Ophthalmology

MBBS Recap: high-yield notes for revision

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Revision notes for the MD/MS entrance (MEC PG): the facts an examiner asks in Ophthalmology, grouped by topic.

Optics and refraction

Eye as an optical system

- Total power about **60 D**: **cornea about 43–44 D** (the larger share, because of the air-cornea interface), crystalline lens about 16–19 D at rest. The lens is the only part that changes power.
- Accommodation (the amplitude falls with age, from about 14 D in childhood to under 1 D by 60): ciliary muscle contracts, zonules slacken, the lens becomes thicker and more convex anteriorly, the pupil constricts (near triad: accommodation, convergence, miosis), the anterior chamber shallows. For distance the reverse occurs.
- Hypermetropes accommodate the most (for distance and near); myopes the least.
- Critical period for visual development: first 2–4 months for fixation reflexes; adult acuity by about 6 years. Most newborns are hypermetropic (about +2 to +3 D), the error falling towards emmetropia in childhood (emmetropisation).

Refractive errors

Error	Focus of parallel rays	Lens	Notes
Myopia	in front of retina	**concave (minus)**	axial commonest; may lead to divergent squint; **posterior staphyloma** (Scarpa's staphyloma, the same lesion), Foster-Fuchs spot, lacquer cracks and retinal detachment in pathological myopia (above about 6 D); **low-dose atropine (0.01–0.05%)** and outdoor time slow childhood myopia (LAMP study, 2019)
Hypermetropia	**behind retina**	**convex (plus)**	accommodative esotropia in children; shallow anterior chamber, angle-closure risk
Astigmatism	two focal lines (different power in different meridians)	**cylindrical**	with-the-rule: vertical meridian more powerful (corrected with plus cylinder at 90 or minus at 180)
Presbyopia	physiological, **not a refractive error**	plus add for near	onset **40–45 years**; falling lens elasticity and ciliary function; bifocal or progressive lens

- Anisometropia: different refraction in the two eyes (each dioptre of difference gives about 2% difference in image size, and about 5% is tolerated, so spectacles suit up to about 3–4 D; contact lenses or refractive surgery beyond). Aniseikonia: unequal image size. Anisocoria: unequal pupils. Do not confuse them.
- Nuclear cataract causes an index myopia (see lens).

Astigmatism classification and prescriptions

- Simple: one meridian emmetropic (myopic or hypermetropic). Compound: both meridians ametropic in the same direction. Mixed: one myopic, one hypermetropic.
- Reading a prescription (sphere, cylinder, axis): the cylinder acts at 90 degrees to its axis. Principal meridians are always perpendicular. The second principal meridian is sphere plus cylinder, with signs.
- Example: -3 sph / +2 cyl x 90: vertical meridian -3, horizontal -1; both minus so compound myopic; vertical meridian is the stronger so with-the-rule.
- Transposition: add sphere and cylinder for the new sphere, change the cylinder's sign, turn the axis by 90 degrees. Spherical equivalent = sphere plus half the cylinder.
- Keratoconus is a cause of irregular astigmatism (corrected with rigid gas-permeable lenses).

Refractive surgery and examination instruments

- LASIK uses an **excimer laser (argon fluoride, 193 nm)**; done only after 18 years and with a stable refraction. Radial keratotomy (classic, now obsolete) flattened the centre in low myopia.
- **Direct ophthalmoscope**: virtual, erect image, **magnification about 15x**; monocular; small field. **Indirect ophthalmoscope**: real, inverted image, 2–5x, wide field, stereopsis, used for retinal periphery.
- Distant direct ophthalmoscopy (about 25 cm): normal red glow; grey glow suggests retinal detachment; absent glow suggests vitreous haemorrhage; central black spot against the glow suggests lens or corneal opacity; oil-droplet reflex indicates keratoconus.
- Keratometer: corneal curvature. Pachymeter: corneal thickness. Aesthesiometer: corneal sensation. Pentacam (Scheimpflug imaging): investigation of choice for keratoconus.
- Purkinje-Sanson images: four normally; in aphakia the third and fourth (lens images) are absent; in pseudophakia all are seen.

Retinoscopy

- Plane mirror at 1 m: **'with' movement in emmetropia, hypermetropia and myopia under 1 D; 'against' movement in myopia over 1 D**; neutral at exactly 1 D of myopia. Streak retinoscopy is preferred; the working-distance lens is subtracted.

Conjunctiva and cornea

Corneal anatomy and physiology

- Layers: epithelium, **Bowman's layer**, stroma (thickest), **Descemet's membrane**, endothelium. Pre-Descemet (Dua's) layer described in 2013. Schwalbe's line marks the end of Descemet's membrane.
- Transparency: avascularity, regular lamellar arrangement, relative dehydration kept by the **endothelial pump** (endothelial cells do not regenerate). Nutrition from aqueous; oxygen from the atmosphere (tear film).
- Sensory supply: nasociliary branch of the ophthalmic nerve (V1). Reduced corneal sensation is characteristic of herpes simplex keratitis.
- Corneal grafting succeeds largely because the cornea is avascular and an immune-privileged site.
- Corneal opacities: **nebula** (faint; iris details visible), **macula** (denser; iris details partly seen), **leucoma** (dense white; iris not seen, so **maximum visual loss**).

Corneal ulcers

- Classic hypopyon ulcer ("ulcus serpens"): **Streptococcus pneumoniae** (the exam answer for the commonest bacterial cause in South Asian texts); in Western series staphylococci and Pseudomonas lead. In Nepal and South Asia, where agricultural injury is common, **fungal keratitis makes up a large share of all corneal ulcers** (up to about half in some South Asian series). **Contact lens wearers and lens-related ulcers: Pseudomonas aeruginosa** (rapidly progressive, greenish-yellow slough, melts the cornea).
- Organisms that penetrate an intact epithelium: Neisseria, Corynebacterium diphtheriae, Haemophilus, Listeria, Shigella.
- Hypopyon is sterile unless Descemet's membrane is breached (fungus can penetrate it).
- **Fungal keratitis**: injury with vegetable matter (rice stalk, tree twig) or long-term topical steroids; dry-looking grey-white infiltrate with feathery edges, **satellite lesions**, immobile hypopyon, Wessely ring; symptoms milder than signs. Commonest organisms Fusarium and Aspergillus. **Natamycin 5%** is first-line for filamentous fungi (MUTT I, 2013: better than topical voriconazole, especially for Fusarium); voriconazole for yeasts or deep disease; steroids contraindicated.
- **Acanthamoeba**: contact lenses with home-made saline, tap water, swimming; **pain out of proportion to signs** (radial keratoneuritis), pseudodendrites, then **ring infiltrate**. Treat with PHMB 0.02% and/or chlorhexidine, with propamidine or hexamidine.
- **Herpes simplex keratitis**: **dendritic ulcer** with terminal bulbs, reduced sensation, may coalesce into a geographic ulcer. Treatment: topical aciclovir or ganciclovir (trifluridine, idoxuridine). **Steroids are contraindicated in epithelial disease**; used under cover in stromal (disciform) keratitis.
- **Mooren's ulcer**: painful, progressive peripheral ulcer with an undermined advancing edge, idiopathic and probably autoimmune (a diagnosis of exclusion after rheumatoid and other systemic causes); treated with steroids, conjunctival resection and systemic immunosuppression.
- General treatment of ulcers: intensive topical antimicrobials, cycloplegic (atropine for pain and to prevent synechiae); perforation: tissue glue or graft.

