

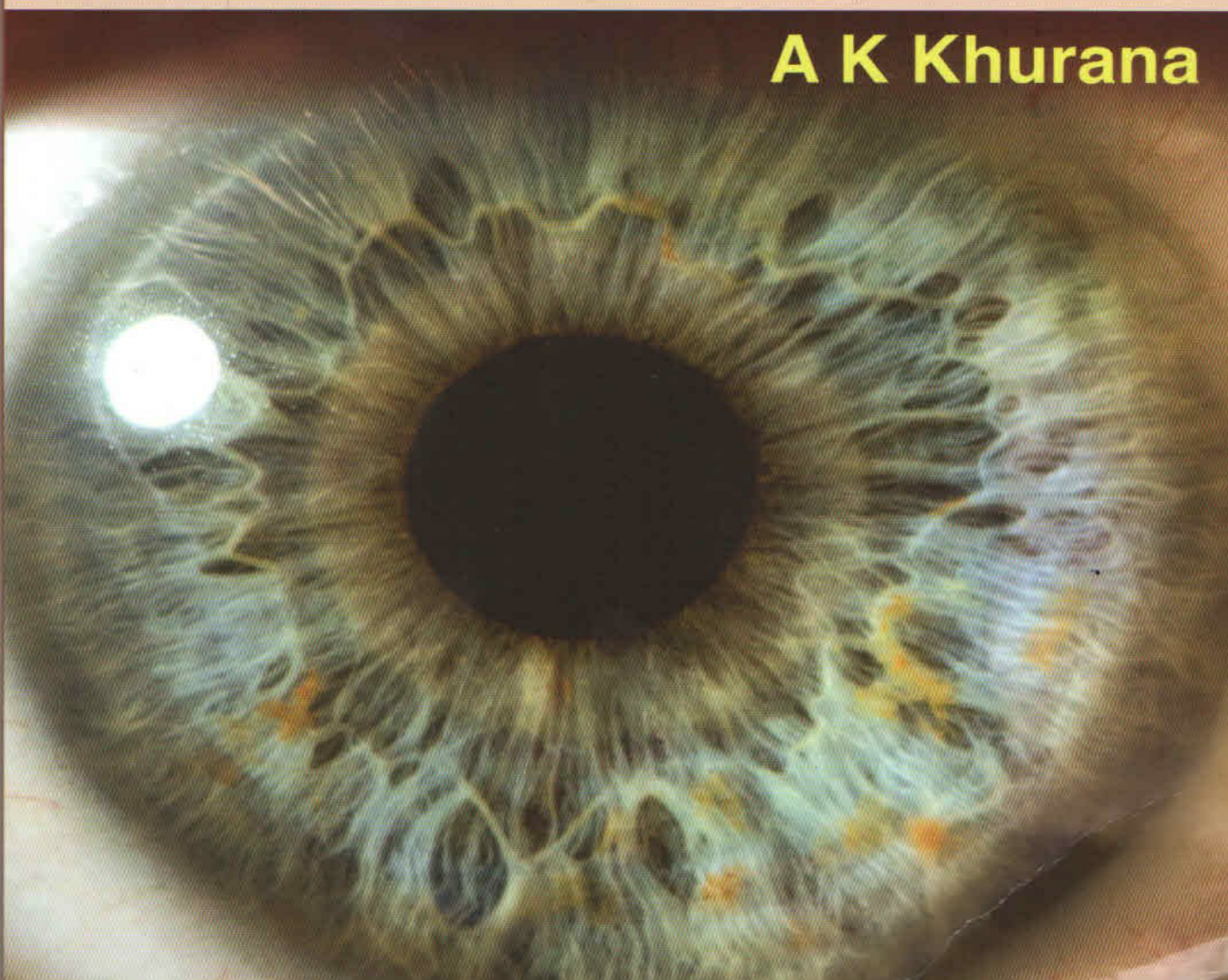


A Free Companion to
Comprehensive Ophthalmology, 6/E

Review of

OPHTHALMOLOGY

A K Khurana



Review of
OPHTHALMOLOGY

Review of **OPHTHALMOLOGY**

Quick Text Review & MCQs

Sixth Edition

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Dedicated to

My parents and teachers for their blessings

My students for their encouragement

My children for their patience

&

My wife for her understanding

PREFACE

Sixth edition of *Review of Ophthalmology* has been thoroughly revised and updated with recent advances in each aspect to keep abreast with newer concepts and principles of investigative modalities, treatment modalities and surgical procedures evolved over the period. However, the main layout and organisation of the book has not been changed. Twenty chapters of the book have been arranged.

Quick Text Review provides a quick reference to the main aspects of Ophthalmology in an orderly and easily reproducible manner. Though a quick review, the subject in this heading has been covered in depth and extensively including the recent advances. The important text on which MCQs are based has been highlighted with under rule.

