Primary Congenital Glaucoma

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The term primary congenital glaucoma (PCG) was first described by Hippocrates (460–377 BC), while Berger first linked the elevated intraocular pressure (IOP) to enlargement of the globe. Buphthalmos is the visible enlargement of the globe at birth or soon after birth due to congenital glaucoma. PCG is developmental glaucoma occurring due to an obstruction in aqueous outflow as a result of abnormal development of the trabecular meshwork and anterior chamber angle (pathophysiology is explained in Chap. 1). The anatomical classification of developmental glaucoma is mentioned in Chap. 2, where PCG is essentially labeled as glaucomas with isolated trabeculodysgenesis. PCG can be sporadic or inherited in an autosomal recessive pattern. Some of the genetic associations include mutations in known genes like *CYP1B1*, *LTBP2*, *TEK*, *MYOC*, *GPATCH*, *PLOD2*, and *PRSS56*. Based on the presentation, it is further classified into neonatal PCG (<1 month), infantile PCG (>1 month to 24 months), or late-onset PCG (>24 months). Table 9.1 lists classification for PCG based on disease severity (Gupta V et al 2022).

Table 9.1 Severity staging for primary congenital glaucoma (PCG). *Each parameter is worth 1 point. A case is severe if total score is ≥4.

Parameters*	Non-severe PCG	Severe PCG
Age of onset	Infantile	Neonatal
Corneal diameter (in mm)	<13	≥13
Axial length (in mm)	<24	≥24
Corneal haze	Clear cornea or anterior segment structures can be made out despite the haze	Total (no anterior segment structures visible)
Corneal haze after IOP lowering	Reduced	Persisting
Surgeries required for IOP control	≤2	>2

9.1 Case Examples

Case 9.1

A 6-day-old male child presented with an enlarged eyeball and hazy enlarged cornea of both eyes (Fig. 9.1) since birth. Parents also complained that the child had photophobia and watering.

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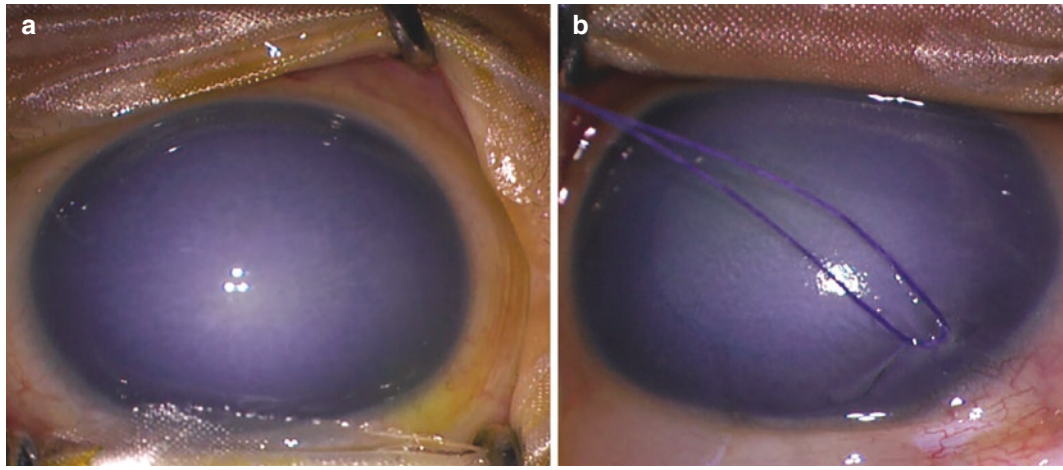


Fig. 9.1 Clinical picture of right eye (RE) (**a**) and left eye (LE) (**b**) of neonatal PCG showing enlarged corneal diameter, stretched limbus, and central corneal haze with peripheral clearing

