III peripheral nerve travels within the lateral wall of the cavernous sinus, dividing into superior (innervates the LPS, SR) and inferior (MR, IR, IO) branches that enter the orbit via the superior orbital fissure and annulus of Zinn.
- Parasympathetic fibers from the Edinger-Westphal nucleus travel in the IO branch as far as the ciliary ganglion and then in the short ciliary nerves to the globe where they innervate the ciliary muscle and pupillary sphincter

11.2.2.2 Causes

- Acquired
  - Compression by a PCoA aneurysm (pupil involvement)
  - Microvascular disease: HTN, DM (usually pupil sparing)
  - Tumours: direct damage from adjacent tumours such as meningioma's, affecting areas of the base of the skull or adjacent to the pituitary fossa and cavernous sinus
  - Closed head trauma (pupillary involvement in most cases) or birth trauma
  - GCA
- Congenital

11.2.2.3 Muscle Sequelae

- All muscles affected: overaction contralateral LR, SO, SR, and IO
- Superior division: overaction contralateral IO, contracture of ipsilateral IR, secondary inhibitional palsy of contralateral SO
- Inferior division: overaction contralateral LR, SR and SO
- MR: overaction contralateral LR, contracture ipsilateral LR, secondary inhibitional palsy of contralateral MR
- SR: overaction contralateral IO, contracture of ipsilateral IR, secondary inhibitional palsy of contralateral SO
- IR: overaction contralateral SO, contracture of ipsilateral SR, secondary inhibitional palsy of contralateral IO
- IO: overaction contralateral SR, contracture of ipsilateral SO, secondary inhibitional palsy of contralateral IR

11.2.2.4 Investigations

- Non-traumatic partial CN III palsy ± pupil involvement: CTA/MRA to exclude a posterior communicating artery aneurysm
- Non-traumatic complete CN III palsy with pupil sparing (usually ischaemic — likelihood increased if age >40, known vasculopathy,

acute-onset, non-progressive, no other neurological abnormality): bloods (FBC/ESR/CRP to rule out GCA if age ≥50, glucose to rule out DM), MRI head if no recovery of function at 3 months. Initial review every 2–3 days for the first week after presentation to ensure no pupil involvement occurs.
- Aberrant regeneration of CN III palsy without hx of trauma: MRI to rule out SOL
- Hess chart (see Fig. 2.33)

11.2.2.5 Treatment

- Urgent referral to neurosurgeons if posterior communicating artery aneurysm is found on imaging
- Conservative
  - Symptomatic diplopia (only present if the ptosis does not cover the visual axis): prisms (limited use though as diplopia reverses in different positions of gaze), occlusion of an eye with a patch or CL
  - Mydriasis causing photophobia: tinted glasses, painted CL, constriction of pupil with pilocarpine drops
  - Ptosis: ptosis crutches fitted to spectacle frames
- Surgical
  - Symptomatic diplopia or cosmetic appearance: Botox, muscle surgery
  - Ptosis

11.3 Cranial Nerve IV Palsy (Fig. 11.2)

11.3.1 Examination

- Congenital — unilateral: head tilt to unaffected side, facial asymmetry (reduction of distance between the lateral canthus and the corner of the mouth on the side of the head posture), large hyperphoria (sometimes exceeding 20 PD), manifest vertical deviation with the head straight, vertical deviation increase on near fixation, excyclotorsion in primary position (seen on fundus examination), positive Bielschowsky head tilt test, large vertical fusion amplitude of ≥10 PD

Fig. 11.2 Patient with a right CN IV palsy

- Congenital — bilateral: alternating hypertropia of non-fixing eye with a constant large V-pattern esotropia (≥25 PD), chin down head posture, positive Bielschowsky head tilt test to either side with reversal of hypertropia on right and left tilt (helps differentiate from primary ET with IOOA), excyclotorsion in primary position, large vertical fusion amplitude of ≥10 PD
- Acquired — unilateral: hypertropia on affected side that is worse on adduction, head tilt/face turn to unaffected side (to overcome vertical diplopia), positive Bielschowsky head tilt test (fixation at 3 m target), vertical fusion amplitude of 2–3 PD
- Acquired — bilateral (see Table 11.4): chin depression, reversal of hypertropia on right and left gaze and on dextro- and laevo-depression, positive Bielschowsky head tilt test to either side, V-pattern esotropia, symptomatic excyclotorsion >10° in primary position, vertical fusion amplitude of 2–3 PD
- Perform a dilated fundus examination to look for excyclotorsion of the fundus (normally an imaginary line drawn horizontally from inferior 1/3 of the disc intersects the fovea. A line drawn in the same manner crosses superior to the fovea in an eye that is excyclotorted)

11.3.2 Discussion Points

11.3.2.1 Anatomy

- CN IV nucleus lies just below CN III nucleus in the lower midbrain at the level of the inferior colliculus
- Fasciculus decussates within the anterior medullary venum and exits the midbrain posteriorly.
- CN IV peripheral nerve curves around the midbrain, passes anteriorly between the posterior cerebral and superior cerebellar arteries, travels within the lateral wall of the cavernous sinus (inferolateral to CN III, superior to V1), enters the orbit through the SOF (but superior to the annulus of Zinn) and terminates in the SO muscle.

11.3.2.2 Causes

- Congenital (1/3 of cases - see Table 11.5)
- Acquired
  - Closed head trauma
  - Microvascular disease: age >40, acute onset, non-progressive, no other neurological abnormality, known vasculopathy
  - Tumours
  - GCA

11.3.2.3 Muscle Sequelae

- Overaction of ipsilateral IO
- Overaction of contralateral IR
- Secondary inhibitional palsy of contralateral SR

11.3.2.4 Investigations

- Double Maddox rod to measure cyclotorsion
- Bloods to rule out GCA (FBC/ESR/CRP if age ≥50), DM (glucose)
- MRI head if: age <40, progressive, no recovery of function at 3 months, associated neurological abnormality
- Hess chart (see Figs. 2.34 and 2.35)

11.3.2.5 Treatment

- Conservative
  - Symptomatic diplopia: prisms, occlusion of eye with patch or CL

Table 11.4 Features suggestive a bilateral CN IV palsy

• Chin down head posture • Alternating hypertropia: confirmed with a bilaterally positive Bielschowsky head tilt test with right hypertropia on right head tilt and left hypertropia on left head tilt • Prominent V pattern esotropia (≥25 PD) • Excyclotorsion >10° in the primary position • Bilateral failure of adduction on depression

Table 11.5 Features suggestive of a congenital CN IV palsy

• Facial asymmetry • Old photographs demonstrating head posture • Vertical fusion amplitude well in excess of normal 2–4 PD, which is the usual finding in acquired palsies

- Surgical
  - Symptomatic diplopia or cosmetic appearance: Botox, muscle surgery (Harada-Ito for excyclotortion)