Multiple Choice Questions (MCQs) arranged in twenty chapters matching the text review. Most of the MCQs are single best response type, barring a few extra edge questions. While framing the thought-provoking MCQs, Particular care has been taken to include all those important MCQs which have repeatedly appeared in various postgraduate medical entrance tests held in the last ten years up to 2014. Answers to the MCQs have been given at the bottom of each page to facilitate easy reading.

Key features of sixth edition

- Main feature of this book is that it is based on the *Khurana's Comprehensive Ophthalmology*, a textbook, which is used by most of the students during their graduation course.
- Provides a means for quick text revision and self-assessment to the medical students preparing for competitive postgraduate entrance examinations.
- Quick review of the text given in Section I provides an opportunity for preparing for the viva questions commonly asked in clinical/practical examinations and various interviews.
- Includes description of femtosecond laser and its role in cataract and corneal surgery.
- Community ophthalmology chapter has been updated in view of the objectives under Vision 2020, National Program for Control of Blindness in India, during 12th five year plan (2012-2017).
- Chapter on Clinical Methods in Ophthalmology includes uses of recently introduced sophisticated equipment
- Important feature of the sixth edition of the book is the active role of two young ophthalmologists, Aruj K Khurana, trained at Sankara Nethralaya, Chennai and Bhawna Khurana, trained at Guru Nanak Eye Centre, Maulana Azad Medical College, New Delhi, who have virtually revamped the text.

It is my great pleasure to convey my gratitude to all those, whose blessings and contribution has made this venture possible. I shall remain ever indebted to my parents and teachers for their unending blessings. I wish to express my deep sense of gratitude to Sr Prof CS Dhull, Director, PGIMS and Sr Prof SS Sangwan, Vice-Chancellor, University of Health Sciences, Rohtak, Haryana, for providing a working environment. I owe a lot of my students who have been a constant source of inspiration and encouragement. The sincere help rendered by Dr Shweta Goel needs to be acknowledged.

My wife Dr Indu Khurana and my daughter Arushi Khurana, the main forces behind me, need special mention for their endless love, patience and sacrifices.

I thank Shri Jitendar P Vij (Group Chairman), Mr Ankit Vij (Group President) and Mr Tarun Duneja (Director-Publishing) of M/s Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India, for their enthusiastic cooperation and accomplishing the task in a splendid manner.

Sincere efforts have been made to verify the correctness of text and the answers to the MCQs. However, in spite of the best efforts, ventures of this kind are not likely to be free from human errors, some inaccuracies, ambiguities and typographic mistakes. Therefore, a feedback from the users will be of utmost help in improving future editions of the book. Endeavour of this kind shall be highly appreciated and duly acknowledged.

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CHAPTER

1

Anatomy, Development and Physiology of Eye

Quick Text Review

ANATOMY OF EYE

EYEBALL

Dimensions of an adult eyeball

- Anteroposterior diameter : 24 mm
- Vertical diameter : 23 mm
- Horizontal diameter : 23.5 mm
- Circumference : 75 mm
- Volume : 6.5 cc
- Weight : 7 g

Segments and chambers of the eyeball

Anterior segment. It includes crystalline lens and structures anterior to it viz. iris, cornea and two aqueous humour filled spaces, the anterior and posterior chamber.

Angle of anterior chamber from anterior to posterior comprises:

- Schwalbe's line
- Trabecular meshwork
- Scleral spur
- Band of ciliary body and
- Root of iris

Anterior chamber. Its depth in the centre is 2.5–3 mm, it is comparatively shallow in very young children and old people. The chamber shallows by 0.01 mm per year. It is shallower in hypermetrops and deeper in myopes. Usually males have larger anterior chamber dimensions than female and volume of aqueous humour in it is 0.25 ml. Posterior chamber contains about 0.06 ml of aqueous humour.

Posterior segment. It includes structures posterior to the lens viz. vitreous humour, retina, optic disc, choroid and pars plana (part of ciliary body).

CORNEA

- It is a transparent, dehydrated and avascular structure.
- Forming 1/6th of the outer fibrous coat of eyeball.

Dimensions

- Anterior vertical diameter : 11 mm
- Anterior horizontal diameter : 12 mm
- Posterior diameter : 11.5 mm
- Radius of curvature of central part
 - Anterior : 7.8 mm
 - Posterior : 6.5 mm
- Thickness
 - at the centre : 0.52 mm
 - at the periphery : 1 mm
- Refractive index : 1.33
- Refractive power : 45 D

Note:

- **Pachymetry** 500-600 micron, always central thickness measured because centre is the thinnest part.
- **Specular microscopy** is a detailed microscopic analysis of individual cell morphology and an estimate of cellular density.

Layers of cornea

- **Epithelium:** Stratified squamous type. Corneal epithelium replaces itself about once a week.
- **Bowman's membrane:** Once destroyed does not regenerate.
- **Stroma:** Constitutes 90% of total thickness. Consists of collagen fibres (lamellae arranged in many layers).
- **Pre-Descemet's membrane or Dua's layer** (discovered in 2013) is about 15 micrometer thick acellular structure which is very strong and impervious to air.
- **Descemet's membrane:** Once destroyed, it regenerates. Its prominent peripheral end forms Schwalbe's line.
- **Endothelium:** Cell density in a young adult is about 6,000 cells/mm². Metabolically, it is the most active layer of cornea.