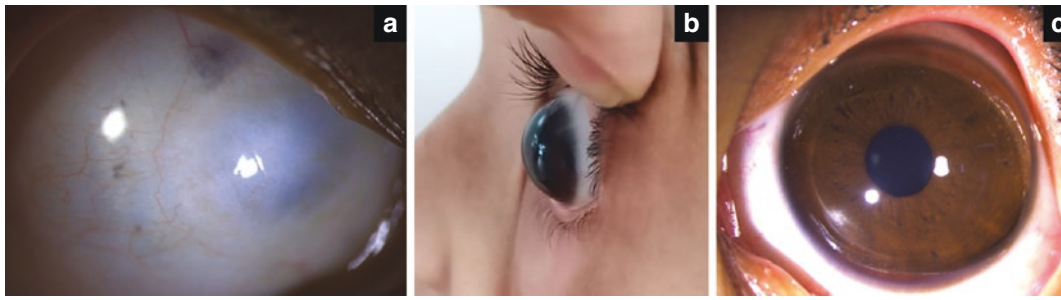


Fig. 9.2 Differentials of primary congenital glaucoma: (**a**) clinical picture of sclerocornea showing a small opacified cornea with no definitive boundary between sclera and cornea, (**b**, **c**) clinical picture of keratoglobus showing globular protrusion of cornea from limbus to limbus

Examination: The child had enlarged corneal diameter, stretched limbus, and central corneal haze with peripheral clearing (Fig. 9.1a, b), and IOP (measured while sleeping) was 28 mmHg in the right eye (RE) and 32 mmHg in the left eye (LE). Central corneal thickness was 850 μm (RE) and 910 μm (LE). No other systemic comorbidities were present.

Diagnosis: The patient was diagnosed with both eye neonatal PCG.

Differential diagnosis:

- Congenital hereditary endothelial dystrophy: Bilateral symmetric diffuse corneal opacification varying from a blue-gray ground-glass appearance to total corneal opacification (involving peripheral cornea unlike in PCG), without megalocornea. However rarely CHED and congenital glaucoma may coexist.
- Other conditions with corneal opacity/edema: Sclerocornea (Fig. 9.2a), obstetric trauma causing tears in Descemet's membrane, ulcers, metabolic diseases, and other corneal dystrophies – look for high IOP and megalocornea.
- Nasolacrimal duct obstruction: Only epiphora will be present, the absence of corneal involvement as well as photophobia.
- Axial myopia, megalocornea, and keratoglobus (Fig. 9.2b,c): Only enlargement of the eye (axial myopia)/cornea alone in megalo-

cornea or globular protrusion of corneal (keratoglobus) with no limbal stretching and presence of clear cornea and normal IOP.
- Proptosis (Video 9.1) due to any intraorbital mass lesion: There will be only outward protrusion of eye and imaging (ultrasonography, computed tomography or magnetic resonance imaging) would help to find the mass lesion/confirm the diagnosis.

Treatment: Initially started on BE betaxolol bd, pilocarpine 2% TDS, and oral acetozolamide 250 mg (1/8) tablet TDS.

It was followed up with both eyes combined trabeculectomy with trabeculotomy (CTT) augmented with mitomycin C 0.04% under general anesthesia.

Learning Points
- The classic triad for symptoms of PCG includes epiphora (Fig. 9.3), photophobia, and blepharospasm.
- Neonatal PCG presents within the first month of birth. It has a worse prognosis than infantile PCG. Angle surgeries are less effective in severe PCG with corneal haze and enlarged eye compared to non-severe PCG.
- Brimonidine is contraindicated in children less than 2 years of age due to the risk of central nervous system depression. It is better to avoid till 6 years of age, in children with cognitive impairment and children with weight <15 kg.