11.4 Cranial Nerve VI Palsy

11.4.1 Examination

- Esodeviation which increases in the distance
- Face turn towards affected side
- Abduction deficit
- Examine the fundus to look for optic disc swelling

11.4.2 Discussion Points

11.4.2.1 Differential Diagnosis of Abduction Deficit

- Neurological
  - CN VI palsy (see Table 11.6)
- Mechanical
  - Orbital trauma (blow out fracture of medial orbital wall): Hx + CT scan
  - TED: proptosis, eyelid signs
  - Duane's syndrome: retraction of globe on adduction
- Myopathic:
  - Myasthenia gravis
- Other
  - Distance ET of high myopia: can lead to progressive loss of abduction

11.4.2.2 Anatomy

- CN VI nucleus lies in the lower pons anterior to the fourth ventricle, at the level of the facial colliculus
- CN VI fasciculus travels anteriorly through the medial lemniscus and corticospinal tract, just medial to the trigeminal nuclear complex and vestibular nuclei
- CN VI basilar nerve emerges from the pontomedullary junction, ascends in the subarachnoid space between the pons and clivus, before turning anteriorly over the petrous apex of the temporal bone and under the petroclinoid ligament to enter the cavernous sinus. It then runs within the sinus itself and then enters the orbit via the SOF and annulus of Zinn to terminate in the LR muscle.

Table 11.6 Factors suggesting a bilateral CN VI palsy

- Incomitant ET on both right and left gaze
- Bilateral contracture of the MR muscles in long standing total bilateral palsies
- Slow peak saccadic velocity on abduction
- V-pattern esotropia: more likely in the presence of a bilateral palsy

11.4.2.3 Causes

- Acquired
  - False localising sign: raised ICP from SOL (CN VI subjected to traction as rise in ICP causes a downward displacement of the brainstem)
  - Fascicular CN VI palsy: demyelination, CVA, metastatic tumours
  - Peripheral CN VI palsy:
    Microvascular disease
    Closed head injury
    Localised compression of the nerve by a primary pituitary tumour, craniopharyngioma or meningioma in the base of the skull or close to the pituitary fossa or cavernous sinus
    Basilar artery aneurysm
    Metastatic tumours
    Bacterial infection of the middle ear: spread to petrous temporal bone, involving the sixth and fifth nerves, presenting as a CN VI palsy with ipsilateral facial pain (Gradenigo's syndrome)
- Congenital

11.4.2.4 Muscle Sequelae

- Contracture of ipsilateral MR
- Contralateral MR overaction
- Secondary inhibitional palsy of contralateral LR

11.4.2.5 Investigations

- Bloods to rule out GCA (FBC/ESR/CRP if age ≥50), DM (glucose)

- MRI head if no recovery of function at 3 months
- Hess chart (see Figs. 2.36 and 2.37)

11.4.2.6 Treatment

- Conservative
  - Symptomatic diplopia: prisms, occlusion of eye with patch or CL
- Surgical:
  - Symptomatic diplopia or cosmetic appearance: Botox, Muscle surgery (if total palsy with no recovery of CN VI function — vertical muscle transposition using the Hummelsheim and Jensen operations / if partial palsy with residual CN VI function — LR resect/MR recess)

11.5 Brown's Syndrome

11.5.1 Examination

- Limitation of elevation in adduction (normal depression in adduction): if the restriction of movement is severe, there may also be some limitation of direct elevation and even of elevation in abduction
- Discomfort on attempting elevation in adduction
- Down drift of the affected eye on contralateral version
- Overaction of the contralateral SR muscle: other muscle sequelae do not develop, therefore there is no overaction of the SO on the affected side
- Abnormal head posture, comprising a head tilt to the affected side, a face turn to the contralateral side and chin elevation
- V pattern
- Absence of cyclotropia

11.5.2 Discussion Points

11.5.2.1 Pathogenesis

- Abnormalities of the superior oblique tendon sheath including shortening (tight SO anterior tendon sheath), inflammation or thickening

11.5.2.2 Other Diagnoses to Consider

- Isolated IO palsy: more frequently seen following orbital trauma or in association with MG — SO overaction, A pattern, negative FDT
- Double elevator palsy: limitation of upgaze on both adduction and abduction, presence of ptosis, Bell's phenomenon may be intact, confirming the absence of any mechanical restriction of elevation
- Orbital blow out fracture: limitation of elevation, enophthalmos, infraorbital nerve anaesthesia
- Congenital ocular muscle fibrosis syndrome: fibrosis of IR muscle will result in limitation of upgaze — limitation will be greatest in abduction with retraction of the globe on attempted up-gaze

11.5.2.3 Causes

- Abnormalities of the superior oblique tendon sheath
- Congenital: affecting SO/trochlear complex
- Acquired (inflammation or trauma affecting the trochlear region): inflammation — RA, orbital inflammation, chronic sinusitis / surgery — SO tuck, scleral buckling, orbital

11.5.2.4 Investigations

- Hess chart (see Fig. 2.38)
- FDT: positive test
- Field of binocular single vision: if diplopia can be elicited
- MRI for acquired Brown's syndrome

11.5.2.5 Treatment

- Majority of patients with Brown's syndrome of early onset maintain symptom free binocular single vision with a relatively slight head posture. Field of binocular single vision is usually adequate and in the optimum position on depression of gaze. These patients do not require treatment
- Conservative: retrotrochlear steroid injection
- Surgical (SO tenotomy): indications — significant head posture or if strabismus in primary position

11.6 Duane's Retraction Syndrome

11.6.1 Examination

- Limitation of horizontal eye movement: usually comprising a moderate or marked limitation of abduction. In most cases, these is little or no limitation of adduction; in others adduction is restricted but to a lesser extent that abduction. Less commonly, the limitation of adduction exceeds the limitation of abduction
- Compensatory head posture (adopted to centralise the often-narrow field of binocular single vision — determined by deviation in primary position and by the pattern of ocular movement): face turn to affected side if ET, face turn to unaffected side if XT
- Retraction of globe on adduction, with narrowing of palpebral fissure
- Manifest strabismus: usually ET (more marked for distance fixation and reduced for near fixation) when head is straight, XT occurs when adduction is more limited than abduction
- Upshoot and/or downshoot on adduction
- Poor convergence
- Associated ocular abnormality: colobomata, heterochromic iridis, lens opacities, microphthalmos and persistent pupillary membrane
- Skeletal and facial abnormalities: Goldenhars and Klippel-Feil syndrome, abnormal ear formation, deafness, syndactyly, cleft palate and spinal meningocoele

11.6.2 Discussion Points

11.6.2.1 Pathogenesis

- Congenital disorder associated with hypoplasia of CN VI with subsequent aberrant coinnervation of LR and MR by CN III

