General Head and Neck

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Gross Anatomy

Arterial: Divided into three arterial plexuses: deep facial, subdermal, and subcutaneous plexus, all connected by small musculocutaneous perforating arteries.

Lateral face—(lateral to the nasolabial region): *External carotid* → perforators of the transverse facial, submental, and posterior auricular arteries.

Anterior face—Superiorly: *Internal carotid* → ophthalmic (eyes, upper 2/3 of nose, central forehead). Inferiorly: *External carotid* → facial → inferior/superior labial and angular.

Venous: Mostly coursing parallel and opposite to arterial flow. Connections to pterygoid plexus/cavernous sinus present with valveless, bidirectional flow distally (e.g., angular vein) = "danger triangle." Supratrochlear/supraorbital → angular (joins superior labial) → facial → common facial → *internal*/*external jugular veins* ← superficial temporal.

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Innervation

Facial Nerve

Extratemporal → posterior digastric and stylohyoid muscle branches → enters parotid gland.

Travels deep to SMAS, typically entering muscles from deep side.

- Temporal br. → frontalis and upper orbicularis oculi muscle (OOM). Runs underneath the superficial layer of the deep temporal fascia over the zygomatic arch and divides into 2–4 branches.
- Zygomatic br. → lateral aspect of lower OOM, enters the muscle from deep.
- Buccal br. → procerus, medial lower OOM, nasal muscles, cheek, upper orbicularis oris.
- Marginal mandibular br. → lower orbicularis oris, lip depressors. Relationship to mandible angle is dependent on degree of neck flexion/extension, and age.

Sensory and Autonomic

CN V1 (ophthalmic) → lacrimal, frontal (supraorbital, supratrochlear), nasociliary nerves

CN V2 (maxillary) → zygomaticotemporal, zygomaticofacial, infraorbital nerves

CN V3 (mandibular) → auriculotemporal, buccal, lingual, inferior alveolar/mental nerves

Sympathetic—postganglionic = from superior cervical ganglion → vasoconstriction

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Parasympathetic—parotid = inferior salivary nucleus, submandibular and sublingual = superior salivary nucleus.

Lymphatics

Divided into 3–5 lymph node (LN) "vessels" running laterally from midline

Above the brow → preauricular and deep parotid LNs

Lateral eyelids → parotid LNs

Medial canthus → buccinator, parotid and submandibular LNs (follows along with the angular vein)

External nose and cheeks → submandibular LNs

Lateral lower lip and upper lip → **ipsilateral** submandibular LNs (and some parotid drainage)

Central lower lip and chin → **bilateral** submental LNs

Tissue Layers/Fascial Compartments

Scalp Layers: Skin → SubQ → galea aponeurotica → loose areolar tissue → pericranium

Temporal Region Layers: Skin → SubQ → superficial temporal fascia (aka TP Fascia, includes superficial temporal a. & v. and joins with the galea superiorly) → loose areolar tissue → superficial layer of the deep temporal fascia → superficial fat pad → deep layer of the deep temporal fascia → deep fat pad → temporalis muscle → pericranium

Face and Neck

Superficial cervical fascia—contiguous superiorly with the **SMAS**; travels from the clavicle up to the zygoma and becomes superiorly the galea. Envelopes mimetic muscles.

Deep cervical fascia

1. Superficial layer (investing): envelopes salivary glands, masseter, and SCM
2. Middle layer (pretracheal): muscular division = straps, visceral division = pharynx, larynx, trachea, thyroid, buccopharyngeal fascia
3. Deep layer (prevertebral): cervical vertebrae, paraspinal musculature

Carotid sheath—consists of all three layers, jugular vein, carotid artery, CN X.

Structure

Buttresses—**Horizontal**: frontal, zygomatic, maxillary, mandibular

Vertical: nasomaxillary, zygomaticomaxillary, pterygomaxillary, mandible condyle/ramus

Orbit bones—(clockwise) frontal, ethmoid, lacrimal, palatine, maxillary, sphenoid, zygomatic

Musculature

CN 3—superior, medial and inferior rectus, inferior oblique, levator palpebrae superioris

CN 4—(trochlear) = superior oblique

CN 6—(abducens) = Lateral rectus

CN 5—**Masticatory muscles**: temporalis, masseter, medial and lateral pterygoid

CN 7—**Facial animation muscles**:

Face: Upper 1/3—frontalis, corrugator supercilii, orbicularis oculi, procerus, depressor supercilii

Face: Middle 1/3—orbicularis oris, buccinator, zygomaticus major/minor, levator labii (×2), levator anguli oris, risorius, nasalis, depressor septi

Face: Lower 1/3—depressor anguli oris, depressor labii inferioris, mentalis, platysma