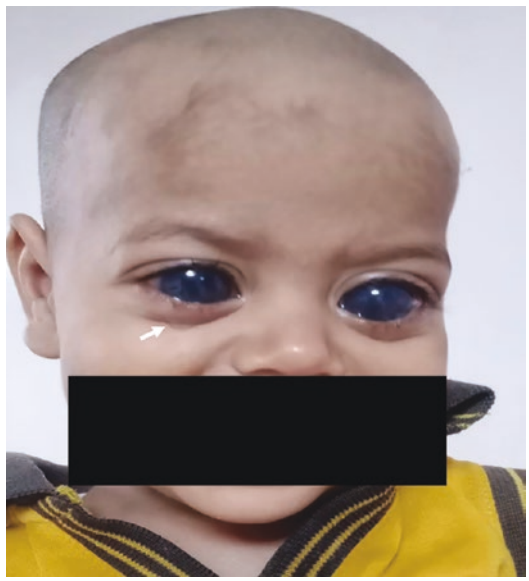


Fig. 9.3 Clinical picture of a child with primary congenital glaucoma having epiphora (white arrow) due to corneal involvement caused by uncontrolled intraocular pressure in both eyes

Case 9.2

A 10-month-old female child presented with an enlarged eyeball and whitish localized opacity of the cornea in the LE.

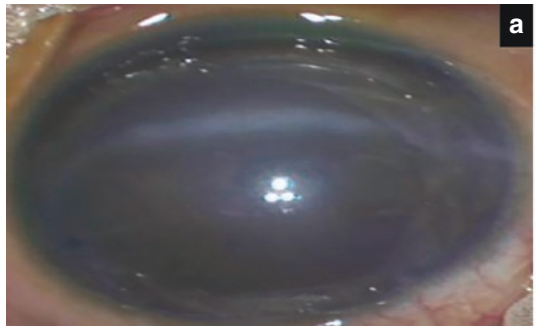
Examination: The patient had enlarged cornea, stretched limbus, and Haab's striae in LE (Fig. 9.4a), while RE appeared normal. IOPs were RE 10 mmHg and LE 24 mmHg. Central corneal thickness: RE 522 μm and LE 682 μm. Axial lengths (AL) were RE 21 mmHg and LE 23 mmHg.

Diagnosis: Unilateral non-severe PCG associated with focal corneal edema due to Haab's striae (LE).

The differential diagnosis for unilateral PCG:

- Retinoblastoma (Fig. 9.5): Look for leucokoria. As a result, distant direct ophthalmoscopy showing a good glow is a necessary requisite before labeling a child with unilateral buphthalmos as primary congenital glaucoma. Fundus examination with indirect ophthalmoscopy or ultrasonography (in case of media haze) to look for mass with calcification confirms the diagnosis.
- Traumatic glaucoma: Rule out the history of trauma.
- Persistent fetal vasculature (PFV) with glaucoma: Initially affected eye may be smaller at birth which when affected with glaucoma too can undergo corneal stretching and increase in AL secondary to increased IOP.
- Other differential diagnoses: congenital anomalies and unilateral microphthalmos with secondary glaucoma.

Examination under anesthesia (EUA): In LE, crescentic opacification corresponding to Haab's striae was seen, intraoperative OCT (iOCT) shows scans which show horizontal and vertical



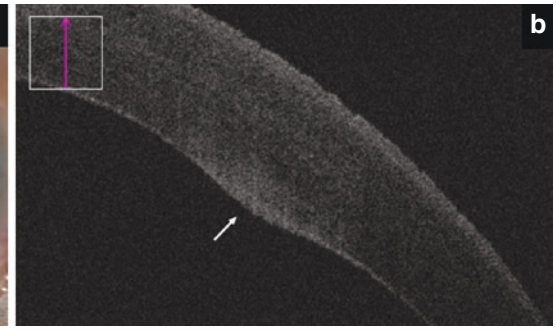


Fig. 9.4 (**a**) Clinical picture of an unilateral primary congenital glaucoma showing Haab's striae (**b**) microscope-integrated intraoperative OCT picture (iOCT machine) (rescan 700 microscope-mounted OCT system, Carl Zeiss Meditec Jena, Germany) showing the morphological appearance of Haab's striae, note the posterior intracameral bulge with posterior corneal hyper-reflectivity at the site of Haab's striae