Keratoconus and dystrophies

- Keratoconus: conical ectasia, onset puberty, frequent change of glasses, irregular astigmatism. Signs: **Munson's sign** (lower lid bulges on down-gaze), Fleischer's ring (iron line at the cone base; not the Kayser-Fleischer ring), **Vogt's striae** (vertical stress lines), oil-droplet reflex, scissoring reflex on retinoscopy. Treatment: **corneal collagen cross-linking** (riboflavin plus UVA) to halt progression; rigid gas-permeable lens, intracorneal ring segments, keratoplasty in advanced disease.
- Associations: atopy, Down syndrome, Ehlers-Danlos, eye rubbing.
- Haab's striae (horizontal breaks in Descemet's) are of **congenital glaucoma**; Vogt's striae are of keratoconus.
- Stromal dystrophies: **granular** (AD, TGFBI; hyaline, stains with Masson trichrome), **lattice** (AD, TGFBI; amyloid, Congo red), **macular** (**autosomal recessive**, CHST6; glycosaminoglycan, Alcian blue; the only one that involves the stroma out to the limbus and the worst for vision). IC3D classification (2015, revised 2024) groups dystrophies by gene.

Conjunctivitis

Type	Key facts
Adenoviral (epidemic keratoconjunctivitis)	red watery eye, **tender preauricular node**, follicles; **subepithelial infiltrates in the second week**; highly contagious; supportive treatment
Acute haemorrhagic	enterovirus 70 and Coxsackie A24
Hyperacute purulent	gonococcus; threatens the cornea; systemic ceftriaxone
Trachoma	Chlamydia trachomatis A–C; follicles, **Arlt's line** (linear scar of upper tarsal conjunctiva), **Herbert's pits** (healed limbal follicles), pannus, trichiasis and entropion; Leber cells are in follicles; WHO simplified grading TF, TI, TS, TT, CO
Vernal (VKC)	atopic, spring and summer, young boys; cobblestone papillae on upper tarsus, **Horner-Trantas dots** (eosinophil clumps at the limbus), ropy discharge (Maxwell-Lyons sign), shield ulcer; treat with mast-cell stabilisers, topical steroid pulse, cyclosporine or tacrolimus
Phlyctenular	**delayed hypersensitivity to endogenous microbial proteins** (tuberculosis, staphylococcus); limbal nodule, fascicular ulcer; steroids
Inclusion	adult chlamydia D–K, follicular

- Follicles (lymphoid): viral, chlamydial, drug toxic. Papillae: allergic, bacterial. Giant papillae: VKC, contact lens.
- Pterygium: triangular fibrovascular growth on the nasal side, crossing the limbus; recurrence reduced by conjunctival autograft and mitomycin C. Pinguecula does not cross the limbus.
- Pterygium detail: wing-shaped, **starts on the nasal side in the interpalpebral fissure** and is linked to ultraviolet light, dust and dryness; it has a **cap** (the grey zone at the leading edge), a **head** (apex) and a body; an iron line in the corneal epithelium just ahead of the head is **Stocker's line**. Treat only for visual axis encroachment, induced astigmatism, restricted movement or cosmetic reasons; bare-sclera excision recurs often, hence conjunctival autograft with fibrin glue.

Dry eye and the tear film

- Tear film layers (the classic exam answer, three): outer **lipid** (Meibomian glands; slows evaporation), middle **aqueous** (lacrimal and accessory glands of Krause and Wolfring), inner **mucin** (goblet cells; makes the cornea wettable). Current view (TFOS DEWS II, 2017): two layers, a lipid layer over a **muco-aqueous gel**, the mucin mixed through the aqueous.
- **Aqueous-deficient** dry eye (Sjögren syndrome the classic cause) versus **evaporative** dry eye (Meibomian gland dysfunction, the commonest cause overall). TFOS DEWS II (2017) defines it by tear-film instability, hyperosmolarity and ocular surface inflammation.
- Tests: **Schirmer I** (filter strip in the lower fornix at the junction of its middle and outer thirds for 5 minutes, **no anaesthetic**, so basal plus reflex secretion; normal about 15 mm, under 10 mm abnormal, under 5 mm markedly so, as in Sjögren syndrome); done **after topical anaesthetic** it measures **basal** secretion alone (the basic secretion test); **Schirmer II** adds anaesthetic and nasal mucosal stimulation to test **reflex** secretion. **Tear break-up time** (fluorescein; under 10 seconds abnormal) tests stability; **rose bengal or lissamine green** stains devitalised cells (rose bengal stings); fluorescein stains epithelial defects.
- Treatment: preservative-free artificial tears, lid hygiene and warm compresses, punctal plugs, topical ciclosporin or lifitegrast, short steroid courses.

Scleritis and episcleritis

Feature	Episcleritis	Scleritis
Pain	mild or none	**severe, deep, boring**, radiating to face, worse at night
Colour	salmon pink, sectoral	**violet or bluish**
Phenylephrine 10%	**blanches** (superficial plexus)	**does not blanch** (deep plexus)
Association	usually idiopathic, self-limiting	systemic disease in up to half: **rheumatoid arthritis** (the commonest), granulomatosis with polyangiitis, SLE, relapsing polychondritis
Treatment	lubricants, mild topical NSAID or steroid	**oral NSAID or systemic steroid**, immunosuppressant or biologic; topical drops alone are not enough

- Posterior scleritis can mimic a mass or cause exudative detachment; B-scan shows thickened sclera with fluid in Tenon's space (**T-sign**); **necrotising scleritis** (with inflammation) is the worst type and threatens the eye; **scleromalacia perforans** is necrosis without pain or inflammation in long-standing rheumatoid arthritis.
- Lid glands (also under eyelid conditions): **chalazion** is a sterile lipogranuloma of the **Meibomian (tarsal) gland**; a **stye** is an acute staphylococcal infection of the gland of **Zeis or Moll**; Krause's and Wolfring's glands are accessory lacrimal glands.

Neuroparalytic, interstitial and zoster keratitis; band keratopathy

- **Neuroparalytic (neurotrophic) keratitis** follows trigeminal (V1) damage: an insensitive cornea loses its trophic and blink protection and the epithelium breaks down (after acoustic neuroma surgery, herpes zoster, herpes simplex, diabetes). **Exposure keratitis** is the facial (VII) palsy or proptosis lesion: the lids cannot close but sensation is intact. Treatment: lubricants, tarsorrhaphy; current practice adds topical **cenegermin** (recombinant nerve growth factor, FDA 2018) for persistent defects.
- **Interstitial keratitis**: deep stromal vascularisation and haze, usually bilateral in late **congenital syphilis** (age 5–20; **Hutchinson's triad**: notched incisors, eighth-nerve deafness, interstitial keratitis), an immune reaction to treponemal antigen; less often tuberculosis, leprosy, herpes, Cogan syndrome (with vestibuloauditory loss). Topical steroid and cycloplegic, with systemic penicillin for the syphilis; healed ghost vessels remain.
- **Band keratopathy**: calcium in **Bowman's layer and the anterior stroma** across the exposed **interpalpebral zone**, starting at 3 and 9 o'clock with a clear zone at the limbus and clear holes (nerves); causes chronic uveitis (JIA), phthisis, hypercalcaemia, vitamin D excess, renal failure, silicone oil; treated by removing the epithelium and **chelation with EDTA**.
- **Herpes zoster ophthalmicus**: **Hutchinson's sign** (vesicles on the tip or side of the nose, supplied by the external nasal branch of the anterior ethmoidal nerve, from the **nasociliary nerve**) predicts ocular involvement, since the nasociliary also supplies the globe. Oral aciclovir 800 mg five times a day or valaciclovir 1 g three times a day for 7 days, best within 72 hours of the rash; complications keratitis, uveitis, raised pressure, cranial nerve palsies, post-herpetic neuralgia; recombinant zoster vaccine (Shingrix) prevents it in older adults.

Uveitis

Classification (SUN)

- Anterior (iritis, iridocyclitis), intermediate (pars planitis), posterior (choroiditis, retinitis), panuveitis. Granulomatous or non-granulomatous.