Specialized Structures

Eye—Conjunctiva → cornea (sclera posteriorly) → Anterior chamber (aqueous humor) → iris → ciliary muscle, suspensory ligaments and lens → vitreous chamber (and body/fluid)

Ethnic Anatomic Considerations

Eyelid morphology—absence of an upper eyelid crease (e.g., Asian eyelid) is a result of:

1. Fusion of the orbital septum to the levator aponeurosis below the superior tarsal border

2. Protrusion of the preaponeurotic fat pad and a thick subQ fat layer at the tarsal border
3. Insertion of the levator into the orbicularis muscle and lid skin is closer to the lid margin

Nasal morphology-

Platyrrhine (broad and flat) = thick skin, low radix, short dorsum, bulbous tip, nostril flaring

Mesorrhine = low radix, variable dorsal projection, rounded and underprojected tip

Leptorrhine (tall and thin) = thin skin, long and high dorsum, projected tip, narrow ala

Micro Anatomy/Pathology of Head and Neck Structures

Skin: Epidermis—stratum corneum → lucidum → granulosum → spinosum → basale (basal layer) = location of melanocytes, Merkel cells

Dermis—90 % of skin thickness. Papillary layer (vascular network) → reticular layer (structure, elasticity) contains hair follicles, sweat (apocrine/eccrine) glands, sebaceous glands, nerve endings, collagen/elastin. Basement membrane = type IV collagen

Thyroid: Central follicle interstitial space (colloid) surrounded by simple cuboidal epithelium as the secretory cells. Intermixed with C-cells (parafollicular cells) that secrete calcitonin

Parathyroid: Embedded in the thyroid capsule, contains (1) chief (principle) cells which are small and oxyphilic and secrete PTH and (2) oxyphil cells—have no secretory function

Salivary: Based on the secretory acinus which is comprised of either mucous- or serous-secreting cells → intercalated ducts (simple cuboidal epithelium that is myoepithelial cell lined) → striated ducts (site of active water resportion and ion exchange) → interlobular ducts. Sublingual = ↑ mucin; parotid = ↑ serous; submandibular = mixed

Lymphoid: Tonsils are lined by squamous cells and contain lymphoid follicles below the surface containing germinal centers (similar to lymph nodes). Partially encapsulated with deep crypts present

Embryologic Development

Branchial Apparatus

1. Mandibular arch: Meckel's cartilage—malleus head and neck, incus body and short process, anterior malleal ligament, mandible
   Nerve: CN V3 → masticatory muscles, tensor tympani, tensor veli palatini, mylohyoid, anterior digastric muscle
   Artery: Maxillary artery
   Hillocks of His: 1 (tragus), 2 (helical crus), 3 (helix)
   Pouch: Eustachian tube, middle ear/mastoid, inner layer of tympanic membrane
2. Hyoid arch: Reichert's cartilage—manubrium of malleus, long and lenticular process of incus, stapes (not footplate) styloid process, stylohyoid ligament, lesser cornu and superior ½ of hyoid
   Nerve: CN VII → facial animation, stapedius, stylohyoid, posterior digastric
   Artery: Stapedial artery
   Hillocks of His: 4 (antihelix crus), 5 (scapha), 6 (lobule)
   Pouch: supratonsillar fossa, palatine tonsils, middle ear
   Groove: external auditory canal, outer layer of tympanic membrane
3. Cartilage—greater cornu and inferior ½ of hyoid bone
   Nerve: CN IX—stylopharyngeus muscle, superior and middle constrictors
   Artery: common and internal carotid arteries
   Pouch: thymus, inferior parathyroids
4. Aortic arch: Cartilage—thyroid and cuneiform
   Nerve: Superior laryngeal nerve (cricothyroid and inferior pharyngeal constrictors
   Artery: Aorta (left); subclavian artery (right)
   Pouch: Parafollicular cells of thyroid, superior parathyroids

5. and 6. Cartilage: Cricoid, arytenoid, and corniculate
   Nerve: Recurrent laryngeal nerve (remaining intrinsic laryngeal muscles)
   Artery: Ductus arteriosus and pulmonary artery

Physiology

Mastication/Deglutition: Oral Phase—Mastication prepares food to become bolus with salivary mixture. Next, tongue compresses bolus against the palate and posterior pharynx with tongue elevation. Hyoid elevates and bolus is propelled toward the vallecula.

Pharyngeal Phase—Reflexive (CN IX and X) activated elevation of the larynx/hyoid bone, elevation of the soft palate, contraction of the superior constrictor, and pushing of the bolus posteriorly by the tongue base. Next, the multiple levels of laryngeal closure occur: epiglottis, AE folds, and arytenoids, false cords, and true cords. Lastly, the pharyngeal constrictors contract and the cricopharyngeus opens, triggering the esophageal phase.