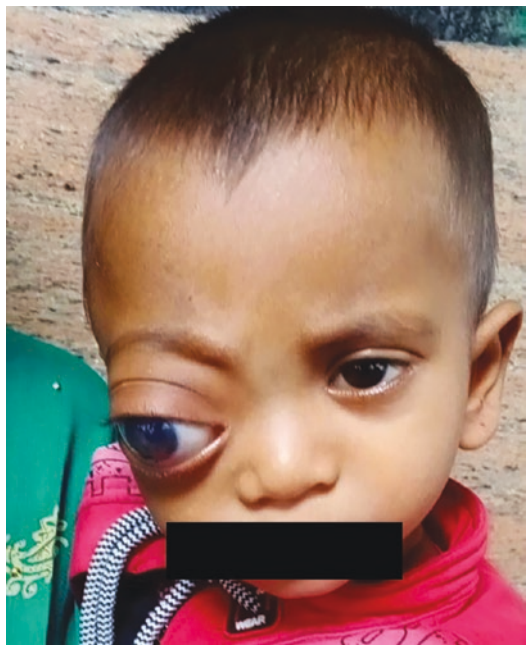


Fig. 9.5 Clinical picture of a patient with right eye retinoblastoma showing enlargement and protrusion of the eye

cross-sections across the Haab's striae (Fig. 9.4b). Fundus: RE cup-disk ratio (CDR) 0.2:1, healthy neuro-retinal rim, LE good glow was present CDR 0.7:1, and circumferential thinning of the neuroretinal rim.

Treatment: LE microvitreoretinal blade assisted 200° goniotomy through two side ports was performed under Healon (Abbott Medical Optics, Santa Ana, California) cover under general anesthesia.

During follow-up at 5 years, the RE showed IOP of 24 and 28 mmHg on 2 consecutive follow-ups. CRD remained 0.2:1. She was started on betaxolol drops for control of IOP.

Learning Points

- PCG is usually bilateral (70–95%), and unilateral presentation is uncommon (Figs. 9.6 and 9.7). Fellow eyes of unilateral PCG may not have subtle angle dysgenesis, manifesting later in life, so they should be monitored for IOP rise on every follow-up. Development of ocular hypertension (like in this case) or glaucomatous optic neuropathy calls for treatment.
- Refraction and amblyopia therapy must not be missed while following up congenital glaucoma patients, especially if unilateral.

Case 9.3

A case of a 6-year-old male patient with bilateral PCG. He had a history of both eyes operated trabeculotomy with trabeculectomy augmented with mitomycin C at 1.5 years of age.

Examination: BE best-corrected visual acuity 6/12 (power of glasses: RE −4.75DS/−2DC, LE −4.25DS/−1DC). BE showed Haab's striae (Fig. 9.8a–d) involving central cornea. AS OCT of BE angle showed anterior iris insertion and hyper-reflective membrane causing angle

Fig. 9.6 Clinical picture of a child with bilateral primary congenital glaucoma showing enlarged eyes, stretched limbus and diffuse corneal haze in both eyes

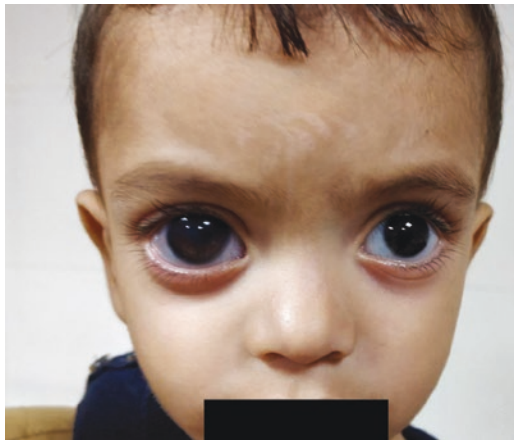


Fig. 9.7 Clinical picture of a child with (unilateral) right eye primary congenital glaucoma. Note the enlargement of eye and stretching of limbus in right eye compared to left eye

dysgenesis (Fig. 9.8e). Current IOPs were RE: 10 mmHg and LE 12 mmHg.