Acute anterior uveitis

- Painful red eye, photophobia, lacrimation, **circumcorneal (ciliary) congestion**, small irregular pupil from **posterior synechiae**, cells and flare in the anterior chamber, hypopyon in severe cases.
- Associations of anterior uveitis: **HLA-B27** (the commonest identifiable association of acute anterior uveitis) (ankylosing spondylitis, reactive arthritis, psoriatic arthritis, inflammatory bowel disease); juvenile idiopathic arthritis (young girls, ANA positive, chronic and asymptomatic, high risk of band keratopathy and cataract), Behçet disease (hypopyon), sarcoidosis, Fuchs' (chronic).
- **Treatment: topical corticosteroid plus a cycloplegic** (atropine 1% or homatropine, to relieve spasm, prevent posterior synechiae and rest the iris). Complications: synechiae, complicated cataract, secondary glaucoma, CME.
- A man with chronic low back pain and an acute red eye should prompt thinking of ankylosing spondylitis.

Granulomatous features

- **Mutton-fat keratic precipitates**, **Koeppe nodules** (at the pupil margin) and **Busacca nodules** (on the iris surface) indicate **granulomatous** uveitis: tuberculosis, sarcoidosis, syphilis, sympathetic ophthalmitis, Vogt-Koyanagi-Harada, leprosy, toxoplasmosis.
- Non-granulomatous: fine KPs, no nodules; HLA-B27, trauma, idiopathic.

Special forms

- **Fuchs' heterochromic iridocyclitis**: young adult, unilateral, chronic and quiet ("white" uveitis); triad of **heterochromia, diffuse stellate small KPs and posterior subcapsular cataract**; **no posterior synechiae**, no CME; glaucoma is common; steroids are of no benefit; cataract surgery good. Rubella virus is associated.
- **Intermediate uveitis (pars planitis)**: vitreous **snowballs** and **snowbanks**; associated with multiple sclerosis; CME is the common cause of vision loss.
- **Posterior uveitis**: toxoplasma retinochoroiditis gives the "**headlight in fog**" appearance; CMV retinitis ("pizza pie") in AIDS with CD4 below 50, treated with ganciclovir or valganciclovir.
- **Sympathetic ophthalmitis**: bilateral granulomatous panuveitis, most often **4–8 weeks** after a **penetrating injury involving the uvea** (ciliary body, iris incarceration) of the exciting eye (rarely before 2 weeks; about 90% within a year, but even decades later); also after intraocular surgery; earliest symptoms **photophobia and blurred near vision (weak accommodation)**, earliest sign retrolental flare and cells or keratic precipitates in the sympathising eye; **Dalen-Fuchs nodules**. Prevention: early repair, or enucleation of a blind, hopeless exciting eye within about 2 weeks. Treat with high-dose steroids and immunosuppressants.
- **Behçet's**: oral and genital ulcers, hypopyon uveitis, retinal vasculitis; pathergy; **HLA-B51** (a split of B5). **Vogt-Koyanagi-Harada**: bilateral granulomatous panuveitis with exudative detachments, meningism, poliosis and vitiligo; **HLA-DR4**, commoner in Asians.
- **Juvenile idiopathic arthritis**: oligoarticular disease with a positive ANA in young girls gives **chronic anterior uveitis, silent with a white eye**, found late with posterior synechiae, band keratopathy, cataract and glaucoma; hence regular slit-lamp screening from diagnosis (every 3 months in the highest-risk group: oligoarticular, ANA positive, onset at 6 years or under, within 4 years of onset; AAP and ACR, 2019). Methotrexate, then adalimumab (SYCAMORE, 2017), for steroid-dependent disease.
- Endophthalmitis: see lens; panophthalmitis favours evisceration over enucleation.

Drug-induced uveitis

- Rifabutin, cidofovir, bisphosphonates, brimonidine (granulomatous) and prostaglandin analogue drops; in modern oncology, **immune checkpoint inhibitors** and BRAF/MEK inhibitors.

Mydriatics and cycloplegics

- Atropine 1% (longest acting; young children's cycloplegic refraction and uveitis), homatropine, cyclopentolate, **tropicamide (quickest and briefest, routine fundus examination)**. **Phenylephrine (an alpha-1 agonist) dilates through the dilator pupillae without cycloplegia**, so it is the choice where accommodation should be kept (elderly); the 2.5% strength is used, since 10% can raise blood pressure in infants and cardiac patients. Tropicamide with phenylephrine is the usual combination for fundus examination.

Lens and cataract

Cataract types and associations

- Commonest overall: **age-related (senile)**; **cortical (cuneiform)** is the commonest morphological type in the standard text (Khurana: the exam answer); population studies in Asia often find nuclear cataract commoner; nuclear sclerosis causes myopic shift.
- **Nuclear cataract**: increased refractive index of the nucleus gives **index myopia ("second sight")**, so a presbyope may read without glasses.
- **Posterior subcapsular**: **corticosteroids** (systemic, inhaled or topical; topical steroids also raise IOP), diabetes, ionising radiation, uveitis, retinitis pigmentosa, myopia. Causes the greatest glare and difficulty in bright light and with reading.
- Eponyms: **sunflower** (Wilson's disease, with Kayser-Fleischer rings; and chalcosis from a retained copper foreign body); **rosette or flower-shaped** (blunt trauma); **oil droplet** (galactosaemia); **snowflake** (diabetes, polyol pathway: sorbitol); **Christmas tree** (myotonic dystrophy); **rainbow or bread-crumb, polychromatic lustre in the posterior cortex** (**complicated cataract**, from uveitis, high myopia, retinitis pigmentosa); Vossius ring (iris pigment imprint after blunt trauma); coralliform and blue dot (congenital).
- Congenital causes: rubella (nuclear pearly white), galactosaemia, hypocalcaemia, Down syndrome, Lowe syndrome. Leukocoria: commonest cause congenital cataract; the dangerous one is retinoblastoma.
- Associated drugs: steroids, chlorpromazine and quetiapine, amiodarone (anterior), miotics.

Hypermature (Morgagnian) cataract

- Liquefied cortex with a sinking nucleus. Commonest complication: **phacolytic glaucoma** (lens protein leaks through an intact capsule, macrophages block the meshwork; open angle); also phacoanaphylactic uveitis and lens subluxation. An intumescent (swollen) cataract instead causes phacomorphic (angle-closure) glaucoma.

Surgery

- **Phacoemulsification with a posterior chamber foldable IOL through a clear corneal incision** is the standard; manual small-incision cataract surgery (SICS) is widely used in resource-limited settings, including Nepal; extracapsular extraction is classic. Intracapsular is obsolete.
- Indication: **visual disability** (functional need), not cataract ripeness. Biometry (A-scan, IOLMaster) chooses the IOL power.
- **Commonest complication: posterior capsule opacification (after-cataract)**, treated by **Nd:YAG laser capsulotomy**. Soemmering's ring is retained cortex between capsule layers.
- **Cystoid macular oedema (Irvine-Gass syndrome)**: commonest cause of unexpected visual loss weeks after uncomplicated surgery, **peak about 4–6 weeks** (range about 3–12 weeks); OCT shows cystic spaces; fluorescein shows a **petaloid** pattern; treat with topical NSAID plus steroid.
- **Endophthalmitis**: acute (1–7 days, pain and hypopyon) most often **coagulase-negative staphylococci (Staphylococcus epidermidis)**; **Propionibacterium (now Cutibacterium) acnes** in delayed chronic disease. Prevention: **povidone-iodine 5%** before surgery (the best evidence) and intracameral cefuroxime (ESCRS, 2007). Treatment: intravitreal

vancomycin 1 mg and ceftazidime 2.25 mg; **EVS (1995): immediate vitrectomy only when vision is light perception only**; with hand movements or better, tap and inject.

- Shallow anterior chamber after surgery: with low IOP a wound leak (Seidel's test); with high IOP pupil block, malignant glaucoma or suprachoroidal haemorrhage.
- IOL relative contraindication: juvenile idiopathic arthritis uveitis (selected). In children, posterior capsulotomy and anterior vitrectomy are combined to prevent opacification.