Speech (Articulation): Speech sounds produced by a coordination of lip, tongue, and mandibular musculature activity.

Phonation: The production of voice, dependent on vocal properties: position, vibratory capacity, length, and tension.

Lacrimation: Spontaneous, reflexive, or emotional based tear production.

Nerve Pathway: Superior salivary nucleus → parasympathetic fibers of the GSPN → IAC → middle cranial fossa → joins sympathetic greater petrosal nerve → pterygopalatine ganglion → lacrimal gland (and nasal mucosal glands)

Lacrimal System: Lacrimal gland (aqueous component) tear secretion is spread across the surface of the eye. Tarsal glands contribute the lipid component and conjunctival glands secrete mucous component. Lacrimal fluid is drawn into the punctum by capillary action → lacrimal canaliculi → lacrimal sac → nasolacrimal duct → inferior meatus

Testing

Imaging

CT scan: Ideal for osseous visualization. Temporal bone = 0.5–0.625 mm thick slices. Max-face = 1.25 mm slices; neck = 3 mm slices. Axial images with coronal and sagittal recons. Volume rendering with 3-D reconstruction models. Contrast for delineating soft-tissue abscesses and cellulitis.

MRI: Ideal for soft-tissue (skull base, neural tissue, cartilage) visualization with multiplanar images, even without contrast. Gadolinium contrast—risk of nephrogenic systemic fibrosis. Cons = motion artifact, pulsation artifact, metallic object interaction, greater cost, longer scan time. Most use a 1.5–3 T field strength.

Ultrasound: Good soft-tissue and fluid resolution, noninvasive, inexpensive, often requires "specialized training" for interpretation. Combined with Doppler for flow testing.

Cineradiography: Functional fluoroscopy, useful to delineate anatomic abnormalities in addition to functional (mastication, deglutition, esophageal) abnormalities.

Bone scan (bone scintigraphy): Nuclear scan utilizing T-99 m, for functional testing of bone lesions by highlighting areas of increased metabolic activity. Less expensive than FDG-PET.

DEXA: (Aka—bone density scan) low-dose X-ray for bone density testing, structural, inexpensive.

Angiography: The gold standard for evaluating vascular injury and vascular anatomy, but lengthy, expensive, and invasive.

CT angiography: Screening tool for penetrating neck trauma or blunt trauma. Quick and noninvasive, easily accessible. Requires iodinated contrast.

Radiogram

FDG-PET: Best technique for metabolic function testing. Poor spatial resolution which can be enhanced with hybrid scanning techniques (with MRI or CT).

Functional

Rhinomanometry: Measures transnasal airflow from the nares to nasopharynx, allowing for pressure changes and therefore resistance to be elucidated. Assesses turbulence vs. laminar flow. Clinically applicable in assessing degree of nasal obstruction. Use of decongestant spray attempts to separate structural/anatomic from functional/mucosal causes of obstruction.

Schirmer test: A small strip of filter paper is placed inside lower lid (± topical anesthetic) and checked at 5 min. >15 mm of moisture on filter paper strip after 5 min = normal. Mild lacrimal dysfunction = 9–14 mm, moderate = 4–8 mm, severe = <4 mm.

Assessment and Management

Differential Diagnosis Formation for Head and Neck Masses/Disorders

KITTENS Method . . .
K = Congenital, I = Infectious and Iatrogenic, T = Toxins and Trauma, E = Endocrine, N = Neoplastic, S = Systemic

Also, remember important info: Age, associated symptoms, symptom/sign characteristics

Management Algorithm

Management options can be arranged from most conservative and least invasive to most aggressive and high risk. Stepwise approach vs. combined approach may be useful.

1. Do nothing
2. Lifestyle: diet, exercise, sleep, habit changes
3. Therapy: physical/occupational therapy, stretching, massage, heat, ice
4. External applications: dressings, external splints
5. Medication: topical vs. systemic, taken orally, IM, IV, etc.
6. Surgery: prophylactic, diagnostic and/or therapeutic
7. Ancillary treatments: chemotherapy, radiation therapy, cryotherapy, etc.
8. Complementary and alternative treatments

Photography

Standardized pre-, intra-, and postoperative photography help achieve consistency, facilitate comparisons, and demonstrate anatomic detail. Keys include:

Photographic Consent—Use of photos for non-treatment purposes (presentations, lectures, print/Internet media, etc.) requires consent. Consent not required for treatment purposes.