11.6.2.2 Other Diagnoses to Consider

- Congenital CN VI palsy: large angle esotropia with limited abduction but no evidence of limited adduction nor the associated globe retraction and the upshoot or downshoot
- Infantile esotropia: abduction can usually be demonstrated either by occluding the contralateral eye for a period, or by rotating a young child to induce vestibular nystagmus (thus demonstrating movement past the midline), no other characteristics of Duane's syndrome will be present
- Mobius syndrome: bilateral CN VII weakness and loss of abduction, absence of retraction of the globe and narrowing of the palpebral fissures

11.6.2.3 Classification

- Brown's classification (based on clinical features alone):
  - Type A: with limited abduction and less marked limitation of adduction
  - Type B: limited abduction but normal adduction
  - Type C: limitation of adduction exceeds the limitation of abduction with XT
- Huber's classification (based on EMG findings):
  - Type I: marked limitation of abduction
  - Type II: limitation of adduction
  - Type III: limitation of both abduction and adduction

11.6.2.4 Associations

- Goldenhar syndrome
- Klipper-Feil syndrome: short webbed neck, restricted movement of cervical spine
- Wildervanck syndrome: Klipper-Feil, Duane, deafness

11.6.2.5 Investigations

- Hess chart (see Figs. 2.39–2.41)

11.6.2.6 Treatment

- The vast majority of patients with Duane's syndrome maintain comfortable binocular single vision and remain compensated, usually with a comparatively slight face turn
- Surgical: indications — decompensation giving rise to a manifest strabismus in the primary position in childhood or symptoms at a later stage, cosmetically poor compensatory head posture, cosmetically poor manifest strabismus, severe globe retraction ± upshoot and downshoot

11.7 Restrictive Myopathy in TED

11.7.1 Examination

- Ocular motility
  - Mechanical restriction of ocular movement ± pain on looking in the direction of limited movement
  - Retraction of the globe occurs when movement away from the site of the restriction is attempted (commonly seen on upgaze)
  - In order of decreasing frequency the muscles involved are: IR muscle (restricted up gaze), MR muscle (restricted abduction), SR muscle (restricted downgaze), LR muscle (restricted adduction although LR is usually spared even when enlargement is evident on CT scan)
  - Common ocular posture is hypotropia of the more affected eye, sometimes with associated ET
  - An abnormal head posture, commonly chin elevation, is often adopted, ± face turn: purpose is to avoid an uncomfortable position of gaze, to centralise a field of binocular single vision
  - Enlarged vertical fusion amplitude

11.7.2 Discussion Points

11.7.2.1 Investigations

- Hess chart (see Fig. 2.44)
- Field of binocular single vision (see Fig. 2.58)
- Forced duction test to confirm presence and extent of mechanical restrictions

11.7.2.2 Treatment

- Conservative
  (a) Treatment of diplopia: prisms, Botox, occlusion (last resort)
- Surgical
  (a) Aims of extraocular muscle surgery are to improve the patient's appearance and to establish a field of binocular single vision in the primary position and on down-gaze, extending the area into other fields of gaze if possible
  (b) Patient should be euthyroid and the ocular muscle imbalance should have remained stable for at least 3 months before considering surgery
  (c) Categorise the ocular motility disturbances into recognisable patterns:
    1. Unilateral or grossly asymmetrical bilateral restriction of elevation
       - Incomitant (increase in vertical deviation on upgaze and a reduction on downgaze, usually with an intact inferior field of BSV): mechanical restriction of ipsilateral IR — tx with ipsilateral IR recession
       - Concomitant (vertical deviation that is the same on upgaze and which decreases minimally or not at all on downgaze, usually with no field of BSV): mechanical restriction of ipsilateral IR + contralateral SR — tx with IR recession ± SR recession
    2. Unilateral or grossly asymmetric bilateral restriction of abduction
       - Incomitant (ET which increases in the direction of mechanical restriction and reduces in the opposite field of gaze + face turn away from the side with the mechanical restriction + intact field of BSV): mechanical restriction of ipsilateral MR — tx with ipsilateral MR recession
       - Concomitant (ET in all positions of gaze): bilateral mechanical restriction of both MR — tx with unilateral or bilateral MR recession
    3. Unilateral or grossly asymmetric bilateral restriction of both elevation and abduction: management is the same as for pattern (1) and (2)
    4. Bilateral symmetric restriction of elevation
       - Neither eye is able to maintain fixation in primary position
       - Asymmetrical mechanical restriction of elevation, with a −2 to −3 restriction in the more mobile eye

   - A pattern ET is present on upgaze, with a convergence retraction movement as the eyes attempt to move into the field of maximum restriction
   - Contraction of the SR, if present, will restrict movement on down-gaze
   - Tx with bilateral IR recession
5. Bilateral restriction of both elevation and abduction
6. Mechanical restriction of the superior rectus muscles resulting in limited down-gaze
   - Limitation of depression that is greatest in abduction
   - Treat with SR recession

11.8 Orbit Examination Sequence

- Introduce yourself
- Quick inspection of patient to look for features of a craniosynostosis (e.g. frontal bossing and other anomalous bony changes), lid changes (e.g. lid retraction), goitre, temporal fossa fullness (sphenoid wing meningioma)
- Inspect for an apparent exophthalmos or enophthalmos by the following technique
  - Ask patient to tilt head slightly forwards and to look straight ahead
  - Stand behind the patient and look over the patient's forehead and eyebrows from above, sighting the plane of the face. Elevate both upper eyelids.
  - Note the position of the front of each globe in relationship to each other. A disparity between the two globes of more than 2 mm is abnormal
- Palpate the circumference of the orbital rim
- Ask the patient to close their eyes and gently touch the patient's closed eyelid for
  - Any thrills or pulsation movements
  - Any anterior extensions of an anterior or retrobulbar orbital mass
- Compare the ease of globe retropulsion for the two orbits by gently pushing the globe posteriorly through the patient's closed eyelids.
- Perform exophthalmometry
  - Position yourself directly in front of the patient. Your right eye measures the patient's left eye, and your left eye measures the patient's right eye
  - Place the instrument so that the foot plates of the exophthalmometer rests on the lateral rims at the level of the lateral canthi: note the intercanthal reading on the exophthalmometer
  - Close your right eye and ask the patient to look at your open left eye to achieve straight ahead alignment. Using your open left eye, align the instruments two vertical markers (usually red) on the millimeter scale and read off where the patient's anterior corneal surface of the cornea appears on the millimeter scale. Obtain a similar measurement for the patients left eye by using your right eye. A difference of more than 2 mm is considered abnormal
- Measure globe displacement
  - Horizontal displacement:
    Ask the patient to fixate at a distant target straight ahead. Occlude the fellow eye if strabismus is present
    Imagine a straight vertical line down the middle of the patients face
    Hold a ruler horizontally across the bridge of the patient's nose, perpendicular to the imaginary vertical line
    Measure the distance from the center of the nasal bridge to the medial limbus of the right eye. Repeat measurement for the left eye. The difference between the two measurements is the amount of horizontal displacement
  - Vertical displacement:
    Ask the patient to fixate at a distance target straight ahead.
    Hold a ruler horizontally along the patient's nasal bridge at the level of the lateral canthi
    Hold another ruler vertically, perpendicular to the horizontal ruler, to pass through the center of the patient's right pupil and measure the distance from the edge of the horizontal ruler to the pupillary center.