SCLERA

Thickness of sclera

- At posterior pole: 1 mm (thickest)
- At the insertion of extraocular muscles: 0.3 mm (thinnest)
- Equator: 0.5 mm
- Lamina cribrosa is the thinnest sieve like sclera through which pass fibres of the optic nerve.

CRYSTALLINE LENS

Dimensions

Lens is a transparent, biconvex, crystalline structure placed between iris and vitreous in a saucer shaped depression called patellar fossa.

- Diameter: 9-10 mm
- Thickness varies with age from 3.5 mm (at birth) to 5 mm (at 60 to 70 years); in an adult average is 4.25 mm
- Thickness of the lens capsule at anterior pole is 14 µm.
- Weight varies with age from about 135 mg (0-9 year), 175 mg (20-30 years) to 255-275 mg (60 to 80 years)
- Radius of curvature
 - Anterior : 11 mm
 - Posterior : 6 mm
- Refractive index : 1.39
- Refractive power : 15-16D

Structure

Lens capsule is thinnest at the posterior pole.

Lens epithelium. It is a single layer on the anterior (front) surface. There is no epithelium on posterior surface.

Nucleus: It is the central part of the lens containing oldest lens fibres.

- **Embryonic nucleus:** Corresponding to the lens at 1-3 months of gestation. It consists the oldest primary fibres
- **Fetal nucleus** (3 months gestation till birth). Its fibres meet around the Y-shaped sutures (anterior Y is erect and, posterior Y is inverted).
- **Infantile nucleus:** From birth to puberty
- **Adults nucleus:** Lens fibres formed after puberty to rest of life

Cortex: It is the peripheral part containing the youngest fibres.

IRIS AND CILIARY BODY

- Iris is thinnest at its root.

- **Anterior limiting membrane** is the anterior most condensed part of stroma. It is deficient in the area of crypts. Definitive colour of the iris depends upon the amount of pigment in this layer.
- **Anterior pigmented epithelium** of ciliary body is forward continuation of the pigment epithelium of the retina.
- **Posterior non-pigmented epithelium** of ciliary body is forward continuation of the sensory retina.
- **Ciliary processes** (About 70-80 in number) are white, finger-like projections from the pars plicata, part of the ciliary body.

VITREOUS, RETINA AND VISUAL PATHWAY

Vitreous

- Volume of vitreous is approximately 4 cc (about two-third of the volume of the eye).
- Vitreous consists of large molecules of hyaluronic acid.
- **Subhyaloid space** refers to the potential space between vitreous and retina.
- **Vitreous base** refers to its strongest attachment to the pars plana and the retina in the region of ora-serrata.

Retina

- Dimensions of retina
 - Optic disc : 1.5 mm
 - Macula lutea : 5.5 mm (15° visual field)
 - Fovea centralis : 1.5 mm (5° visual field)
 - Foveola : 0.35 mm
 - Thickness of retina : 0.5 mm near optic disc, 0.2 mm at equator, and 0.1 mm most anteriorly
- Optic disc, 1.5 mm in size, is responsible for blind spot of Mariotte
- Rods and cones are sensory end organs of the vision
- Rods are absent in the foveal region. Ganglion cell layer is thickest in the macular region
- Henle's layer refers to thickened outer plexiform layer in the foveal region
- Foveola is the most sensitive part of retina. It contains only cones and their nuclei covered by a thin internal limiting membrane
- Major retinal vessels are present in the nerve fibre layer
- Superficial capillary network of the retina is present at the level of nerve fibre layer
- Nourishment of macula-lutea is entirely dependent upon the choroid.

Visual pathway

Visual sensation neurons

- *First order*—bipolar cells
- *Second order*—ganglion cells
- *Third order*—neurons of lateral geniculate body.

Optic nerve

- *Fibres of optic nerve* once cut, do not regenerate, because they are not covered by neurilemma.
- *Length of optic nerve*
 - Total length : 47-50 mm
 - Intraocular part : 1 mm
 - Intraorbital part : 30 mm
 - Intracanalicular part : 6-9 mm
 - Intracranial part : 10 mm
- *Diameter of optic nerve*
 - Intraocular (optic disc) : 1.5 mm
 - Intraorbital part : 3-4 mm
 - Intracranial part : 4-7 mm
- Intraocular part of optic nerve is closely related to ophthalmic artery, which crosses obliquely over it.