Room setup—appropriate flashes, background, camera mount

Patient preparation—remove glasses, jewelry, place hair back, avoid excessive makeup

Positioning—Frankfort horizontal plane = top of tragus (superior EAC) to the infraorbital rim (estimated by junction of lower lid and cheek skin). In some cases to avoid submental laxity, the natural horizontal facial line may be preferred. Oblique facial views should align either (1) nasal tip with far cheek, (2) nasal dorsum overlying the far medial eye, or (3) medial canthus aligned with the lateral oral commissure. Lateral views should be void of over- or under-rotation. Avoid head tilting by keeping ear lobes symmetric. Include from the top of the hairline to the sternal notch.

Views/Series—Standard procedures have standard views. **Uniformity is key**. Utilize perspective/reference photos as needed. Typically with a 105 mm lens at 1 m distance

Camera Terminology—Aperture = the size of the iris of the lens, determines the amount of light hitting the camera film/sensor. Measured in an "*f-stop,*" which is a fraction, and therefore increases as the aperture decreases. Smaller aperture = greater field depth.

Shutter speed = How long the iris is open and therefore how long the sensor is exposed to light.

Depth of field = (aka—focal range) The distance between the closest and farthest in-focus areas of a photograph. The smaller the aperture (↑ *f-stop*) = the greater the depth of field.

Focal Length = the distance in millimeters from the optical center of the lens to the focal point, which is located on the sensor. Shorter focal length = larger field of view. Longer focal length = narrower field of view.

Lenses: Normal—When the focal length approaches the diagonal measurement (43.27 mm) of a rectangular 35 mm × 24 mm pane, the standard size that was previously film and is now a sensor. Wide angle—shorter focal length and shorter lens but a wider field of view. Telephoto—longer focal length and a longer lens, leaving a narrower field of view.

Resolution = A measurement of the pixel count of an image, given per inch or total. Increase resolution for print media (>300 ppi) and decreases for Internet use (72–150 ppi).

Zoom: Optical zoom—changes the amount of the scene hitting the sensor, thus allowing for more detail that can be enlarged without issue. Digital zoom—interpolates data in the scene to fit on the sensor, mimicking zoom without gaining detail. Can result in blurry, pixilated images.

Facial Analysis

Facial Subunits (Table 4.1)

Forehead: Extends from the hairline (or the superior extent of the frontalis in receding hairlines) down to the superior orbital rim. Contains a continuation of the scalp layers, with the frontalis contained between divided galeal layers.

Periorbital region: Includes the upper and lower lids, medial and lateral canthal regions, and the globe

Cheek: Extends from the preauricular crease anterior to the nasolabial fold; from the zygomatic arch/inferior orbital rim down to the inferior border of the mandible.

Nose

Perioral region and chin: From the subnasale and nasolabial folds to the menton, between lateral commissure bilaterally.

Neck: Key area of rejuvenation is the cervicomental angle, with superior neck skin behaving more like cheek skin, and lower neck skin more like chest skin (Table 4.2).

Table 4.1 Soft-tissue landmarks

Trichion (Tn)	Forehead/hairline junction at midline (~ upper edge of frontalis)
Glabella (G)	Prominent forehead/brow junction at midline
Radix (R)/Nasion (N)	Root of the nose, corresponding with soft-tissue nasion
Rhinion (Rh)	Junction of the nasal bone and upper lateral cartilage
Supratip (Su)	Gentle soft-tissue break between nasal dorsum and tip
Nasal tip (Tp)	Leading edge of nasal profile
Subnasale (Sn)	Soft-tissue point at the junction of the columella and upper lip
Vermillion (Vm)	Mucocutaneous junction of the upper lip and lower lip
Stomion (St)	Midpoint of the embrasure of lips when closed
Mentolabial sulcus (Ms)	Point of greatest depth above chin
Pogonion (Pg)	Most prominent soft-tissue point of chin
Menton (M)	Soft-tissue point at the inferior-most border of the chin at midline

Table 4.2 Hairline evaluation

Classification	Description
Type I	Minimal or no recession of the hairline
Type II	Areas of recession at the frontotemporal hair line
Type III	Deep symmetrical recession at the temples that are bare or only sparsely covered. Anterior hairline at midline is receding
Type IV	Hair loss is primarily from the vertex, limited recession of the frontotemporal hairline
Type V	Vertex hair loss region is separated from the frontotemporal region but is less distinct; the band of hair across the Crown is narrow
Type VI	Frontotemporal and vertex bald regions are joined together
Type VII	Most severe form, a narrow band of hair remaining in a horseshoe shape

Hamilton-Norwood Classification. Based on anterior and vertex degree of recession

Table 4.3 Skin analysis: Fitzpatrick's classification of skin types

Type	Skin color and features	Tanning ability
I	White skin, blue eyes, blond/red hair	Always burns, does not tan
II	White skin, blue eye	Easily burns, tans poorly
III	Darker white skin	Mild burn, average tan
IV	Brown skin	Occasionally burns, tans easily
V	Dark brown skin	Rarely burns, tans very easily
VI	Black skin	No burns, dark tan

Skin Tension Lines

Relaxed Skin Tension Lines: Direction of greatest elasticity, traveling **perpendicular to the facial musculature**. The exception is on the eyelids where the rigid tarsal plate overrides the orbicularis oculi pull. They tend to form in the direction in which rhytides form. The long axis of incisions and their scars need to line up with the RSTLs to close with minimal tension and avoid scar widening (Tables 4.3 and 4.4).