Management: The patient was advised to use refractive glasses and undergo lifelong follow-up.

Learning Points

- The anterior chamber angle in PCG usually shows anterior iris insertion, hyper-reflective membrane over angle, and the absence of identifiable Schlemm's canal. The angle is wide open with prominent angle dysgenesis. Iris configuration may range from flat, concave to wraparound iris configuration.
- Causes of decreased vision in PCG: Corneal scarring from Haab's striae, corneal decompensation or associated irreversible corneal opacity, a refractive error such as myopia (axial elongation) or myopic astigmatism [corneal stretching, Haab's striae (Fig. 9.9) or bleb induced], glaucomatous optic neuropathy, and amblyopia more prominent in unilateral cases (if refractive glasses are not used).
- Parameters that need to be assessed during follow-up (by EUA until old enough for cooperation):
  - IOP
  - Bleb status
  - Corneal diameter (once enlarged, do not reverse even if IOP is controlled)
  - Corneal opacification (may clear if IOP is controlled)
  - Cup-disc ratio (may reverse if IOP is controlled)
  - Refraction
  - Peripheral retinal screening to rule out retinal degeneration or tears
  - Ultrasound A-scan: Axial length (not reversible even if IOP is controlled), B-scan if there is significant corneal opacity to look at posterior segment

Case 9.4

A 4-month-old male child presented with an enlarged eyeball in both eyes. The patient had a family history of congenital glaucoma in his elder sister. Parents gave a history of consanguineous marriage.

Pedigree chart: (Fig. 9.10)

Examination: Enlarged corneal diameters in both eyes: RE 12.5 mm and LE 12 mm. Corneal haze in both eyes (RE > LE) (Fig. 9.11). IOPs were RE 24 mmHg and LE 22 mmHg on medical treatment.

Diagnosis: BE infantile PCG

Treatment: Same as Case 9.1

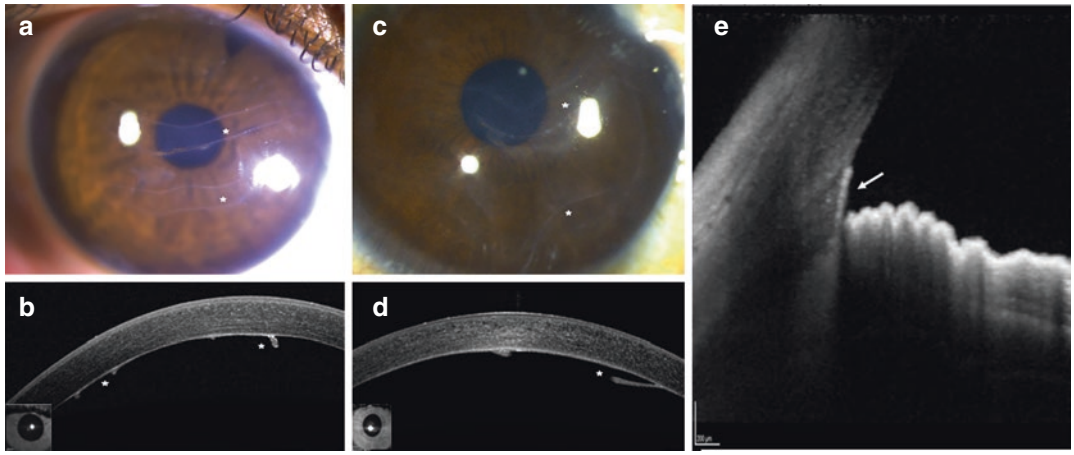


Fig. 9.8 Slit-lamp clinical picture (**a**, **c**) and AS-OCT (**b**, **d**) of bilateral primary congenital glaucoma showing Haab's striae in central and peripheral cornea (star). (**e**) Anterior segment OCT of right eye angle showing anterior iris insertion and hyper-reflective membrane over the angle (arrow), the Schlemm's canal is not visible