Repeat measurements for the left eye. The difference between the two measurements is the amount of vertical displacement
- Ask the examiner whether the following is required
  - Ocular motility
  - Examination of the pupils
  - Examination of the eyelids

11.9 TED (Fig. 11.3)

11.9.1 Examination

- Check proptosis
  - Measure the degree of proptosis using an exophthalmometer
  - Axial, usually bilateral, but can be quite asymmetric
- Examine the eyelids
  - Measure the eyelid position and function (PA, MRD1, LF)
  - Look for lid swelling and erythema
  - Look for upper and lower lid retraction
  - Look for temporal flare of the upper eyelid (lid just keeps getting higher toward the lateral canthus — peak of normal eyelid is just nasal to the pupil)
  - Look for lid lag in downgaze
  - Look for lagophthalmos
- Perform ocular motility to look for the presence of any restrictive myopathy
- Slit lamp examination

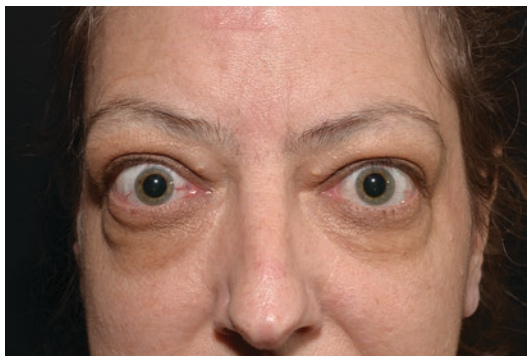

Fig. 11.3 Facial photo of a patient with TED showing bilateral proptosis with upper lid oedema and upper and lower eyelid retraction

  - Check corneal sensation
  - Look for conjunctival and caruncular injection and/or chemosis
  - Look for signs of corneal exposure, superior limbic keratoconjunctivitis
  - Check IOP in primary position and upgaze (more than 5 mmHg difference)
  - Perform a dilated fundus exam to look for optic disc swelling or pallor and choroidal folds
- Systemic examination
  - Examine for goitre, palmar erythema, atrial fibrillation, and pretibial myxedema
  - Look for signs of hyperthyroidism (warm peripheries, tachycardia, atrial fibrillation, hair loss) or hypothyroidism (bradycardia, dry thin hair, dry coarse skin)
- Check optic nerve function for compressive optic neuropathy
  - VA
  - RAPD
  - Colour vision (first sign of early optic nerve compression is reduced colour vision)

11.9.2 Discussion Points

11.9.2.1 Investigations

- Thyroid functions tests (TSH, T4 — most patients will have a high T4 and a low TSH level, although in 5–10% of patients, thyroid orbitopathy will be associated with a euthyroid condition) and thyroid autoantibodies (anti-TSH receptor, anti-thyroid peroxidase, anti-thyroglobulin antibodies)
- In some patients, the diagnosis is so obvious that no imaging is necessary
- CT scan with axial and coronal cuts (see Fig. 2.46): enlarged extraocular muscles, proptosis (>1/3 of eye in front of imaginary line from medial to lateral canthus), CT is preferred imaging modality for planning orbital decompression
- MRI (T2 STIR): better soft tissue resolution and used for grading disease activity, enlarged muscle bellies with sparing of the tendons

- Orthoptic review: Hess/Lees chart, field of binocular single vision, field of uniocular fixation
- Serial visual evoked potentials (VEP — provides objective assessment of optic nerve function — important to know that patient is euthyroid before evaluating the result, as hypothyroid patients without optic nerve compression can show a delay in the P100 component of the VEP)
- Forced duction test: confirm presence and extent of mechanical restrictions

11.9.2.2 Treatment

- Achieve a euthyroid state without post-treatment hypothyroidism — seek consultation with an endocrinologist if the patient is not seeing one. Treatment of hyperthyroidism — carbimazole or propylthiouracil, radioactive iodine — short course of prophylactic oral steroid to prevent new onset or progression of TED, thyroidectomy. Treatment of hypothyroidism — levothyroxine
- Promotion of smoking cessation
- Before initiating treatment, determine where the patient's condition falls in the natural history of the disease. Try to determine whether patient is in the "active" stage (swelling or redness of the orbital, lid, and conjunctival tissues — eyelids look "wet" as though you could squeeze oedema fluid out, eyelid swelling and any diplopia are much worse in the mornings) or "chronic" stage (morning eyelid swelling and diplopia are gone, signs of acute inflammation are no longer present, any remaining proptosis and lid retraction probably will not change) of the disease
- Mild TED/CAS <3 — most patients will require only medical management during the active stage — monitor patients for corneal exposure and treat irritation with lubricating drops and ointment, elevate head of the bed to reduce morning swelling or diplopia, sunglasses to decrease photophobia and feelings of dryness, prisms for diplopia
- Moderate-severe TED/CAS ≥3 — consider immunosuppression (systemic corticosteroids — IV methylprednisolone or oral prednisolone, rituximab, etanercept, AZT) or orbital radiotherapy (2000 rad — for patients with restrictive myopathy but not for acute optic nerve compression — contraindications include hx of skin cancer, age less than 35 years old)
- Sight threatening TED — admit patient, IV methylprednisolone 1 g every day for 3 days (maximum total dose of 8 g — if dose exceeds measure LFT's as small risk of acute liver damage). Surgical decompression (fat and/or bony decompression) if the steroid therapy fails and if systemic steroid therapy is contraindicated or has intolerable side effects
- Surgical (decompression then strabismus surgery then lid surgery) — when you have confirmed that there has been no change over 3–6 months, the patient may want to consider procedures to improve the remaining proptosis, lid retraction, and strabismus (to correct diplopia: conservative — prisms, botulinum injection, and Bangerter foils, surgical — indicated when there is diplopia in primary gaze and downgaze and stable inactive TED with stable myopathy for at least 6 months)

11.10 Post Enucleation Socket Syndrome (PESS)

11.10.1 Examination

- Enophthalmos
- Upper eyelid sulcus deformity
- Ptosis or eyelid retraction
- Laxity of the lower eyelid
- A backward tilt of the ocular prosthesis (viewed from side of patient)

11.10.2 Discussion Points

11.10.2.1 Indications for an Enucleation

- Painful blind eye
- Blind unsightly eye
- Intraocular tumour

- Severe irreparable ocular trauma and high risk of sympathetic ophthalmia

11.10.2.2 Treatment

- Correction of orbital volume deficiency
  - Secondary orbital implant surgery:
    - Baseball implant
    - Hydroxyapatite implant
    - Porous polyethylene (Medpor) implant
    - Bioceramic implant
    - Dermis fat graft implant
- Correction of residual orbital volume deficiency (in spite of the insertion of a secondary orbital implant of adequate size):
  - Placement of a subperiosteal implant using pieces of Medpor
  - Structural fat grafting to the orbital apex
  - Intermittent injection of hyaluronic acid filler into the orbital apex
  - Injection of small hydrogel implants into the orbital apex
- Correction of lower eyelid laxity: LTS.