Lens position

- **Ectopia lentis**: Marfan syndrome (upward and outward), **homocystinuria** (downward, with thromboembolism), Weill-Marchesani, Ehlers-Danlos, trauma. Uniocular diplopia; iridodonesis; the lens edge shows as a golden crescent on oblique illumination and a dark crescent against the red glow on distant direct ophthalmoscopy; dilated slit-lamp examination confirms it.

Lenticonus

- **Anterior lenticonus: Alport syndrome** (COL4A5, haematuria, deafness). **Posterior lenticonus**: usually isolated; also seen in Lowe (oculocerebrorenal) syndrome, with cataract and glaucoma.

Glaucoma

Basics

- Normal IOP **10–21 mmHg** (mean 16; measured by Goldmann applanation tonometry, the gold standard). Raised IOP is the main modifiable risk factor but neither necessary nor sufficient (normal-tension glaucoma exists).
- Glaucomatous optic neuropathy: increasing cup-disc ratio (normal about 0.3), vertical elongation, notching, bayoneting, nasal shifting of vessels, **splinter haemorrhages**; thinning of the retinal nerve fibre layer on OCT.
- Aqueous: produced by the ciliary body (non-pigmented epithelium); **drains through trabecular meshwork to Schlemm's canal (conventional)** and via uveoscleral outflow (unconventional).
- Gonioscopy: assess the angle (Shaffer, Spaeth grading). **Fincham's test** separates the halos of angle closure from those of immature cataract.

Primary open-angle glaucoma

- Chronic, painless, bilateral, asymmetric. Field loss: earliest an enlarged blind spot and a **paracentral scotoma in Bjerrum's area** (10–20 degrees from fixation), then Seidel's (sickle) scotoma, the **arcuate (Bjerrum's) scotoma**, **Roenne's nasal step**, a ring (double arcuate) scotoma, leaving a central tubular island and a temporal island at the end. **Arcuate fibres are the most susceptible**; the **papillomacular bundle is the most resistant**, so central acuity is kept until late. Familial (MYOC, OPTN).
- Treatment (exam answer): medical first (prostaglandin analogue), then laser trabeculoplasty, then trabeculectomy (with mitomycin C). Current practice: **selective laser trabeculoplasty (SLT) is an accepted first-line alternative to drops** (LiGHT trial, 2019; NICE 2022); MIGS (minimally invasive glaucoma surgery: iStent, XEN) for mild to moderate disease; tube shunts for refractory glaucoma.

Primary angle-closure glaucoma

- **Mechanism: relative pupillary block** (aqueous cannot pass between the iris and the lens), peripheral iris bows forward (iris bombe), closes the angle. Risk factors: **hypermetropia, shallow anterior chamber, older women**, Asian ethnicity, dim light, mydriatics.
- Acute attack: severe pain, **halos**, vomiting, hazy cornea, **vertically oval, fixed mid-dilated pupil**, shallow chamber, **stony-hard eye**. Late signs: iris atrophy, **glaukomflecken**, Vogt's triad.
- Treatment: lower IOP with **acetazolamide (i.v.), topical beta-blocker, pilocarpine (once the IOP falls), steroids, osmotic agents (mannitol)**; definitive **laser peripheral iridotomy** (also prophylactic for the fellow eye). **Mydriatics and atropine must be avoided**, as must anticholinergics; topiramate causes a bilateral non-pupil-block angle closure (ciliochoroidal effusion), treated with cycloplegics and stopping the drug, not iridotomy. Current practice: **clear lens extraction** is an alternative first treatment for primary angle closure glaucoma (EAGLE trial, 2016); prophylactic iridotomy for angle-closure suspects alone gives little benefit (ZAP trial, 2019).
- Eye pain after the cinema (dim light causes dilatation) is a classic history.

Drugs

Class	Example	Mechanism	Notable adverse effects
Prostaglandin analogues (first line)	**latanoprost**, travoprost, bimatoprost	increase uveoscleral outflow	**increased iris pigmentation**, eyelash growth, periocular fat loss, macular oedema, uveitis
Beta-blockers	timolol, betaxolol	reduce aqueous production	bronchospasm, bradycardia
Alpha-2 agonists	**brimonidine**, apraclonidine	reduce production, increase uveoscleral outflow	**allergy and uveitis**, drowsiness in infants (avoid in under 2 years)
Carbonic anhydrase inhibitors	acetazolamide, dorzolamide	reduce production	paraesthesia, metabolic acidosis, renal stones; avoid in sulfa allergy
Miotics	pilocarpine	increase trabecular outflow	miosis, myopia, retinal detachment risk
Rho-kinase inhibitors (newer)	netarsudil	trabecular outflow, lower episcleral venous pressure	conjunctival hyperaemia, corneal verticillata
Osmotic agents	mannitol	reduce vitreous volume	emergency use

Other glaucomas

- **Congenital (primary infantile)**: triad of **photophobia, lacrimation, blepharospasm**; **earliest sign hazy cornea**; buphthalmos (corneal diameter above about 12 mm in infancy; normal newborn about 10 mm), **Haab's striae**, deep chamber; commonest gene **CYP1B1** (autosomal recessive); **treatment is surgical** (goniotomy or trabeculotomy; combined trabeculotomy-trabeculectomy), drugs only as a bridge.
- Secondary glaucomas: **neovascular** (CRVO "100-day glaucoma", diabetes the commonest cause overall),

phacolytic, steroid-induced (topical steroids), pigmentary, pseudoexfoliative, uveitic, traumatic (angle recession).

- Normal-tension glaucoma: IOP in the normal range with damage; vascular factors.

Tonometry and anterior chamber depth

- **Imbert-Fick law** (pressure = force ÷ area flattened) underlies applanation tonometry (Goldmann flattens a circle **3.06 mm in diameter**, about 7.35 mm^2, at which corneal rigidity and tear-film attraction cancel out, so the force in grams × 10 gives mmHg); a thick cornea reads falsely high, a thin one falsely low. Tonography measures facility of outflow.
- **Shallow chamber**: old age, hypermetropia, primary angle closure, intumescent cataract, forward lens dislocation. **Deep chamber**: aphakia, posterior lens dislocation, high myopia, buphthalmos.

Retina

Layers and basics

- Ten layers from outside: **retinal pigment epithelium, photoreceptors, external limiting membrane, outer nuclear, outer plexiform, inner nuclear, inner plexiform, ganglion cell, nerve fibre, internal limiting membrane**. Rods: 120 million, scotopic; cones: 6 million, concentrated at the fovea.
- Investigations: fundus fluorescein angiography, **OCT** (cross-sectional; investigation of choice for macular oedema), **OCT angiography**, ERG (generalised photoreceptor function), EOG (RPE), VEP (optic nerve).
- **Photostress test**: after a bright light bleaches the photopigment, the time to read again within a line of baseline (normally under about a minute) is **prolonged in macular disease** (CSCR, maculopathy), normal in optic nerve disease.

Diabetic retinopathy

- Commonest cause of blindness in the working-age population in developed countries; the principal determinant is the **duration of diabetes**.
- **Earliest visible lesion: microaneurysm**; the earliest histological changes are capillary basement membrane thickening and **pericyte loss**. Then dot-blot haemorrhages, hard exudates, cotton-wool spots, IRMA, venous beading.
- Non-proliferative (mild, moderate, severe by the "4-2-1" rule), proliferative (**neovascularisation of the disc or elsewhere**, driven by **retinal ischaemia raising VEGF**), **diabetic macular oedema** (commonest cause of vision loss).
- Treatment: glycaemic and blood-pressure control; **panretinal photocoagulation** for proliferative disease; **intravitreal anti-VEGF (ranibizumab, aflibercept, bevacizumab) for macular oedema** (first line when the centre is involved); steroid implants; vitrectomy for vitreous haemorrhage or tractional detachment. Fenofibrate slows progression (FIELD, ACCORD Eye; LENS, 2024). Current practice: anti-VEGF is an alternative to PRP for proliferative disease (DRCR Protocol S, 2015), and faricimab (anti-VEGF plus angiopoietin-2, 2022) is a newer agent for macular oedema.
- Screening (ADA 2024): type 2 at diagnosis; type 1 within 5 years of diagnosis; in pregnancy before conception or in the first trimester (gestational diabetes does not need it); then every 1–2 years. AI-graded fundus photographs are approved for screening (FDA, 2018).