EXTRAOCULAR MUSCLES

Origin and insertion

- *Four rectus muscles* (superior, inferior, medial and lateral) arise from the common tendinous ring (annulus of Zinn) at the apex of the orbit, and are inserted on the sclera at following distances from the limbus:
 - Medial rectus : 5.5 mm
 - Inferior rectus : 6.5 mm
 - Lateral rectus : 6.9 mm
 - Superior rectus : 7.7 mm
- *Superior rectus and medial rectus* have an attachment with the dural sheath of the optic nerve, this accounts for the painful movements in retrobulbar neuritis.
- *Lateral rectus* muscle arises by two heads.
- *Inferior oblique* (shortest extraocular muscle), is the only muscle arising from the floor of the orbit. It is inserted on the sclera posterior to the equator in the area coinciding with the macular region.
- *Superior oblique* (longest extraocular muscle) arises from the apex of the orbit, turns around the trochlea and is inserted in the upper and outer part of the sclera behind the equator.

Nerve supply

- *3rd cranial nerve*: Superior rectus, medial rectus, inferior rectus and inferior oblique.
- *4th cranial nerve*: Superior oblique.
- *6th cranial nerve*: Lateral rectus. Palsy produces eyeball inward, i.e. esotropia or convergent squint, and homonymous (uncrossed) diplopia.

Actions

Muscle	Primary action	Secondary action	Tertiary action
MR	Adduction	—	—
LR	Abduction	—	—
SR	Elevation	Intorsion	Adduction
IR	Depression	Extorsion	Adduction
SO	Intorsion	Depression	Abduction
IO	Extorsion	Elevation	Abduction

APPENDAGES OF THE EYE AND ORBIT

Conjunctiva

1. *Epithelium*: Stratified squamous non-keratinized
 - Marginal conjunctiva - 5 layered
 - Tarsal conjunctiva - 2 layered
 - Fornix and bulbar conjunctiva - 3 layered
 - Limbal conjunctiva - 5 layered
 - Globlet cells are seen in nasal part of conjunctiva. Maximum density of globlet cell is present infero-nasally and in the fornices.
2. *Adenoid layer*: Consists of fine connective tissue reticulum. It is most developed in the fornices. It is not present since birth but develops after 3–4 months of life (so conjunctival inflammation in infants does not produce follicles). Limbal stem cells are present in the limbal conjunctiva.
3. *Fibrous layer*: It contains all the blood vessels and nerves.

Glands of eyelids

- *Meibomian glands* (Tarsal glands) are modified sebaceous glands; about 20-30 in each lid.
- *Glands of Zeis* are modified sebaceous glands which open into follicles of eye lashes.
- *Glands of Moll* are modified sweat glands which open into hair follicles.
- *Accessory lacrimal glands* of Wolfring are present near the superior border of upper tarsus.

Lacrimal apparatus

- *Accessory lacrimal glands of Krause* are about 42 in the upper fornix and 6–8 in the lower fornix
- *Tears* are produced after one week of life
- *Lacrimal sac* when distended, is about 15 mm in length and 5–6 mm in breadth
- *Angular vein* is situated 8 mm medial to the medial canthus.

Nasolacrimal duct

- *Length* 12–24 mm, diameter 4–5 mm
- *Directed* downward, slightly outwards and backwards
- *Opens in* inferior meatus
- *Narrowest point* is near the upper end
- *Valve of Hasner* is present near its lower end.

ORBIT

- *Volume*—30 cc. The eyeball occupies one-fifth of the volume
- *Thinnest wall*—medial
- *Thickest wall*—lateral
- *Floor* is commonly involved in blow-out fractures
- *Surgical spaces* in orbit—four (subperiosteal space, peripheral space, central space or muscle cone and Tenon's space).

Bones, walls and fissures of orbit

Walls of orbit are formed by following bones:

1. *Medial wall*
 - Frontal process of maxilla
 - Lacrimal bone
 - Orbital cribriform plate of ethmoid and
 - Body of sphenoid
2. *Lateral wall*
 - Zygomatic bone
 - Greater wing of sphenoid
3. *Superior wall (roof)*
 - Orbital Plate of frontal bone
 - Lesser wing of sphenoid
4. *Floor* (commonly involved in blow out fracture)
 - Orbital surface of maxillary bone
 - Orbital surface of zygomatic bone
 - Palatine bone

Fissures and foramen of orbit are:

- *Inferior orbital fissure*
 - Present between floor and lateral wall
- *Superior orbital fissure*
 - It is at orbital apex, lateral to optic foramen
- *Optic canal/Optic foramen*
 - Formed by two wings of lesser wing of sphenoid at orbital apex.

DEVELOPMENT OF THE EYE

Eyeball and its related structures are derived from the following primordia:

- *Optic vesicle* (Neuroectodermal structure)—an outgrowth from the prosencephalon
- *Lens placode* (a specialised area of surface ectoderm) and surrounding surface ectoderm
- *Mesoderm* surrounding the optic vesicle
- *Visceral mesoderm* of maxillary process.

STRUCTURES DERIVED FROM THE EMBRYONIC LAYERS**1. Surface ectoderm**

- The crystalline lens
- Epithelium of the cornea
- Epithelium of the conjunctiva
- Lacrimal gland

- Epidermis of eyelids and its derivatives viz., cilia, tarsal glands and conjunctival glands
- Epithelium lining the lacrimal apparatus.