Lines of Maximal Extensibility: Tend to run in the direction of the mimetic musculature.

Langer Lines: Typically form in the direction of rhytides. Can be perpendicular to RSTLs and are based more on the direction of skin pull and the resulting rhytides.

Overall, scars are least conspicuous when placed in creases, and creases tend to occur perpendicular to muscle action.

Facial Divisions

Vertical 5ths: Based on the width of one eye, which should equal 1/5 of the facial width. Helical rim → lateral canthus → medial canthus/nasal ala → contralateral medial canthus/nasal ala → lateral canthus → helical rim.

Horizontal 3rds: Trichion → **glabella** → subnasale → menton.

Horizontal lower face: In the absence of a defined trichion/hairline, the lower face can be divided with 43 % from **nasion** → subnasale, and 57 % from subnasale → menton.

Blepharoptosis

Anatomy: Levator aponeurosis originates from the lesser wing of the sphenoid and inserts on the orbicularis oculi, dermis, and tarsal plate. CN 3 innervation providing 10–12 mm of lid elevation. Attaches to the orbital septum ~2.5 mm above the tarsal plate.

True lid ptosis = intrinsic drooping vs. pseudoptosis which is secondary to other issue giving the impression of ptosis.

Congenital Ptosis: Developmental dysgenesis of the levator muscle, presents shortly after birth and is not progressive. Absent eyelid crease.

Acquired Ptosis: **Myogenic** (typically **senile ptosis**) = the most common type. The levator attachments to the tarsus stretch and dehisce.

Traumatic = 2nd most common. Allow for ~6 months of recovery and healing before repair.

Table 4.4 Glogau photoaging classification

Type	Severity	Typical age range	Characteristics
I	Mild	Late 20s to 30s	Little wrinkling, no keratosis, requires little or no makeup
II	Moderate	30s to 40s	Early wrinkling with facial motion, early actinic keratosis
III	Advanced	50s or older	Persistent wrinkling, discoloration with telangiectasias, visible actinic keratosis
IV	Severe	60s to 70s	Generalized wrinkling, actinic keratosis with or without malignancy

Neurogenic = CN 3 palsy, Horner's syndrome, myasthenia gravis.
Mechanical = severe upper lid dermatochalasis and excessive weight, growths, etc.

Diagnosis and Testing: Degree of ptosis is measured by the amount of lid descent over the upper limbus; mild = 1–2 mm, moderate = 3 mm, severe = >4 mm. Levator function is measured by the amount of excursion with lid opening; good = >10 mm, fair = 5–10 mm, poor = 0.5 mm. Margin reflex distance one (MRD_1) measurement is required as well.

Treatment Options: Levator aponeurosis advancement done via external approach, external levator resection, frontalis suspension, or Mueller muscle/conjunctival resection.

Dental Anatomy

Pediatric dentition: 20 teeth; 4 incisors, 2 canines, 4 M per arch. Lettered A-J (R → L maxilla) and K-T (L → R mandible).

Adult dentition: 32 teeth; 4 incisors, 2 canines, 4 premolars, 6 molars per arch. Numbered 1–16 (R → L maxilla), 17–32 (L → R mandible).

Terminology: Mesial vs. distal, buccal vs. lingual. Overbite = amount of vertical incisor overlap. Overjet = amount of horizontal overlap of incisal edges. Crossbite = horizontal malalignment of teeth, either anterior or posterior. Open bite = occlusal surfaces not in contact when in centric occlusion (when condyle is in natural resting position).

Occlusion: Refers to tooth relationship to one another. Angle classification:

Class I—Mesiobuccal cusp of the maxillary first molar fits into the buccal groove of the mandibular first molar. *Class I occlusion does not = normal occlusion*.

Class II—Mandibular molar is distally positioned . . . "underbite."

Class III—Mandibular molar is mesially positioned . . . "overbite."

Cephalometric Evaluation

Allows for standardized measurements from lateral cephalograms to determine the relationship between the skull base, maxilla, and mandible. Evaluate dentofacial proportions and the diagnostic, anatomic basis for the deformity. Surgery planned based on aesthetic evaluation, not cephalometrics. Utilizes hard tissue/bone landmarks with the "hinge"point of the condyle and relationship to the sella.