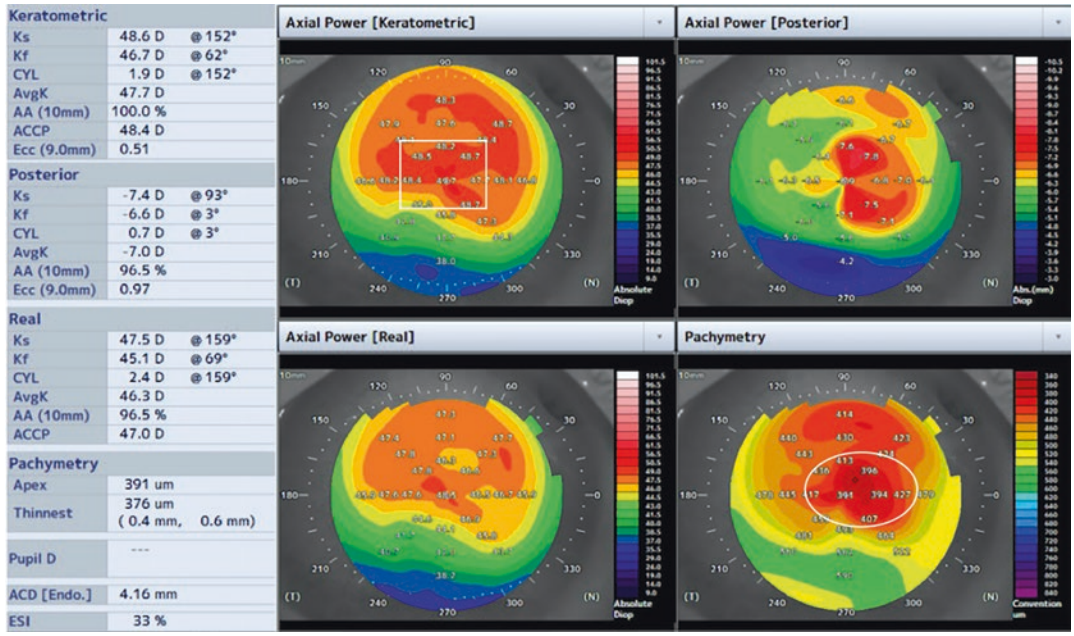


Fig. 9.9 Corneal tomography (Pentacam Comprehensive Eye Scanner- Oculus Optikgeraete GmbH; Wetzlar, Germany) in a primary congenital glaucoma with Haab's striae showing corneal astigmatism upto 7D and corneal steepening (box) and thinning (oval)