2. Neural ectoderm

- Retina with its pigment epithelium
- Epithelial layers of ciliary body
- Epithelial layers of iris
- Sphincter and dilator pupillae muscles
- Optic nerve (neuroglia and nervous elements only)
- Definitive or secondary vitreous
- Ciliary zonules.

3. Associated paraxial mesoderm

- Blood vessels of choroid, iris, ciliary vessels, central retinal artery and other vessels
- Substantia propria, Descemet's membrane and endothelium of cornea
- The sclera
- Stroma of iris
- Ciliary muscle
- Sheaths of optic nerve
- Extraocular muscles
- Fat, ligaments and other connective tissue structures of the orbit
- Upper and medial walls of the orbit
- Connective tissue of the upper eyelid.

4. Visceral mesoderm of maxillary process below the eye

- Lower and lateral walls of orbit
- Connective tissue of the lower eyelid.

IMPORTANT MILESTONES IN THE DEVELOPMENT OF THE EYE**Embryonic and fetal period**

<i>Stage of growth</i>	<i>Development</i>
2.6 mm (3 weeks)	Optic pits appear on either side of cephalic end of forebrain
3.5 mm (4 weeks)	Primary optic vesicle invaginates
5.5 to 6 mm	Development of embryonic fissure
10 mm (6 weeks)	Retinal layers differentiate, lens vesicle formed
20 mm (9 weeks)	Sclera, cornea and extra-ocular muscles differentiate
25 mm (10 weeks)	Lumen of optic nerve obliterated
50 mm (3 months)	Optic tracts completed, pars ciliaris retina grows forwards, pars iridica retina grows forward and lid folds develop

60 mm (4 months)	Hyaloid vessels atrophy, iris sphincter, dilator and ciliary muscles develop
230-265 mm (8th month)	Fetal nucleus of lens is complete, all layers of retina nearly developed and macula starts differentiation.
265-300mm (9th month)	Except macula, retina is fully developed, infantile nucleus of lens begins to appear, pupillary membrane and hyaloid vessels disappear. Medulation of optic nerve reaches lamina cribrosa.

Eye at birth and post-natal development

- *Anterior posterior diameter* about 16.5 mm (70% of adult size) which is attained by 7-8 years of age.
- *Corneal diameter* is about 10 mm. Adult size (11.7 mm) is attained by 2 years of age.
- *Lens* is spherical and 3.5 mm thick at birth. Lens grow through out life and become 5 mm thick at 60 years of age.
- *Macula* differentiate 4-6 months after birth.
- *Refractive status*. New born is hypermetropic by +2 to +3 D.
- *Fixation status* developing at 1 month and is completed by 6 months.

PHYSIOLOGY OF EYE

PHYSIOLOGY OF TEAR FILM

(See page 75)

PHYSIOLOGY OF CORNEA

Corneal transparency is the result of:

- *Peculiar arrangement* of corneal lamellae (lattice theory)
- *Avascularity of cornea*
- *Relative dehydration* maintained by epithelial and endothelial barriers and active bicarbonate pump of the endothelium
- *Swelling pressure* of stroma
- *Corneal crystallines* (water soluble proteins of keratocyte)

Corneal metabolism. Epithelium is metabolically more active than endothelium:

- Glucose and other solutes are derived from aqueous humour and perilimbal capillaries
- Oxygen is derived from the air through tear film
- Respiratory quotient of cornea is 1.

PHYSIOLOGY OF CRYSTALLINE LENS

Lens transparency is the result of:

- Avascularity
- Tightly-packed lens fibres
- Arrangement of lens proteins
- Semipermeable lens capsule
- Active pump mechanism in lens fibres
- Auto-oxidation and high concentration of reduced glutathione
- Aquaporin-O also help in maintaining transparency.

Lens metabolism

- *Metabolic activity* of the lens is largely limited to epithelium and cortex, nucleus is relatively inert
- *80% glucose is metabolised* anaerobically by the glycolytic pathway, 15% by HMP shunt, and a small proportion via Krebs cycle
- *Soribital pathway* plays role in diabetic cataract
- *Respiratory quotient* of lens is 1
- *Preventive antioxidants mechanism* of lens are enzymatic (glutathione, glutathione peroxide, superoxide dismutase and catalase) and non-enzymatic (vitamin C, vitamin E and carotenoids).

PHYSIOLOGY OF AQUEOUS HUMOUR

(See page 44)

PHYSIOLOGY OF VISION

Initiation, processing and transmission of visual impulse

Sensory nerve endings for visual sensation are rods and cones. Each eye contains about 120 million rods and 6 million cones and only 1.5 million ganglion cells.

Visual pigments (in rods rhodopsin with spectrum of 500 nm and in cones erythrolabe with spectrum 565 nm, chlorolabe with spectrum 535 nm, and cyanolabe with spectrum 440 nm), absorb light and trigger receptor potential which unlike other receptor systems leads to hyperpolarization of the cells and not the depolarization. This phenomenon of conversion of light energy into nerve impulse is called phototransduction.