Most common abnormalities:

1. Maxillary excess—vertical excess of middle third, convex profile typically a class II occlusion and lip incompetence. Treatment = LeFort I osteotomy with impaction.
2. Maxillary deficiency—deficiency of infraorbital/paranasal sinuses.
   Treatment = leFort I osteotomy with expansion ± bone grafting.
3. Mandibular excess—(prognathism) a prominent lower 1/3 with a class III occlusion.
   Treatment = maxillary advancement ± mandibular setback.
4. Mandibular deficiency—(retrognathism) deficient lower 1/3 with a class II occlusion.
   Treatment = mandibular advancement.

Basic Surgical Principles

General Principles

Alimentation/Nutrition

Malnutrition: Complete H&P may show >12 % weight loss, alcohol abuse, advanced-stage H&N cancer, fat/muscle wasting, vitamin deficiency stigmata. Labs = albumin <3.0 g/dL: 1–2 months window. Transferrin < 150 mg/dL—7 day half-life. Pre-albumin = t ½ of 3–5 days. Average adult requires 30–35 kcal/kg/day. Protein supplementation vital.

Nutrition delivery: Oral supplementation ideal if possible.

Enteral feeds: NG tube best option, temporary (2–4 weeks), but risk of obstruction, nasal/sinus inflammation, esophagitis. Gastrostomy tube better tolerated long term. May be placed either percutaneously vs. open.

Parenteral nutrition: Rapid, not GI tract dependent. TPN must be given via central line. Indications for TPN = severe protein malnutrition, defunct GI tract, refractory chyle leak.

Wound Healing

Three phases of wound healing:

1. Inflammatory Phase (days 1–6)
   Initial **vasoconstriction** for 5–10 min followed by **coagulation** via platelet aggregation and fibrin accumulation. Histamine, serotonin, and NO-mediated vasodilation and increased vascular permeability allow for immune cells signaled by platelet products, complement, etc. to enter tissues. Predominant cell types = neutrophils (24–48 h) for early phagocytosis and inflammatory product production. **Macrophages** (48–96 h) for growth factor secretion and continued cleanup. Predominant cell up to fibroblasts, **Most critical to wound healing**. Lymphocytes' (5–7 days) questionable role, possibly for remodeling.
2. Fibroproliferative Phase (day 4–week 3)
   Fibroblasts move into the wound on day 3, and are the dominant cell at day 7. Collagen synthesis peaks from day 5 to week 3. Initial HA, dermatan, and chondroitin production are followed by collagen. Tensile strength increases from day 5 and on. Angiogenesis occurs with early VEGF production. Epithelialization begins.
3. Maturation/Remodeling Phase (week 3–1 year)
   After 3–5 weeks, collagen breakdown and synthesis are balanced. Early type III collagen is replaced by type I collagen, eventually hitting a normal 4:1 ratio. Reaches peak tensile strength (80 %) at 60 days.

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Other important processes/factors/cells:

Epithelialization—requires mobilization of epithelial cells, migration, and mitosis followed by differentiation.

Contraction—a result of myofibroblast contractile forces. Appears at day 3, max at days 10–21, disappear as contraction is complete.

Types of Wound Healing—Primary: closed within hours of creation by reapproximating edges of wound. Secondary: wound allowed to heal on its own by granulation, contraction, and epithelialization. Delayed primary: subacute/chronic converted to acute wound by debridement then closed.

Factors that decrease/affect wound healing.

Genetic: predisposition to keloid or hypertrophic scarring, collagen abnormalities, skin pigmentation, sebaceous quality, wound location, age.

Systemic: delayed healing with diabetes, atherosclerosis, renal failure, immunodeficiency, smoking, vitamin deficiency, hypothyroidism.

Vitamins required for wound healing = vitamin A (increases tensile strength and epithelialization), vitamin C (needed in collagen

synthesis), vitamin E (cell membrane-stabilizing antioxidant), and zinc (enzyme cofactor).

Local: infection ($>10^5$) decreases oxygen, lowers pH, slows angiogenesis, increases edema. Radiation, free radicals, denervation.

Hemostasis

Conceptual components of hemostasis

1. Blood vessel: Immediate vasoconstriction, damaged vessel wall presents factors that induce platelet aggregation.
2. Platelets: vWF and other factors assist the exposed collagen fibers in inducing platelet adhesion, aggregation, shape change, and secretion of additional coagulation factor stimulators.
3. Coagulation system: Cascade set in motion by activated lipoproteins/enzymes that results in thrombin-activating fibrin and plug formation.

Anticoagulants

Unfractionated Heparin—inactivates factors II, IX, X, XI, and XII. t½ = 60 min. Monitored by aPTT.