Hypertensive retinopathy (Keith-Wagener)

- Grade I: mild generalised arteriolar narrowing. Grade II: more marked narrowing with focal constriction and **AV nicking** (copper- and silver-wiring are signs of arteriolar sclerosis, Scheie's separate grading). Grade III: **flame haemorrhages, cotton-wool spots, hard exudates**. **Grade IV: papilloedema** (malignant hypertension; emergency). Modern Wong-Mitchell (2004): mild, moderate, malignant.
- Arteriovenous crossing signs (the arteriole's thickened wall compresses the vein in their shared sheath): **Salus** (vein deflected at the crossing), **Bonnet** (vein banked distal to it), **Gunn** (vein tapered on either side).

Vascular occlusions

	CRAO	CRVO
Presentation	**sudden painless** profound loss	sudden painless blurring
Fundus	**pale retina, cherry-red spot**, box-carring, attenuated arterioles; embolus (Hollenhorst plaque)	**"blood and thunder"**: flame haemorrhages in all quadrants, dilated tortuous veins, disc swelling
Cause	embolus from carotid or heart (atrial fibrillation), giant cell arteritis	hypertension, diabetes, hyperviscosity, glaucoma; ischaemic type causes **neovascular glaucoma at about 100 days**
Treatment	exam answer: ocular massage, anterior chamber paracentesis, carbogen, acetazolamide (none proven); current practice: **treat as a stroke** (AHA 2021 statement): same-day stroke-unit work-up, thrombolysis within about 4.5 hours under trial; ESR/CRP for GCA	anti-VEGF for macular oedema; PRP for neovascularisation

- Branch retinal artery occlusion: sectoral field loss; amaurosis fugax: transient monocular loss (curtain) from carotid emboli.
- Commonest cause of vision loss in CRVO: macular oedema.

Retinal detachment

- Types: **rhegmatogenous (commonest)**, from a retinal break with liquefied vitreous passing beneath; risk factors: high myopia, aphakia, lattice degeneration, trauma; **tractional** (proliferative diabetic retinopathy, ROP); **exudative** (tumours, Harada disease, toxaemia).
- Features: flashes (photopsia), floaters, **a curtain-like field loss**; Shafer's sign (tobacco dust: pigment cells in the anterior vitreous).
- Treatment: pneumatic retinopexy, scleral buckle, **vitrectomy**; laser or cryotherapy for breaks without detachment.

Macular and heredofamilial disorders

- **Age-related macular degeneration**: commonest cause of irreversible central vision loss in the elderly in developed countries. Dry (drusen, geographic atrophy; AREDS2 supplements slow progression to advanced disease; complement inhibitors pegcetacoplan and avacincaptad pegol approved for geographic atrophy, FDA 2023) and **wet (choroidal neovascularisation: metamorphopsia, subretinal fluid or blood)**: **intravitreal anti-VEGF is the treatment of choice**. Smoking is the main modifiable risk.

- **Retinitis pigmentosa**: rod-cone dystrophy, second to third decade; **night blindness first**, tunnel vision, ring scotoma; **attenuated arterioles, waxy disc pallor, bone-spicule pigment**; **ERG is flat or extinguished (investigation of choice)**, EOG abnormal. Associations: Usher, Laurence-Moon-Bardet-Biedl, abetalipoproteinaemia, Refsum. Gene therapy (voretigene for RPE65) is a modern option.
- **Stargardt** (commonest inherited macular dystrophy): autosomal recessive (ABCA4); childhood or teenage central loss; "beaten-bronze" macula with yellow pisciform flecks (fundus flavimaculatus); **dark (silent) choroid on fluorescein angiography**; ERG and EOG normal in the early stage. **Best disease** (vitelliform): autosomal dominant, **BEST1 on 11q13**, egg-yolk lesion, **EOG abnormal (low Arden ratio) with normal ERG**.
- **Central serous chorioretinopathy**: young to middle-aged men, type A personality, stress and **corticosteroids** (any route), pregnancy; serous detachment of the macula with blurring, **micropsia** and metamorphopsia; fluorescein shows a single **ink-blot** or **smokestack** leak, OCT the subretinal fluid; most resolve in 3–4 months once the trigger is removed (**stop or reduce steroids**); half-dose photodynamic therapy (preferred) or focal laser for persistent fluid; anti-VEGF only for a secondary neovascular membrane.
- Drug retinopathies: chloroquine/hydroxychloroquine bull's-eye maculopathy (AAO 2016: hydroxychloroquine at most 5 mg/kg real weight a day; baseline exam, then yearly from 5 years with fields and OCT); tamoxifen crystalline; vigabatrin field constriction; ethambutol optic neuropathy.
- **Retinopathy of prematurity**: screening criteria differ (UK: under 31 weeks or under 1,501 g; AAP: 30 weeks or less, or 1,500 g or less); in South Asia, where bigger babies get it, wider criteria (about 34 weeks or under 1,750–2,000 g) are used; first exam at about 4 weeks after birth. Unregulated oxygen and VEGF drive it; ICROP3 (2021) zones, stages and plus disease, with aggressive ROP (A-ROP); treat with laser or anti-VEGF (RAINBOW, 2019: ranibizumab).

Retinoblastoma

- Commonest intraocular malignancy of childhood and commonest cause of intraocular calcification. **RB1 tumour suppressor gene on 13q14**; Knudson two-hit; heritable form is autosomal dominant, bilateral in 25–30%; about 40% of cases are heritable. Second malignancies (osteosarcoma) in germline cases; trilateral retinoblastoma adds a pineal tumour.
- Presentation: **leukocoria** (commonest), squint. Histology: Flexner-Wintersteiner rosettes (Homer Wright rosettes and fleurettes too). Imaging: ultrasound and MRI (CT avoided for radiation). Treatment: intra-arterial or systemic chemotherapy, laser, cryotherapy, enucleation for advanced disease; radiotherapy is avoided in germline disease.
- Commonest primary intraocular malignancy in adults: choroidal (uveal) melanoma; the **commonest intraocular malignancy overall in adults is metastasis** (breast in women, lung in men).
- **Choroidal melanoma**: most arise from a pre-existing naevus (risk signs: thickness over 2 mm, subretinal fluid, symptoms, orange pigment, margin near the disc); **mushroom-shaped** tumour after breaking through Bruch's membrane; usually a dome on ultrasound with **low internal reflectivity** and acoustic hollowness. **Liver is the commonest site of metastasis** (surveillance with liver imaging). Treatment: plaque brachytherapy (COMS, 2006: survival equal to enucleation for medium tumours) or proton beam; enucleation for large tumours. Poor prognosis: monosomy 3, **BAP1 loss**, epithelioid cells, ciliary body origin; gene-expression class 2 testing is used in practice. Metastatic uveal melanoma in HLA-A*02:01-positive adults: **tebentafusp** (a bispecific gp100 and CD3 protein, FDA 2022) was the first treatment to prolong survival.