Neuro-Ophthalmology

12

Timothy H. M. Fung and Winfried M. K. Amoaku

12.1 Examination of Patients with Abnormal Pupils

12.1.1 Pupils Examination Sequence

- Introduce yourself
- Quick inspection for the presence of ptosis or heterochromia
- Sit on one side of the seated patient
- In bright lighting
  - Ask patient to look at a distant target (minimise accommodation with its accompanying pupil miosis)
  - Measure and compare pupil size (mm) in each eye with a pupil size gauge on the side of a pen torch
- Ask for room lights to be dimmed
- In dim lighting
  - Ask patient to look at a distant target (minimise accommodation with its accompanying pupil miosis)
  - Measure and compare pupil size (mm) in each eye with a pupil size gauge on the side of a pen torch — use a second pen torch to illuminate both pupils from below the nose if required to discern the pupil sizes
  - Check for direct and consensual light reflex using light source from an indirect ophthalmoscope
  - Check for the presence of a RAPD using light source from an indirect ophthalmoscope
  - Check near reflex: look for any light-near dissociation (significantly better pupillary near reflex than light reflex)

12.1.2 Causes of a RAPD

- Asymmetric optic neuropathies
  - Ischaemic optic neuropathies
  - Advanced glaucoma
  - Optic neuritis
  - Compressive optic neuropathy
- Severe asymmetric retinal diseases
  - Total RD
  - CRAO
  - CRVO

12.1.3 Causes of Light-Near Dissociation

- Adie (Holmes-Adie) tonic pupil
- Argyll Robertson pupil — syphilis

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- Parinaud syndrome
- Myotonic dystrophy

12.1.4 Differential Diagnosis of Anisocoria

- Anisocoria equal in bright and dim illumination
  - Suggests physiologic anisocoria:
    <1 mm difference in pupillary diameter between the eyes
    Brisk pupil response to light
    Brisk pupil response to accommodation
    No associated ptosis or ocular motility problems
- Anisocoria greater in bright illumination
  - Suggests the bigger pupil is the abnormal one
  - Differential diagnosis:
    CN III palsy
    Adie's tonic pupil:
    Pharmacological dilatation:
    - Fixed large pupil
    - Unreactive to light or accommodation
    - Confirm with 1% pilocarpine: mydriatic pupil will not constrict

    Traumatic mydriasis
    Benign episodic unilateral mydriasis
    - More commonly occurs in women
    - Associated with migraines
- Anisocoria greater in dim illumination
  - Suggests the smaller pupil is the abnormal one
  - Differential diagnosis:
    Horner's syndrome
    Pharmacological miosis:
    - Fixed small pupil
    - Unreactive to light or accommodation
    - Confirm with 1% tropicamide: miotic pupil will not dilate

    Posterior synechiae

12.1.5 Clinical Cases for Pupil Examination

12.1.5.1 Horner's Syndrome (Fig. 12.1)

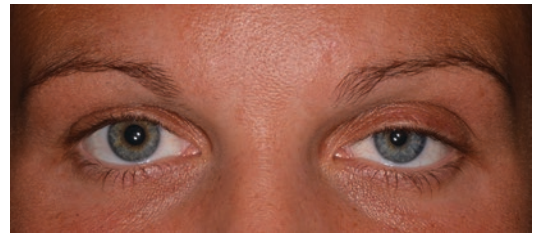

Fig. 12.1 Facial photo of a patient with a left sided Horner's syndrome showing a ptosis and pupil miosis

- Causes
  - Congenital:
    Birth trauma (forceps injury to brachial plexus): ipsilateral arm weakness
    Idiopathic
  - Acquired:
    First order neurone lesion:
    - CVA
    - Vertebrobasilar insufficiency causing lateral medullary syndrome:
      - Occlusion of posterior inferior cerebellar artery
      - Ipsilateral loss of pain and temperature sensation in the face
      - Contralateral loss of pain and temperature sensation in the body
      - Ipsilateral Horner's syndrome
      - Ipsilateral cerebellar ataxia
    - Cervical trauma
    - Syringomyelia
    - Neuroblastoma (child: proptosis, ecchymotic eyelid, opsoclonus, Horner's syndrome)
    - Multiple sclerosis (MS): rare

    Second order neurone (preganglionic) lesion:
    - Tumour: Pancoast, thyroid adenoma, metastasis
    - Thoracic aortic aneurysm
    - Thoracic surgery
    - Brachial plexus injuries (forceps injury at birth)

    Third order neurone (postganglionic) lesion:
    - Cluster headache
    - Middle ear:
      - Otitis media
      - HZO — Ramsay Hunt syndrome
    - Neck:
      - ICA dissection
      - Enlarged lymph nodes