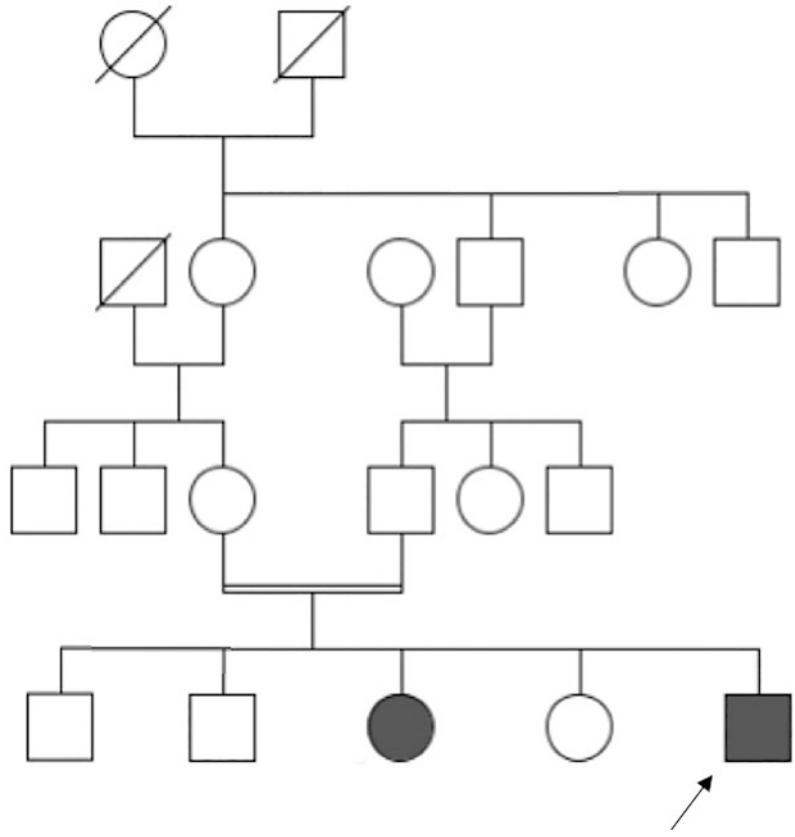


Fig. 9.10 Pedigree chart showing consanguinity and positive family history of a 4 month old child born with both eye primary congenital glaucoma (elder sister has similar disease)

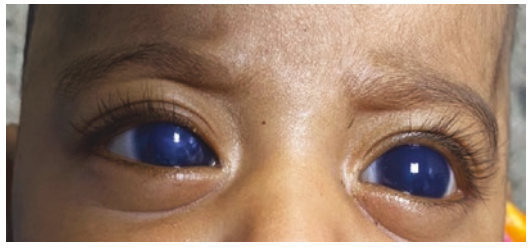


Fig. 9.11 Clinical picture of bilateral infantile primary congenital glaucoma showing enlarged eyeball and corneal haze in both eyes

Learning Points

- PCG occurs in both sporadic and familial patterns (sporadic common).
- Family history is positive in 10–40% of cases, and there is an increased incidence with consanguinity.

9.2 Management of PCG (Fig. 9.12)

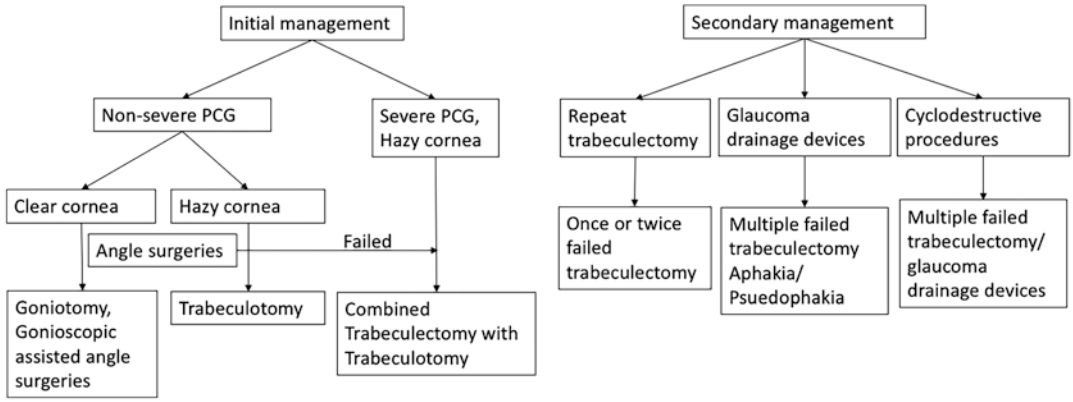


Fig. 9.12 Flow chart showing management of primary congenital glaucoma. Severe and non-severe glaucoma as proposed by the authors (Gupta V et al 2022). PCG- primary congenital glaucoma

9.3 Conclusions

Primary congenital glaucoma has varied clinical presentations (differences in age of onset, severity of signs & symptoms, and response to treatment). Most of them need surgical management for IOP control. Apart from IOP control, refraction & glass prescription (especially in unilateral cases) must be emphasised to prevent ambylopia. With constant efforts, these children grow up to live a productive social and occupational life.

Suggested Reading

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