Fundus signs and sudden loss of vision

- **Cherry-red spot** (a white, opaque perifoveal retina around the thin fovea, through which the choroid shows): central retinal artery occlusion, commotio retinae, and the sphingolipidoses with lipid-filled ganglion cells (**Tay-Sachs**, with hyperacusis and regression in infancy; Sandhoff, Niemann-Pick, GM1, sialidosis). **Roth spots** (haemorrhage with a pale centre): infective endocarditis, leukaemia, severe anaemia, diabetes. **Cotton-wool spots** (nerve fibre layer infarcts): diabetic and hypertensive retinopathy, CRVO, HIV retinopathy, SLE. Salt-and-pepper fundus: congenital rubella, syphilis.
- Sudden **painless** loss: central retinal artery or vein occlusion, vitreous haemorrhage, retinal detachment, macular disease, methanol. **Painful** loss: acute angle closure, acute uveitis, optic neuritis, chemical injury.

Vitreous

- Gel of hyaluronic acid and collagen. **Commonest cause of vitreous haemorrhage: proliferative diabetic retinopathy in adults, trauma in children.** Painless floaters then loss of vision; ultrasound if the fundus is hidden.
- **Persistent hyperplastic primary vitreous (persistent fetal vasculature)**: unilateral leucocoria, **microphthalmos**, shallow chamber, elongated ciliary processes stretched behind the lens; trisomy 13 in bilateral cases. Differs from retinoblastoma (normal-sized eye, calcification).

Neuro-ophthalmology

Visual pathway lesions

Site	Defect
Optic nerve	ipsilateral monocular blindness
Chiasm (central)	**bitemporal hemianopia** (pituitary adenoma: upper quadrants first; craniopharyngioma: lower quadrants first)
Optic tract	contralateral **incongruous** homonymous hemianopia; Wernicke's pupil
Optic radiation	temporal (Meyer's loop): upper "pie in the sky"; parietal: lower quadrantanopia
Occipital cortex	**congruous homonymous hemianopia with macular sparing** (dual blood supply of the macular cortex from the posterior and middle cerebral arteries)

- Left-sided loss in both eyes means a right-sided retrochiasmal lesion. Foster Kennedy syndrome: ipsilateral optic atrophy, contralateral papilloedema (frontal tumour such as olfactory groove meningioma).
- Pathway order: photoreceptor, bipolar cell, ganglion cell, optic nerve, chiasm, tract, **lateral geniculate**, radiation, occipital cortex. Papilloedema is bilateral disc swelling from raised intracranial pressure with normal vision early.
- Optic neuritis: young woman, painful eye movement, central scotoma, reduced colour vision (red desaturation), RAPD, multiple sclerosis association; MRI. **ONTT (1992): i.v. methylprednisolone speeds recovery but does not change**

final vision; oral prednisolone alone at standard dose raised recurrence. Current practice: test for **AQP4 (neuromyelitis optica) and MOG antibodies** in severe, bilateral or atypical cases, which need early steroids and plasma exchange.

- **Uhthoff's phenomenon**: vision worsens for a while with a rise in body temperature (exercise, hot bath) in a demyelinated nerve, as heat slows conduction in damaged axons. **Pulfrich phenomenon**: a swinging object seems to move in an ellipse, as conduction is delayed in one optic nerve.
- Perimetry: **Goldmann is manual kinetic**; **Humphrey is automated static**.

Pupils

- Light reflex: afferent optic nerve; the pupillary fibres leave the optic tract **before the lateral geniculate body** (in the brachium of the superior colliculus) and relay first in the **pretectal nuclei**; then both Edinger-Westphal nuclei, efferent oculomotor nerve, short ciliary nerves. Hence the **consensual reflex**.
- **Relative afferent pupillary defect (Marcus Gunn)**: swinging torch test, pupil dilates when light swings to the diseased eye; causes: optic neuritis, ischaemic optic neuropathy, compressive lesions, extensive retinal detachment, central retinal vessel occlusion, glaucoma (asymmetrical). A dense cataract does not cause an RAPD.
- **Argyll Robertson pupil**: small, irregular, bilateral; **light reflex absent but accommodation reflex preserved** (light-near dissociation); **neurosyphilis** (also diabetes, multiple sclerosis, encephalitis).
- **Adie's tonic pupil**: young woman, unilateral dilated pupil, poor light response, **slow tonic constriction on near effort**, **absent knee and ankle jerks (Holmes-Adie syndrome)**; ciliary ganglion lesion; **denervation supersensitivity: constricts with 0.1% (0.125%) pilocarpine**.
- Non-constricting pupil: constricts to dilute pilocarpine = Adie; fails to constrict to 0.1% but constricts to 1% = third-nerve palsy; fails even to 1% = pharmacological mydriasis (atropine); torn pupil margin = sphincter damage.
- **Horner's syndrome**: ptosis, miosis, anhidrosis, enophthalmos; cocaine 4–10% fails to dilate the Horner pupil; current practice uses **apraclonidine 0.5%**, which dilates the Horner pupil (reversal of anisocoria) by denervation supersensitivity; hydroxyamphetamine localises (post-ganglionic lesions fail to dilate). Painful Horner's of sudden onset: exclude carotid dissection. In a child, exclude neuroblastoma. Anisocoria worse in dim light = Horner's; worse in bright light = abnormal dilated pupil.
- Hutchinson's pupil: unilateral fixed dilated pupil from raised intracranial pressure (uncal herniation).

Cranial nerve palsies

- **Third nerve**: down-and-out eye, ptosis, mydriasis, loss of accommodation; **diabetic and ischaemic palsy spares the pupil**; a compressive lesion (posterior communicating artery aneurysm) involves it.
- **Fourth nerve**: superior oblique palsy; **head tilt to the opposite side** (diplopia reduced), vertical diplopia worse on looking down and in (reading, stairs); longest and thinnest nerve, with the longest intracranial course; it crosses to supply the contralateral muscle. The commonest isolated ocular motor palsy after closed head injury; congenital palsy is the commonest cause overall.
- **Sixth nerve**: lateral rectus; failure of abduction, convergent squint, horizontal uncrossed diplopia. Long intracranial course makes it a false-localising sign in raised intracranial pressure. The commonest ocular motor nerve palsy in adults (microvascular, then raised pressure and tumours).
- "LR6 SO4 and the rest 3."
- **Maximum diplopia occurs on looking in the direction of action of the paralysed muscle.** The head turns towards the muscle's side for horizontal palsies.

Extraocular muscles (actions)

Muscle	Primary	Secondary	Tertiary
Medial rectus	adduction		
Lateral rectus	abduction		
Superior rectus	elevation	**intorsion**	adduction
Inferior rectus	depression	extorsion	adduction
Superior oblique	**intorsion**	depression	abduction
Inferior oblique	extorsion	elevation	abduction

- Best position to test: superior rectus and inferior rectus in abduction; inferior oblique (elevation) and superior oblique (depression) in adduction.
- Yoke muscles (Hering's law): right gaze, right lateral rectus with left medial rectus; right superior rectus with left inferior oblique.
- Three-step (Parks-Bielschowsky) test for a vertical diplopia: **right superior oblique palsy gives a right hypertropia, worse on left gaze and worse on right head tilt** (Bielschowsky positive); the patient tilts the head to the left to avoid diplopia.
- Superior oblique tendon passes through the trochlea.

Doll's eye reflex

- Oculocephalic reflex tests CN III, VI and VIII (brainstem). Intact: eyes move opposite to the head turn. Not done with cervical injury.

Thyroid eye disease

- Commonest cause of both unilateral and bilateral adult proptosis; lid retraction is the commonest sign; **inferior rectus is the muscle most often affected**, then medial rectus (I'M SLOW). Tendon-sparing swelling on imaging (Coca-Cola bottle sign). Stop smoking (the main modifiable risk); radioiodine can worsen it. Treatment (EUGOGO 2021): selenium for mild disease; **i.v. methylprednisolone** (with mycophenolate) for moderate-to-severe active disease; teprotumumab (IGF-1R antibody, FDA 2020) a modern targeted therapy; high-dose steroids and urgent orbital decompression for compressive optic neuropathy. **Dysthyroid (compressive) optic neuropathy** is the main threat to sight, often in a quiet, not very proptosed eye: enlarged muscles crowd the **orbital apex** and compress the nerve (falling vision, colour loss, RAPD); exposure keratopathy is the other.