Receptor potential generated in the photoreceptors is transmitted by electronic conduction to other retinal cells up to ganglion cell. Ganglion cells, however, transmit by action potential to the LGB cells.

Parvocellular system of visual pathway consisting of P ganglion cells and other P cells transmit information about colour and fine details of vision.

Magnocellular system consisting of M ganglion cells and other M cells is concerned with contrast and motion.

Visual perceptions

1. The light sense: It is the awareness of the light. The minimum brightness required to evoke a sensation of light is called the *light minimum*. The rods are more sensitive to low illumination than the cones. Dark adaptation is the ability of the eye to adapt itself to decreasing illumination. Dark adaptation is delayed in:

- Vitamin A deficiency
- Glaucoma
- Pigmentary retinal dystrophy.

2. The form sense: It is the ability to discriminate between the shapes of the objects. Cones play major role in this faculty, therefore form sense is most acute at the fovea where cones are most densely packed and highly differentiated. Visual acuity recorded by Snellen's test chart is the measure of form sense.

3. Sense of contrast: It is the ability of the eye to perceive slight changes in the luminance between

regions which are not separated by definite borders. Contrast sensitivity is decreased in:

- Glaucoma
- Refractive errors
- Diabetes
- Optic nerve diseases
- Cataractous changes.

Measurement of contrast sensitivity: In clinical practice, the contrast sensitivity can be measured by using any of the following charts with letters or stripes represented in various shades of gray:

- Arden gratings
- Cambridge low-contrast gratings
- Pelli-Robson contrast sensitivity chart which consists of low contrast letters with same size
- The Visitach chart, and
- Functional acuity contrast test (FACT).

4. Colour sense vision: It is the ability of the eye to discriminate between different colours. It is a function of the cones. There are three primary colours—red, green and blue. All other colours are produced by mixture of these primary colours (Young Helmholtz's trichromatic theory).

Note: Colour vision involves opponent colour cells and difference between rods and cones is all (intensity, number and colour) except signal transduction.

Multiple Choice Questions (MCQs)

1. **Anteroposterior diameter of normal adult eyeball is:**
 - A. 25 mm
 - B. 24 mm
 - C. 23.5 mm
 - D. 23 mm
2. **Smallest diameter of the eyeball is:**
 - A. Vertical
 - B. Horizontal
 - C. Anteroposterior
 - D. More than 24 mm
3. **Circumference of an adult eyeball is:**
 - A. 80 mm
 - B. 65 mm
 - C. 75 mm
 - D. 70 mm
4. **Volume of an adult eyeball is:**
 - A. 7.5 mL
 - B. 6.5 mL
 - C. 5.5 mL
 - D. 8 mL
5. **Weight of an adult eyeball is:**
 - A. 7 g
 - B. 9 g
 - C. 11 g
 - D. 13 g
6. **Anterior segment of the eyeball includes structures lying in front of the:**
 - A. Iris
 - B. Crystalline lens
 - C. Vitreous body
 - D. Cornea
7. **Posterior segment of the eyeball includes structures present posterior to the:**
 - A. Posterior surface of the lens and zonules
 - B. Iris and pupil
 - C. Vitreous body
 - D. Anterior surface of the lens and zonules
8. **Diameter of an adult crystalline lens is:**
 - A. 5–6 mm
 - B. 7–8 mm
 - C. 9–10 mm
 - D. 11–12 mm
9. **Thickness of the adult crystalline lens is about:**
 - A. 2.5 mm
 - B. 3.5 mm
 - C. 4.25 mm
 - D. 5 mm
10. **Radius of curvature of the anterior surface of an adult crystalline lens with accommodation at rest is:**
 - A. 7 mm
 - B. 10 mm
 - C. 8 mm
 - D. 9 mm
11. **Capsule of the crystalline lens is thinnest at:**
 - A. Anterior pole
 - B. Posterior pole
 - C. Equator
 - D. None of the above
12. **Infantile nucleus of the crystalline lens refers to the nucleus developed from:**
 - A. 3 months of gestation to till birth
 - B. Birth to one year of age
 - C. Birth to puberty
 - D. One year of age to 3 years of age
13. **The lens fibres meet around the Y-shaped sutures in which part of nucleus of the crystalline lens:**
 - A. Embryonic nucleus
 - B. Fetal nucleus
 - C. Infantile nucleus
 - D. All of the above

14. The youngest lens fibres are present in:

- A. Central core of the lens nucleus
- B. Outer layer of the nucleus
- C. Deeper layer of the cortex
- D. Superficial layer of the cortex

15. Schwalbe's line forming part of the angle of anterior chamber is the prominent end of:

- A. Sclera
- B. Descemet's membrane of cornea
- C. Anterior limit of trabecular meshwork
- D. Posterior limit of trabecular meshwork