    - Cavernous sinus pathology:
        - Inflammation: Tolosa-Hunt
        - Vascular: intracavernous carotid aneurysms
        - Tumour
- History
    - First order neurone lesions:
      Limb weakness, slurred speech: CVA
      Paraesthesias and weakness of the limbs, urinary incontinence: MS
    - Second order neurone lesions:
      Haemoptysis, weight loss, SOB, pain in arms or shoulder: lung Ca
    - Third order neurone lesions:
      Headaches, neck pain, facial or orbital pain, facial numbness and dysesthesia, hx of neck manipulation: internal carotid artery dissection
      Episodic headaches associated with epiphora and rhinorrhea: cluster headaches
      Ear pain, discharge, vertigo, tinnitus: Otitis media, Ramsay-Hunt syndrome
      Diplopia: cavernous sinus pathology
      Trauma or surgery
- Examination
    - Pupil miosis with a normal light and near dissociation
    - Anisocoria greater in dim conditions
    - 1–2 mm ptosis
    - Apparent enophthalmos due to 1 mm elevation of the lower lid
    - Iris heterochromia: suggests congenital or longstanding lesions
    - Facial anhidrosis: suggests lesion of first- or second-order neurone
    - No involvement of other cranial nerves (II, III, IV, V, VI)
    - Perform a full neurological examination, and perform a systemic examination to look for scars and masses (lung apices, neck, thyroid)
- Investigations
    - Confirm a Horner's syndrome:
      Apraclonidine 1%:
        - Normally has weak α_1 agonist activity (greatest effect on α_2 receptors)
        - Up regulation of α_1 receptors on iris dilator muscle with sympathetic denervation
        - Test: measure pupil sizes for distance in bright and dark lighting illumination. Instill drops into both eyes. At 60 min, measure pupil sizes for distance again with the same bright and dark lighting illumination as before
        - Positive test result: miotic pupil will dilate whilst normal pupil will not, resulting in a reversal of anisocoria ± reversal of ptosis
    - Identify level of lesion:
      Hydroxyamphetamine 1%:
        - Post-ganglionic lesions will not dilate the miotic pupil whereas the miotic pupil will dilate with first- and second-order neurone lesions
          Phenylephrine 1%:
        - Dilute 0.1 ml of 10% phenylephrine with 0.9 ml of saline
        - Post-ganglionic lesions will dilate the miotic pupil whereas the miotic pupil will dilate with first- and second-order neurone lesions
    - Further tests based on cause:
      First order neurone lesion:
        - MRI brain/spinal cord
        - Urinary catecholamines, MRI neck/chest/abdomen: neuroblastoma
          Second order neurone lesion:
        - CXR: Lung Ca
        - CT thorax: Lung Ca
          Third order neurone lesion:
        - CTA/MRA neck: ICA dissection
        - Lymph node biopsy: tumours
        - ENT assessment: Ramsay Hunt syndrome, Otitis media
- Treatment
    - Treat underlying cause

12.1.5.2 Adie's Tonic Pupil

- Cause
    - Abnormal parasympathetic innervation from ciliary ganglion to the iris and ciliary muscle due to acute viral denervation
- Examination
    - Unilateral and occurs in otherwise healthy women. Mydriatic pupil initially but becomes miotic later on

  - Poor response to light with vermiform eye movements (segmental iris constriction) seen at slit lamp
  - Light-near dissociation
  - Absence of deep tendon reflexes: Adie-Holmes syndrome
- Investigations
  - Confirm diagnosis with 0.125% pilocarpine: constriction of affected pupil (denervation hypersensitivity of sphincter pupillae)
- Treatment
  - Painted CL acting as an artificial pupil for mydriasis
  - Weak strength pilocarpine for mydriatic blurring and accommodative problems

12.2 Examination of Patients with Visual Fields Defects

12.2.1 Confrontation Visual Fields Examination Sequence

- Introduce yourself
- Sit in front of patient at a distance of about 1 m (3 ft)
- Explain to the patient that you will be moving a white dot in and out of the patient's view and that the patient is to tell you when they first see the white dot
- Begin examining the right eye by asking patient to cover their left eye with the palm of their left hand. Cover your right eye with the palm of your right hand
- Ask the patient to fixate on your nose or on your open eye
- Move a white hatpin held midway between yourself and the patient in one quadrant of the monocular field from the periphery to fixation. Ask the patient to inform you when they first see the white hatpin. Repeat in all four quadrants, testing at least two times per quadrant
- Compare the patient's responses to your own visual field
- Repeat process for examining the other eye with the patient asked to cover their right eye with the palm of their right hand and covering your left eye with the palm of your left hand

12.2.2 Differential Diagnosis of Visual Field Defects

- Altitudinal field defects
  - Ischaemic optic neuropathy
  - Hemibranch retinal artery or vein occlusion
  - Glaucoma
  - Optic nerve coloboma
- Arcuate scotoma
  - Glaucoma
  - Ischaemic optic neuropathy
  - Optic disc drusen
- Bitemporal hemianopia
  - Chiasmal lesions
  - Tilted optic discs
  - Sectoral RP
- Binasal hemianopia
  - Glaucoma
  - Bitemporal retinal disease (e.g. RP)
  - Bilateral occipital defect
  - Compressive lesion of both optic nerves or chiasm
  - Functional visual loss
- Blind spot enlargement
  - Papilloedema
  - Glaucoma
  - Optic nerve drusen
  - Optic nerve coloboma
  - Myelinated nerve fibers
  - Myopic discs
- Homonymous hemianopia
  - Optic tract or lateral geniculate nucleus (LGN) lesions
  - Temporal, parietal, or occipital lobe lesions
- Superior quadrantanopia:
  - Temporal lobe lesion
- Inferior quadrantanopia
  - Parietal lobe lesion
- Central scotoma
  - Optic neuritis
  - Optic atrophy
  - Macular lesions
  - Occipital cortex lesions — tip of occipital lobe

- Constriction of peripheral fields
  - Advanced glaucoma
  - Retinal disease, e.g. RP
  - Vigabatrin
  - Bilateral extensive PRP

12.3 Examination of Patients with the Direct Ophthalmoscope

12.3.1 Direct Ophthalmoscopy Examination Sequence

- For the exam the patients will likely have non dilated pupils
- Introduce yourself
- Ask for room lights to be dimmed (if not already dimmed)
- Ask patient to look at distant target
- Hold direct ophthalmoscope with dominant hand. Set focusing lens of direct ophthalmoscope at zero (or the user's refractive error) and check the patients red reflex in both eyes from a distance of 2 ft: look for any obvious media opacities (appear as dark shadows)
- Hold direct ophthalmoscope with right hand. Direct light beam of the direct ophthalmoscope into the center of the patient's right pupil and approach as close to the patient's right eye as you can with your left hand on the patient's forehead and your left thumb used to raise the upper eyelid. While holding the patient's eyelid open
  - Dial the ophthalmoscopes focusing lenses into place to clarify the fundus image
  - Angle the ophthalmoscope about 15° temporal to fixation to examine the patient's optic disc (if not visible, find the optic disc by following a retinal blood vessel)
  - From the optic disc, follow the blood vessels outward to examine the superotemporal, inferotemporal, superonasal and inferonasal areas around the posterior pole
  - Examine the macula
- Repeat process with direct ophthalmoscope held in left hand to examine patients left eye

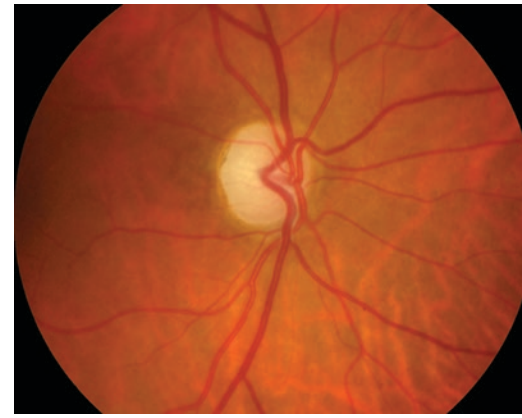

Fig. 12.2 Colour fundus image of a patient with a pale disc

12.3.2 Direct Ophthalmoscopy Clinical Cases

12.3.2.1 Pale Optic Disc (Fig. 12.2)

- Differential diagnosis
  - Congenital:
    Autosomal dominant optic atrophy
    Kjer's, Behr's or Wolfram's syndrome
  - Acquired:
    Ischaemic optic neuropathy: arteritic (GCA), non-arteritic
    Glaucoma
    Compressive lesions: optic nerve sheath meningioma, glioma
    IIH
    Optic neuritis
    Trauma
    Toxic optic neuropathy
    Severe retinal disease
    Lebers Hereditary Optic Neuropathy (LHON)