Disc swelling: papilloedema, papillitis and IIH

- **Papilloedema** (raised intracranial pressure): bilateral, **acuity kept** until late, enlarged blind spot, no RAPD, **transient obscurations** on standing, absent spontaneous venous pulsation. **Papillitis** (anterior optic neuritis): usually unilateral, pain on eye movement, **early loss of acuity**, central scotoma, colour loss, **RAPD**.

- **Idiopathic intracranial hypertension** (pseudotumour cerebri): obese women of childbearing age, headache, obscurations, pulsatile tinnitus, sixth-nerve palsy; normal MRI and MRV, raised opening pressure (25 cm CSF or more in adults; modified Dandy, Friedman criteria 2013). **Weight loss and acetazolamide** first-line (IIH Treatment Trial, 2014); topiramate an alternative; optic nerve sheath fenestration, CSF shunt or venous sinus stenting when vision is failing. Steroids are not used long term.

Colour vision

- Congenital defects are mostly **red-green**, X-linked recessive, about 8% of males and 0.5% of females; **deuteranomaly (weak green) is the commonest** (about 5% of males), then protan defects; **tritan (blue-yellow) defects are rare** and autosomal dominant. Ishihara plates screen for red-green defects; the Farnsworth-Munsell 100 hue test grades all types. Acquired defects: optic nerve disease tends to give red-green loss, retinal disease blue-yellow (Köllner's rule; ethambutol, optic neuritis).

Squint, amblyopia and trauma

Squint and amblyopia

- Concomitant squint: angle constant in all gaze directions. Paralytic: incomitant. Esotropia (convergent) in hypermetropia (accommodative). Exotropia in myopia.
- Tests: **Hirschberg** (corneal reflex), Krimsky, **cover-uncover (tropia)**, alternate cover (total deviation), Maddox rod, synoptophore.
- **Amblyopia**: reduced acuity, not explained by structural disease, from abnormal visual input in the critical period (up to about 7–8 years). Types: strabismic, anisometropic, deprivation (worst; a congenital cataract), ametropic.
- **Treatment: first correct the refractive error, then occlude (patch) the better eye**; atropine penalisation (alternative); results fall after the critical period; binocular games are an emerging approach. A dense congenital cataract should be removed early: unilateral by about 6 weeks, bilateral by about 8–10 weeks.

Orbital disease

- **Preseptal versus orbital cellulitis**: preseptal is a lid disease with normal eye movements and vision. **Orbital cellulitis**: fever, proptosis, **chemosis, painful and restricted eye movements**, reduced vision, RAPD, from sinusitis (ethmoid) in children; imaging with CT; urgent IV antibiotics; drain subperiosteal abscess; risk of cavernous sinus thrombosis.
- Proptosis in children: unilateral, commonest orbital cellulitis; commonest non-inflammatory dermoid cyst; capillary (infantile) haemangioma, now treated first with **oral propranolol**; **bilateral: metastatic neuroblastoma** (ecchymotic "raccoon eyes") (and leukaemic chloroma); **rhabdomyosarcoma** is the commonest primary malignant tumour.
- Thyroid eye disease lid signs: **Dalrymple's** (upper lid retraction, the commonest sign), **von Graefe's** (lid lag on down-gaze), **Stellwag's** (infrequent blinking), **Möbius's** (poor convergence), Kocher's (staring look on fixation), Joffroy's (no forehead wrinkling on looking up). Lid retraction comes from sympathetic overaction of Müller's muscle and fibrosis of the levator.
- Adults: **thyroid eye disease commonest**; commonest primary benign tumour **cavernous haemangioma** (now called cavernous venous malformation); commonest malignant tumour **lymphoma**; metastases from breast (adults), neuroblastoma (children).

Eyelid conditions

- **Stye (external hordeolum)**: staphylococcal abscess of the gland of Zeis or Moll. Internal hordeolum: Meibomian gland.
- **Chalazion**: chronic non-infectious **lipogranuloma of the Meibomian gland**; painless, away from the margin; incision and curettage (conjunctival side); a recurrent chalazion in an older patient suggests **sebaceous gland carcinoma**.
- Terminology: **trichiasis** (inturned lashes), distichiasis (extra row), madarosis (lash loss), poliosis (white lashes), **tylosis** (thickened lid margin), entropion, ectropion, coloboma, ankyloblepharon.
- Ptosis: commonest congenital type simple congenital (levator dystrophy); Marcus Gunn jaw-winking (trigeminal-oculomotor synkinesis); surgery by levator function: levator resection when function is fair or good, **frontalis sling when it is poor (under about 4 mm)**. Acquired: aponeurotic (commonest in the elderly), myasthenia (ice-pack test), third-nerve palsy, Horner's.

Ocular trauma

- Terminology: **BETT** (Birmingham Eye Trauma Terminology): closed globe (contusion, lamellar laceration) or open globe; open globe is a **rupture** (blunt force, inside-out) or a **laceration** (sharp object: penetrating with an entry wound only, perforating with entry and exit, or intraocular foreign body).
- **Chemical injury is an emergency: copious immediate irrigation**, before any history or examination, with neutral pH checked (use 1–2 L, a Morgan lens); alkali (lime, ammonia) penetrates and is worse than acid. Severity graded by limbal ischaemia (Roper-Hall) or limbal and conjunctival involvement (Dua, 2001). Later: cycloplegics, topical steroids, ascorbate and citrate, doxycycline, amniotic membrane or limbal stem cell transplantation (including simple limbal epithelial transplantation, SLET, 2012).
- Blunt trauma: hyphaema, **angle recession (late glaucoma)**, Vossius ring, rosette cataract, **commotio retinae (Berlin's oedema)**, traumatic mydriasis, blowout fracture (orbital floor, then medial wall: diplopia on upgaze from inferior rectus entrapment, infraorbital numbness, enophthalmos; "teardrop" sign on CT; a child with a white-eyed blowout fracture and vomiting or bradycardia from the oculocardiac reflex needs urgent repair).
- **Blow-out fracture mechanism**: a blunt object larger than the orbital rim (fist, ball) raises orbital pressure; the thin **floor medial to the infraorbital groove** gives way (the floor is the classic answer for the commonest blow-out; the medial wall, lamina papyracea, is thinner and often fractures too, alone or with the floor, on CT series) and tissue herniates into the maxillary sinus; the rim is intact. Infraorbital numbness (V2) and restricted **upgaze** (also down-gaze) with diplopia; CT confirms; repair for entrapment or large floor defects, usually within 1–2 weeks (urgently in children). Advise not to blow the nose.
- **Traumatic hyphaema** (blood in the anterior chamber, from a tear at the root of the iris or the face of the ciliary body, where the major arterial circle lies; graded by the height of the level:

I under a third, II a third to a half, III over a half, IV total, the black "eight-ball" hyphaema): the danger is **secondary haemorrhage on days 3–5** (clot retraction) and raised pressure with corneal blood staining. Management: rest with head raised (sit up so blood settles), **rigid shield**, cycloplegic, topical steroid, pressure-lowering drops (a beta-blocker first; avoid miotics, and avoid carbonic anhydrase inhibitors in sickle cell trait or disease), oral tranexamic acid in some units; **avoid aspirin and NSAIDs**; anterior chamber washout for pressure uncontrolled by drugs (for example over 50 mmHg for 5 days, or over 35 mmHg for 7 days, sooner in sickle cell disease) or early corneal blood staining; check the angle later for recession. Sickle-cell patients rebleed and develop optic neuropathy at lower pressures.