Low-Molecular-Weight Heparins—(Lovenox) decreased nonspecific tissue binding, inactivates factors II and X. Increased t½, no lab test monitoring. Reversed with protamine.

Warfarin—Inactivates Vit. K-dependent cofactors II, VII, IX, X, and proteins C and S. t½ = 20–60 h. Monitored by PT/INR. Reversible with vitamin K and/or FFP.

Factor Xa Inhibitors—(Fondaparinux) t½ = 14–20 h. No effect on PT, PTT, or clotting time.

Preoperative Medications

Preoperative antimicrobial coverage should be given 30–60 min before incision.

Skin incisions—cover for *S. aureus*: cefazolin, clindamycin, or vancomycin if PCN allergy

Mucosal incisions—cover for anaerobes: clindamycin or ampicillin/sulbactam

Major aerodigestive surgery—*S. aureus, Pseudomonas*, and anaerobe coverage: clindamycin + gentamicin, or cefazolin + metronidazole

CSF contamination—aggressive *S. aureus, Pseudomonas*, and anaerobe coverage: vancomycin + ceftazidime + metronidazole

Wound Dressings

Moist wound healing = ~30 % faster reepithelialization, plus ↑ local growth factors, ↑ fibroblast, and keratinocyte migration to wound. Oxygen at normal concentrations is required. Growth factor levels are based on oxygen tension. Ideal dressing properties: conform to wound, wick secretions, gentle compression (hemostasis), easy application/removal. Many pros and cons based on whether the dressing is natural (cellulose-based dressings) vs. synthetic, medicated vs. plain, occlusive vs. semipermeable. Skin-equivalent dressings typically contain a biocompatible structural scaffold/matrix with or without cultured keratinocytes or fibroblasts. Usually expensive, mostly for chronic wounds, burns.

Adjunctive Therapies

Hyperbaric Oxygen: Breathing 100 % O_2 while under elevated atmospheric pressure allows for complete hemoglobin saturation and additional O_2 to dissolve in the plasma. Boosts oxygen tension in compromised areas (chronic wounds, ulcers, tenuous flaps/grafts), thus increasing angiogenesis and fibroblast proliferation.

Leeches: Direct venous removal plus secretion of **hirudin**, collagenase, hyaluronidase, and factor X inhibitor, anticoagulant enzymes. Feed for 20 min–2 h, 10–15 ml of blood leeched, with additional oozing secondary to anticoagulants. Used for flap venous congestion. Prophylaxis with fluoroquinolone or third-gen cephalosporin due to *Aeromonas hydrophila* infection risk.

Intralesional Steroid Injection: Decreases local fibroblast proliferation and collagen synthesis, thus favoring net collagen degradation. Useful for postoperative swelling, keloid, or hypertrophic scarring. Therapeutic effect lasts for ~6 weeks, decreased dose needed for earlier injection. Concern for subcutaneous atrophy, up to 4 % in keloid/hypertrophic scar injections.

Complications

Tobacco Morbidity

Increased **tissue ischemia** due to (1) nicotine-induced vasoconstriction via ↑ thromboxane A_2 and platelet aggregation stimulation, (2) inhaled carbon monoxide binds to hemoglobin resulting in carboxyhemoglobin formation, thus decreasing oxygen delivery.

Additional intraoperative and postoperative pulmonary, cardiovascular, and cerebrovascular complications occur due to ciliary paralysis, thrombogenesis, leukocyte dysfunction, and microvascular injury. **Infection** rate is elevated. Wounds heal slower. Risk of skin flap necrosis increases. Suggest tobacco discontinuation for 4 weeks before and 4 weeks after elective surgery. Patient management should include identification of tobacco product use, provision of counseling and smoking cessation information, and selection of preoperative candidates based on tobacco use.

Complication Management

Arguably the most important step to preventing complications is patient selection, and the most important step to dealing with complications is patient education and management of expectations.

Complication management necessitates careful patient selection, estimation of operative risks, and patient-adapted selection of procedures. Preoperatively, the problem belongs to the patient. Postoperatively, the problem belongs to the surgeon.

Increasing frequency of obesity, aging population, and multimorbidity patients require more complication prevention discussions. Age alone is not an independent risk factor, but medical complications are more likely to be present in an advanced age population.

Informed Consent

Informed consent is not a signed piece of paper; it is a discussion of the risks and benefits involved, any alternative treatments, and the risks and benefits of doing nothing. For consent to be valid the patient must (1) be competent to take the particular decision, (2) have received sufficient information to make a decision, (3) not be acting under duress.

Universal Protocol

Intended to prevent wrong person, wrong procedure, wrong site surgery in hospitals and outpatient settings. Consists of three steps: (1) A preoperative/pre-procedure verification process. (2) Marking the operative/procedure site. (3) A "Time Out" (final verification) which is performed immediately before starting the operation/procedure.