12.4 Examination of Patients with Ocular Motility Disorders

12.4.1 Ocular Motility Examination Sequence

- Introduce yourself
- Ask the examiner for the patient's visual acuity: ensure that the patient can fixate on the distant target

- Ask the examiner if they would like you to perform the cover test (cover-uncover test and alternate cover test): move straight to testing ocular movements if the examiner does not want the cover test performed
- Look for any obvious abnormal head postures
- Ask the patient to remove their glasses (if worn): quickly check the glasses to see if the patient is myopic or hyperopic and whether prisms are present in the glasses
- Perform the Hirschberg's test: ask the patient to fixate on light from a pentorch and ask the patient if they can see one or two images
- Ask the patient to look at a distant target (e.g. letter on a snellen chart or logMAR chart) and position yourself slightly to the side of the midline, facing the patient and at arm's length from the patient (do not obstruct patient's view of distance target)
  - Cover each eye in turn with an occluder to ensure the patient can visualise the distant target with each eye: if the patient has NPL vision then cover-uncover test and alternate cover test is not applicable
  - Perform a cover-uncover test to look for tropias:
    Swiftly cover the fixating eye with an occluder and observe the other eye for any movement. Carefully note its direction
    Uncover the eye and allow about 3 s for both eyes to be uncovered
    Swiftly cover the other eye and observe its fellow eye for any movement
  - Perform the alternate cover test to look for phorias:
    Rapidly shift the occluder from one eye to the other several times, not allowing any interval of binocularity
    Ensure that each eye fixes on the target after each movement of the cover
    Observe for any movement of the eyes
- Ask the patient to look at a near accommodative target and position yourself directly opposite the patient within arm's reach
  - Cover each eye in turn with an occluder to ensure patient can visualise near accommodative target with each eye
  - Perform a cover-uncover test to look for tropias:
  - Perform an alternate cover test to look for phorias:
- Repeat cover test with the patient wearing glasses (if patient wears glasses): ask the examiner if they would like you to perform this before going ahead
- Examine ocular movements
  - Sit facing the patient. Shine a light from a pen torch at eye level about 10 to 14 in. in front of the patient, with the patient looking in primary position
  - Ask the patient to inform you if they see double vision at any gaze position
  - Ask the patient to follow the light from your pentorch as you move it into the nine directions of gaze. Elevate the upper eyelid with a finger on your free hand to observe movements in downgaze: note any limitations of movement
  - Examine ductions if you see any limitations on version movements
  - Examine horizontal and vertical saccades: ask patient to look rapidly between targets (e.g. your hands) positioned at 30° on either side of the midline

12.4.2 Clinical Cases of Ocular Motility Disorders

12.4.2.1 Internuclear Ophthalmoplegia (INO) (Tables 12.1 and 12.2)

- Causes
  - Multiple sclerosis
  - CVA
  - Tumours (intrinsic or metastatic) of brainstem or fourth ventricle
- Examination
  - Ipsilateral slow adducting saccade (saccadic velocity slowing — saccadic move-

Table 12.1 Key facts about INO

- Caused by a lesion of the medial longitudinal fasciculus which is a nerve fiber bundle that connects the CN VI nucleus on one side of the pons to the MR subnucleus of the CN III in the contralateral midbrain
- INO should always be suspected whenever there is an acquired limitation of adduction

Table 12.2 Differential diagnosis of an adduction deficit

- Neurologic:
  - INO
- Myopathic:
  - Myasthenia gravis: variability, Cogan's lid twitch, involvement of vertically acting muscles, positive response to the Tensilon test
- Mechanical:
  - Orbital trauma: history of trauma, evidence of mechanical restriction of abduction
  - Duane's retraction syndrome: change in palpebral aperture on horizontal gaze

ments are usually impaired to a greater extent than pursuit movements), contralateral abducting nystagmus
  - Ipsilateral adduction deficit overcome with convergence
  - Exophoria or exotropia in the primary position — increase on attempted horizontal gaze in the direction of action of the affected MR muscle in cases of unilateral INO
  - Skew deviation with the hypertropic eye on the side of the lesion
  - Vertical gaze nystagmus
  - Wall-eyed bilateral INO (WEBINO): bilateral XT on primary gaze, bilateral INO, impaired convergence, ±vertical gaze palsy, ±up beat nystagmus, ±skew deviation
- Investigations
  - MRI brain
  - Hess chart (see Figs. 2.42 and 2.43)

12.4.2.2 Progressive Supranuclear Palsy (Steele-Richardson Syndrome) (Table 12.3)

- Examination
  - Slowing of the vertical saccadic velocity, usually first affecting downgaze, which is followed in due course by a complete vertical saccadic paralysis
  - Voluntary saccades affected first, convergence, and smooth pursuit later
  - Disorders of horizontal gaze are a late feature; eventually some patients may go on to develop a complete ophthalmoplegia
  - Sparing of the vestibulo-ocular reflex
  - Square wave jerks
  - Apraxia of eyelid opening: difficulty in voluntary opening of the eyelids
  - Axial rigidity with limited neck movement
  - Difficulty with swallowing, speech and balance (postural instability)
- Investigations
  - MRI: midbrain atrophy

Table 12.3 Key facts about progressive supranuclear palsy

- Progressive neurodegenerative condition caused by abnormal accumulation of tau proteins
- Definitive diagnosis requires histology (tau inclusions on microscopy)

12.5 Approach to Patients with Nystagmus

12.5.1 Description of Nystagmus

- Rhythmical oscillation of the eyes
- One component of the oscillation is a slow phase drift away from the assumed position of gaze; this component differentiates nystagmus from nystagmus-like oscillations which comprise only saccadic (fast) elements
- Description of nystagmus should include:
  - Type of waveform: Jerk nystagmus — a slow phase that drifts away from fixation (abnormal movement), and a fast corrective movement (saccade) in the opposite direction to regain fixation, Pendular nystagmus: equal velocity slow-phase movements in both directions
  - Direction: described by the direction of the fast phase, i.e. if the fast phase is to the right then the nystagmus is described as

right beating. Both jerk and pendular can be horizontal, vertical or torsional
- Symmetry: conjugate, disconjugate
- Intensity
- Frequency