16. In a normal adult person the depth of anterior chamber in the centre is about:

- A. 2.5 mm
- B. 3 mm
- C. 3.5 mm
- D. 4 mm

17. Is a sweat gland:

- A. Gland of Moll
- B. Gland of Zeis
- C. Meibomian gland
- D. All of the above

18. The layer of the cornea once destroyed does not regenerate is:

- A. Epithelium
- B. Bowman's membrane
- C. Descemet's membrane
- D. All of the above

19. All of the following are true about corneal endothelium except:

- A. Cell density is about 3000 cells/mm² at birth
- B. Corneal decompensation occurs when cell count is decreased by 50 percent
- C. Endothelial cells contain active pump mechanism
- D. Endothelium is best examined by specular microscopy

20. Adult size of the cornea is attained by the age of:

- A. 2 years
- B. 3 years
- C. 5 years
- D. 9 years

21. Sclera is weakest at the level of:

- A. Macula
- B. Equator
- C. Insertion of extraocular muscles
- D. Ora serrata

22. The definitive colour of the iris depends upon the:

- A. Anterior limiting layer
- B. Stroma
- C. Anterior pigmented epithelium
- D. Posterior pigmented epithelium

23. Circulus iridis major is formed by the anastomosis of:

- A. Long posterior ciliary arteries with short posterior ciliary arteries
- B. Anterior ciliary arteries with short posterior ciliary arteries
- C. Long posterior ciliary arteries with anterior ciliary arteries
- D. Long posterior arteries with anterior conjunctival arteries

24. Layer of non-pigmented epithelium of the ciliary body is the forward continuation of the:

- A. Pigment epithelium of the retina
- B. Sensory retina
- C. Internal limiting membrane of the retina
- D. Bruch's membrane of the choroid

25. The number of ciliary processes is about:

- A. 20-30
- B. 50-60
- C. 70-80
- D. 90-100

26. All of the following are true about circulus arteriosus minor except:

- A. It receives contribution from anterior ciliary arteries and long posterior ciliary arteries
- B. It is an arterial and venous plexus
- C. It lies near the pupillary margin
- D. It is the seat of formation of aqueous humour

27. The strongest attachment of the vitreous body to the surrounding structures is at the level of:

- A. Vitreous base
- B. Optic disc
- C. Posterior surface of the lens
- D. Foveal region

28. Diameter of the optic disc is:

- A. 1.5 mm
- B. 2.5 mm
- C. 3.5 mm
- D. 5 mm

29. Diameter of the macula lutea is:

- A. 1.5 mm
- B. 3.5 mm
- C. 4.5 mm
- D. 5.5 mm

30. Diameter of fovea centralis is:

- A. 0.5 mm
- B. 1.0 mm
- C. 1.5 mm
- D. 2.5 mm

31. Henle's layer refers to the thickened outer plexiform layer in the region of:

- A. Foveola
- B. Foveal region
- C. Parafoveal region
- D. Paramacular region

32. Major retinal vessels are present in:

- A. Between the vitreous and internal limiting membrane
- B. The nerve fibre layer
- C. The inner plexiform layer
- D. The inner nuclear layer

33. Optic nerve consists of axons of:

- A. Ganglion cells
- B. Bipolar cells
- C. Rods and cones
- D. All of the above

34. Optic nerve fibres once cut, do not regenerate because they are not covered by:

- A. Myelin sheath
- B. Neurilemma
- C. Both of the above
- D. None of the above

35. Neurons of first order for visual sensations are:

- A. Rods and cones
- B. Bipolar cells
- C. Ganglion cells
- D. None of the above

36. Neurones of third order for visual sensations lie in:

- A. Layer of bipolar cells
- B. Layer of ganglion cells
- C. Lateral geniculate body
- D. Visual cortex

37. The longest extraocular muscle is:

- A. Superior oblique
- B. Inferior oblique
- C. Superior rectus
- D. Inferior rectus

38. The shortest extraocular muscle is:

- A. Superior oblique
- B. Inferior oblique
- C. Superior rectus
- D. Inferior rectus

39. The posterior end of which muscle insertion lies near the macula ?

- A. Inferior oblique
- B. Superior oblique
- C. Superior rectus
- D. Inferior rectus

40. The nerve which has the longest intracranial course is:

- A. Fourth cranial nerve
- B. Third cranial nerve
- C. Sixth cranial nerve
- D. Fifth cranial nerve

41. Glands of Zeis are:

- A. Modified sebaceous glands
- B. Modified sweat glands
- C. Modified lacrimal glands
- D. Modified meibomian glands

42. Ducts of the main lacrimal gland open in:

- A. Superior fornix
- B. Inferior fornix
- C. Both of the above
- D. None of the above

43. Accessory lacrimal glands of Krause are present in the:

- A. Upper fornix
- B. Lower fornix
- C. Both of the above
- D. None of the above