Standard Precautions

A set of infection control practices used to prevent transmission of diseases that can be acquired by contact with blood, body fluids, non-intact skin, and mucous membranes. Treat each patient as if a potential infection source. Also, protects patients from the physician as a vector.

Questions

1. The buccal branch of the facial nerve innervates which muscles of facial animation:
   Procerus, medial, and lower aspect of the orbicularis oculi, nasalis, partial innervation of the zygomaticus major/minor, upper orbicularis oris

2. Which is the most correct regarding the lymphatic drainage of (1) the upper lip/lateral lower lip and (2) the central lower lip/chin:
   (a) No difference, they both drain to ipsilateral submandibular lymph nodes
   (b) **Upper lip/lateral lower lip drains ipsilaterally (submandibular nodes) and central lower lip/chin drains bilaterally (submental nodes)**
   (c) No submental lymph node drainage is present from these areas
3. What are the soft-tissue layers in the temporal region? What layer does the temporal branch of the facial nerve reside in:
   Skin → SubQ → superficial temporal fascia → loose areolar tissue → superficial layer of the deep temporal fascia → superficial fat pad → deep layer of the deep temporal fascia → deep fat pad → temporalis muscle → pericranium
   On the under surface of the superficial layer of the deep temporal fascia
4. Which fascial layer of the neck is contiguous with the SMAS in the face:
   (a) **Superficial cervical fascia**
   (b) Deep payer of the superficial cervical fascia
   (c) Muscular division of the deep cervical fascia
   (d) Investing layer of the deep cervical fascia
5. What are the four vertical buttresses and four horizontal buttresses of the face:
   Vertical: nasomaxillary, zygomaticomaxillary, pterygomaxillary, mandible condyle/ramus
   Horizontal: frontal, zygomatic, maxillary, mandibular
6. What additional muscles does the trigeminal nerve, branch V3 innervate besides the muscles of mastication:
   Tensor tympani, tensor veli palatini, mylohyoid, anterior digastric muscle
7. What additional muscles does the facial nerve innervate besides the muscles of facial animation:
   Stapedius, stylohyoid, posterior digastric muscle
8. In which ganglion are the cell bodies for the postganglionic parasympathetic fibers of the lacrimation nerve pathway found:
   (a) Lacrimal ganglion
   (b) Greater petrosal ganglion
   (c) Otic ganglion
   (d) **Pterygopalatine ganglion**
9. Name two major differences between the bone scan (bone scintigraphy) and DEXA scan (bone density scan):
   – Bone scan = functional test vs. DEXA = structural test only
   – Bone scan = nuclear based on radioactive particles vs. X-ray based
   – Bone scan = more expensive vs. less inexpensive
10. What is the definition of "depth of field" in photography:
    (a) Distance in millimeters from the optical center of the lens to the focal point, which is located on the sensor
    (b) **Distance between the closest and farthest in-focus areas of a photograph**
    (c) Distance between the optical center of the lens and the object to be photographed
11. Which type of zoom, optical zoom or digital zoom, changes the amount of the scene hitting the sensor, thus allowing for more detail that can be enlarged without distortion or pixilation:
    Optical zoom
12. Typically history alone can diagnose congenital blepharoptosis, but if history is equivocal, which of the following will you see with downward gaze:
    (a) No change in the position of the affected upper eyelid
    (b) **Lagophthalmos of the eyelid due to levator fibrosis**
    (c) Additional descent of the affected upper eyelid, matching the gaze
    (d) None of the above
13. Which of the following descriptions and treatment options best fit the cephalometric diagnosis of "mandibular deficiency":
    (a) **Retrognathism—deficient lower 1/3 with a class II occlusion. Treatment = mandibular advancement**.

(b) Prognathism—a prominent lower 1/3 with a class III occlusion. Treatment = maxillary advancement ± mandibular setback.
(c) Deficiency of infraorbital/paranasal sinuses. Treatment = LeFort I osteotomy with expansion ± bone grafting.
(d) Vertical excess of middle third, convex profile typically a class II occlusion, and lip incompetence. Treatment = LeFort I osteotomy with impaction.

14. List the three phases of wound healing, their duration, and the predominant cell type/processes found in each:

Inflammatory = days 1–6, macrophages
Fibroproliferative = day 4–week 3, fibroblasts
Maturation/remodeling = week 3–1 year, fibroblast collagen synthesis

15. How does smoking affect wound healing on a cellular level by inciting tissue ischemia:
(a) **Nicotine-induced vasoconstriction via ↑ thromboxane A_2 and platelet aggregation stimulation**
(b) **Inhaled carbon monoxide binds to hemoglobin resulting in carboxyhemoglobin formation, thus decreasing oxygen delivery**