12.5.2 Classification of Nystagmus

- Early onset
  - Horizontal:
    Idiopathic congenital — bilateral jerk (typically) or pendular nystagmus present in the primary position, intensity worse on fixation, better with convergence and in null zone, presence of a face turn, inverted optokinetic response, absent oscillopsia, latent nystagmus
    Latent/manifest latent nystagmus — bilateral jerk nystagmus, fast phase towards the fixing eye, intensity increases on abduction and decreases on adduction, face turn towards fixing eye, associated with infantile ET
  - Erratic ± Roving: sensory deprivation
- Late onset
  - Conjugate:
    Horizontal:
    - Peripheral vestibular — bilateral jerk waveform present in the primary position, intensity increases in the direction of the fast phase and decreases in the direction of the slow phase, intensity decreases with fixation, intensity increases with removal of fixation, direction of fast phase opposite to the side of the lesion
    - Central vestibular — bilateral jerk waveform present in the primary position, intensity increases in the direction of the fast phase and decreases in the direction of the slow phase, no change in intensity with removal of fixation
    - Periodic alternating — bilateral jerk waveform present in the primary position in which oscillations change direction every few minutes — seen in patients with albinism
    - Gaze evoked — bilateral jerk waveform that only becomes manifest when gaze is directed away from the primary position, absent in primary position, fast phase always in direction of eccentric gaze
    Vertical:
    - Upbeat
    - Downbeat
  - Disconjugate:
    Unilateral:
    - SO myokymia
    - INO
    Bilateral:
    - See-Saw — vertical pendular waveform with synchronous intorsion of the elevating eye and an extorsion of the depressing eye — seen in patients with parasellar tumours
    - Acquired pendular — MS if horizontal, ocular palatal myoclonus if vertical

12.5.3 Causes of Nystagmus

- Congenital
- Acquired
  - Sensory deprivation: ocular albinism, oculocutaneous albinism, CSNB, cone-rod dystrophy, LCA, optic nerve hypoplasia
  - Structural abnormalities: Arnold-Chiari malformations, tumours affecting the brainstem or cerebellum
  - Medications: carbamazepine, lithium, phenytoin, amiodarone, morphine, ketamine abuse, fomepizole
  - CVA
  - Demyelination: MS

12.5.4 History

- Age of onset: onset within first 3 months of life should reliably differentiate congenital nystagmus from other forms
- Visual function: below normal in congenital nystagmus
- Visual symptoms of oscillopsia (illusion of rhythmical movement of stationary objects):

suggestive of acquired nystagmus and not congenital nystagmus
- Visual symptoms of diplopia combined with nystagmus: suggest brainstem involvement:
  - Horizontal diplopia: INO, Arnold-Chiari malformation
  - Vertical diplopia: skew deviation with down-beat nystagmus, and of cavernous sinus spread from a local tumour, which can be associated with see-saw nystagmus
- Systemic symptoms:
  - Vertigo, dizziness, nausea, tinnitus: suggests peripheral vestibular dysfunction
  - Vertigo, dysarthria, dysphagia, diplopia: suggests a pontomedullary lesion
  - Ataxia and coordination difficulty: suggests a cerebellar syndrome
- Medication history: carbamazepine, lithium, phenytoin, amiodarone, morphine, ketamine abuse, fomepizole, nutmeg
- Severe head trauma or brainstem stroke: delayed appearance of an unusual type of nystagmus termed ocular-palatal myoclonus — pendular vertical nystagmus + rhythmical movements of the palate, diaphragm and other structures
- Family history: a number of conditions associated with congenital nystagmus are inherited, including albinism, LCA, idiopathic congenital nystagmus

12.5.5 Examination

- Head posture: feature of congenital nystagmus adopted to improve VA by utilising the null region (e.g. Left head turn implies null zone is in right gaze)
- Nystagmus in the primary position: horizontal — peripheral vestibular, central vestibular, periodic alternating / vertical — upbeat, downbeat
- Nystagmus characteristics on distance and near fixation and on convergence: congenital nystagmus dampens on near fixation and with convergence, subtle forms of see-saw nystagmus may be easier to observe on distance fixation
- Effect of covering one eye (i.e. cover test): latent nystagmus can be identified on cover test — associated with congenital nystagmus, manifest latent nystagmus will show an increase in the intensity of the nystagmus if the non-fixing eye is covered or a dampening or reversal of direction if the fixing eye is covered
- Effect of removing fixation (Spielmann translucent occluder prevents fixation of a non-illuminated target while still observing the eye behind the occluder): peripheral vestibular nystagmus increases when fixation is removed, whereas congenital nystagmus may reduce in intensity, central vestibular nystagmus shows no change
- OKN testing: inverted response with congenital nystagmus (e.g. right beating horizontal nystagmus will continue to show a right beating nystagmus when the drum is rotated to the right)

12.5.6 Investigations

- Refraction: patient's with retinal dystrophies commonly have high levels of refractive error and astigmatism
- Stereoacuity: a near-normal level of Stereoacuity on TNO testing virtually excludes albinism as the cause of congenital nystagmus
- ERG: retinal dystrophies, optic nerve hypoplasia
- VEP: presence of crossed asymmetry in albinism
- MRI of brain, lower brainstem and cerebellum (indications — central vestibular nystagmus, upbeat and downbeat nystagmus, periodic alternating nystagmus, INO, see-saw nystagmus, acquired pendular): exclude the presence of intracranial disease
- In the absence of any evidence of ocular disease and a normal ERG and VEP, the likely diagnosis is congenital idiopathic nystagmus
- Neither latent nystagmus or latent manifest nystagmus require any investigations

12.5.7 Treatment

- Congenital nystagmus
  - Improve VA
    Refractive error correction
    Amblyopia treatment
  - Reduction of nystagmus intensity
    Base out prisms: stimulate convergence can improve VA at distance fixation if patient has BSV
    Surgical
  - Reduction in head posture
    Conservative: prisms with apex pointing towards the null point or base in the direction of the head posture (e.g. right face turn with eyes deviated towards a null region in left gaze, the prism before the right eye is positioned base out and that before the left eye base in)
    Surgical (for head postures more than 20°):
    - Horizontal head posture: Kestenbaum procedure — surgery on all four horizontal rectus muscles with movement of eyes towards head posture (e.g. right head turn — R LR resection, R MR recession, L MR resection, L LR recession)
    - Vertical head posture: Chin down — recession of both SR muscles, Chin up — recession of both IR muscles
- Acquired nystagmus
  - Improve VA by:
    Correction of any refractive errors
    Correction of head posture: prisms
    Correction of oscillopsia: medications (Baclofen for periodic alternating, clonazepam), Botox, surgery
  - Relief of diplopia (involvement of ocular motor nerves from brainstem disease):
    Prisms
    Botox
    Muscle surgery