- **Radiational injury**: **ultraviolet photokeratitis** (snow blindness at altitude, welder's flash, sunlamps) gives severe bilateral pain, photophobia and watering **6–12 hours after exposure**, with diffuse punctate fluorescein staining; cycloplegic, lubricant, a short pad or bandage lens and oral analgesia; heals in 24–48 hours; prevented by UV-blocking goggles. **Eclipse (solar) retinopathy** is a foveal photochemical burn from looking at the sun.
- **Intraocular foreign body**: commonest iron; commonest mechanism hammer-and-chisel; commonest entry cornea; commonest site posterior segment; investigation of choice **non-contrast CT**; **MRI is contraindicated** with possible ferromagnetic foreign body; inert metals (glass, stone, plastic, gold) tolerated. Iron causes siderosis, copper chalcosis (sunflower cataract).
- **Sympathetic ophthalmitis**: see uvea; **penetrating injury with uveal involvement** (and absence of infection or suppuration) increases risk. Chemical injury is not a risk.
- Enucleation (removal of the whole globe; for intraocular malignancy and a blind exciting eye) versus evisceration (contents removed, sclera retained; preferred in panophthalmitis, to avoid opening the subarachnoid space around the optic nerve).

Community ophthalmology

Blindness

- WHO (ICD-10, the exam answer): **blindness** is presenting vision below **3/60** (cannot count fingers at 3 m) in the better eye, or a visual field under 10 degrees from fixation; Park also lists economic blindness (below 6/60), social blindness (below 3/60), manifest (below 1/60) and absolute blindness (no light perception). ICD-11 and the WHO World report on vision (2019): mild (below 6/12), moderate (below 6/18), severe (below 6/60) visual impairment and blindness (below 3/60), measured with presenting vision, so uncorrected refractive error counts.
- **Cataract is the commonest cause of blindness** worldwide and in developing countries, including Nepal; **uncorrected refractive error is the commonest cause of moderate and severe visual impairment** (Vision Loss Expert Group, 2020). Glaucoma is the leading cause of irreversible blindness worldwide.
- Vision 2020: The Right to Sight (WHO and IAPB) targeted avoidable blindness; **cataract, trachoma, refractive error, childhood blindness and onchocerciasis** are priority diseases (glaucoma and diabetic retinopathy added later). After it: the WHO World report on vision (2019), integrated people-centred eye care, and the World Health Assembly's 2030 targets (2021): a 30-point rise in effective cataract surgical coverage and a 40-point rise in effective refractive error coverage.

Vitamin A deficiency (xerophthalmia)

- **Earliest symptom: night blindness (XN)**; **earliest sign: conjunctival xerosis (X1A)**.
- WHO classification: **XN** night blindness; X1A xerosis; **X1B Bitot's spot** (triangular, foamy, silvery-white, temporal, bilateral); X2 corneal xerosis; X3A keratomalacia (under one third of the cornea); X3B (one third or more); XS corneal scar; XF xerophthalmic fundus.
- Treatment: vitamin A 200,000 IU orally on day 1, day 2 and after 2 weeks (age over 1 year; half dose 6–12 months; quarter dose under 6 months). Prophylaxis: Nepal's National Vitamin A Programme (from 1993, national by 2002) gives vitamin A capsules **twice a year, to children aged 6–59 months**, distributed by Female Community Health Volunteers (WHO prophylactic doses: 100,000 IU at 6–11 months, 200,000 IU at 12–59 months).
- Community thresholds (WHO): night blindness above 1%, Bitot's spots above 0.5%, corneal xerosis/ulceration above 0.01%, corneal scars above 0.05%.

Trachoma

- **Chlamydia trachomatis A, B, Ba, C**; leading infectious cause of blindness; spread by flies, fingers and fomites. Sequelae: scarring, **trichiasis**, entropion, corneal opacity. **Von Arlt's line**, Herbert's pits, pannus; Leber cells in follicles. Horner-Trantas dots are of vernal disease, not trachoma.
- **WHO SAFE strategy: Surgery (trichiasis), Antibiotics (azithromycin mass treatment), Facial cleanliness, Environmental improvement. Nepal was validated by the WHO (May 2018) as having eliminated trachoma as a public health problem**, the first country in WHO's South-East Asia Region; the dossier came from Nepal Netra Jyoti Sangh, and the targets were met in all 20 endemic districts. WHO's elimination targets: TF under 5% in children aged 1–9 years and TT unknown to the health system under 0.2% in adults aged 15 and over, in each district.
- WHO simplified grading: TF, TI, TS, TT, CO.

Ophthalmia neonatorum

- Purulent conjunctivitis within 28 days of birth.
- Timing: **day 1 chemical** (silver nitrate); **day 2–5 gonococcus** (the most severe: copious pus, rapid corneal ulceration and perforation); **day 5–14 Chlamydia trachomatis (the commonest infective cause in most countries)**; herpes simplex at 1–2 weeks (vesicles, dendrites).
- Prophylaxis: cleaning, 2.5% povidone-iodine or erythromycin. Treatment: ceftriaxone single dose IM for gonococcus; systemic azithromycin or erythromycin for chlamydia (topical alone is inadequate); treat the mother and partner.

Childhood and screening

- Leading causes of childhood blindness: in low-income countries, corneal scarring (vitamin A deficiency, measles, harmful traditional medicines) and cataract; in higher-income settings, retinopathy of prematurity and cerebral visual impairment.
- Screening: red reflex at birth (Bruckner test), school vision screening; diabetic retinopathy screening.

- Eye donation: corneas retrievable within 6 hours of death (up to about 12 hours if refrigerated); preserved in M-K or Optisol.
- Nepal's cataract services rely on outreach camps with manual SICS; the sutureless SICS technique was refined and spread from Nepal by Sanduk Ruit (Tilganga Institute of Ophthalmology, Kathmandu).

Lacrimal system

Anatomy and secretion

- The exam answer (Jones): **reflex tears from the main lacrimal gland; basal tears from the accessory glands of Krause** (in the fornices) **and Wolfring** (at the border of the tarsal plate). Current view: the main gland also gives much of the basal flow, and the two kinds of secretion are not cleanly separated (TFOS DEWS II, 2017). Meibomian glands give the lipid layer, goblet cells the mucin.
- Nerve supply of the gland: secretomotor parasympathetic fibres from the **superior salivatory nucleus** run in the nervus intermedius and greater petrosal nerve to the **pterygopalatine ganglion**, then by the zygomatic nerve to the lacrimal nerve; a lesion of the facial nerve proximal to the geniculate ganglion gives a dry eye.
- Drainage: puncta, canaliculi (2 mm vertical, 8 mm horizontal), common canaliculus (opens into the sac at the **valve of Rosenmüller**), lacrimal sac in its fossa (between the anterior and posterior lacrimal crests), nasolacrimal duct (about 18 mm) running **downwards, backwards and laterally** to open in the **inferior meatus** at the **valve of Hasner** (the usual site of congenital obstruction).
- The sac lies **below** the medial palpebral ligament: a swelling below it is the sac; above it, a frontoethmoidal mucocele or encephalocele.

Disease

- **Congenital nasolacrimal duct obstruction**: epiphora and mucoid regurgitation from the first weeks; most open by 1 year with sac massage; **probing if it persists beyond 1 year**, intubation or balloon dacryoplasty, then dacryocystorhinostomy (DCR), if probing fails. In practice probing succeeds in most children up to 2–3 years and is often done in the clinic from 6 months (PEDIG).
- **Chronic dacryocystitis** (commonest in middle-aged women; regurgitation on pressing the sac, mucocele; a source of endophthalmitis, so treated before cataract surgery): treated by **DCR**, external or endoscopic (similar success). Acute dacryocystitis: systemic antibiotics, warm compresses, drain a pointing abscess; no probing or syringing in the acute stage; DCR once it settles.
- **Dacryoadenitis**: acute (mumps the commonest cause in children, also EBV, staphylococcus; an S-shaped upper lid) or chronic (sarcoidosis, tuberculosis, IgG4 disease, lymphoma). Epiphora means overflow (blocked drainage) or hypersecretion; syringing and dacryocystography locate the block.

Sources

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