44. Length of the nasolacrimal duct is about:

- A. 8–12 mm
- B. 22–34 mm
- C. 12–18 mm
- D. 18–21 mm

45. Nasolacrimal duct opens into:

- A. Superior meatus
- B. Middle meatus
- C. Inferior meatus
- D. Maxillary sinus

46. Nasolacrimal duct is directed:

- A. Downwards, slightly outwards and backwards
- B. Downwards, slightly inwards and backwards
- C. Downwards, slightly outwards and forwards
- D. Downwards, slightly inwards and forwards

47. In the nasolacrimal duct, valve of Hasner is present at its:

- A. Upper end
- B. Lower end
- C. Middle
- D. None of the above

48. Thinnest wall of the orbit is:

- A. Medial wall
- B. Floor
- C. Roof
- D. Lateral wall

49. Thickest wall of the orbit is:

- A. Medial wall
- B. Lateral wall
- C. Roof
- D. Floor

50. The volume of the orbit is about:

- A. 30 cc
- B. 40 cc
- C. 50 cc
- D. 60 cc

51. All of the following ocular structures are derived from the surface ectoderm except:

- A. Crystalline lens
- B. Substantia propria of the cornea
- C. Conjunctival and corneal epithelium
- D. Lacrimal glands

52. Crystalline lens is derived embryologically from the:

- A. Surface ectoderm
- B. Neuroectoderm
- C. Surface ectoderm and mesoderm
- D. Neuroectoderm and mesoderm

53. Definitive or secondary vitreous is embryologically derived mostly from:

- A. Neuroectoderm
- B. Mesoderm
- C. Surface ectoderm
- D. Surface ectoderm and mesoderm

54. Sphincter and dilator pupillae muscles are derived embryologically from the:

- A. Surface ectoderm
- B. Mesoderm
- C. Neuroectoderm
- D. All of the above

55. All of the following ocular structures are derived embryologically from the neuroectoderm except:

- A. Epithelial layers of ciliary body and iris
- B. Sphincter and dilator pupillae muscles
- C. Optic nerve
- D. Optic nerve sheaths

56. Normal A:V ratio of retinal blood vessels is:

- A. 1 : 2
- B. 2 : 3
- C. 3 : 2
- D. 3 : 4

57. 'Safe zone' of the eye ball is:

- A. At the limbus
- B. 3-4 mm behind the limbus
- C. 8-9 mm behind the limbus
- D. 12 mm behind the limbus
- E. 1 mm behind the limbus

58. Yoke muscle for right superior rectus is:

- A. Left superior rectus
- B. Left inferior oblique
- C. Left inferior rectus
- D. Left superior oblique

59. The short posterior ciliary arteries are about in number:

- A. 10
- B. 20
- C. 30
- D. 40
- E. 45

60. The canal of Schlemm possesses the following anatomic characteristics except:

- A. Contains red cells
- B. Contains aqueous
- C. Lined by endothelium
- D. Contains partitions resembling the dural venous sinuses

61. Muscle in the lid attached to posterior tarsal margin is:

- A. Levator palpebrae superioris
- B. Superior oblique
- C. Muller's muscle
- D. Superior rectus

62. Which of the following extraocular muscle has sympathetic innervation:

- A. Levator palpebrae superioris
- B. Muller's muscle
- C. Superior rectus
- D. Inferior rectus

63. Most sensitive part of eye is:

- A. Fovea centralis
- B. Macula lutea
- C. Blind spot
- D. Temporal retina

64. Volume of the vitreous is:

- A. 2 mL
- B. 3 mL
- C. 4 mL
- D. 7 mL

65. Avascular coat in eye is:

- A. Sclera
- B. Cornea
- C. Retina
- D. Choroid

66. Which continues to grow in the lifetime:

- A. Cornea
- B. Iris
- C. Lens
- D. Retina

67. Which part of orbicularis oculi is known as Horner's muscle:

- A. Orbital
- B. Lacrimal
- C. Temporal
- D. Muller's muscle

68. All visual reflexes are developed by:

- A. 1 year
- B. 2 year
- C. 5 year
- D. 10 year

EXTRA EDGE QUESTIONS**69. Corneal endothelial cell count is done by:**

- A. Specular microscopy
- B. Keratometry
- C. Gonioscopy
- D. Slit lamp

70. Anterior chamber depth:

- A. Increases with age
- B. Is lesser in women
- C. Is lesser in myopes
- D. Has hardly any effect on anterior chamber volume

Clinical Methods in Ophthalmology

Quick Text Review

COMMON OCULAR SYMPTOMS AND THEIR CAUSES

Sudden painless loss of vision

- Central retinal artery occlusion
- Massive vitreous haemorrhage
- Retinal detachment involving macular area
- Ischaemic central retinal vein occlusion.

Sudden painless defective vision

- Central serous retinopathy
- Optic neuritis
- Methyl alcohol amblyopia
- Non-ischaemic central retinal vein occlusion.

Sudden painful loss of vision

- Acute congestive glaucoma
- Acute iridocyclitis
- Chemical injuries to the eyeball
- Mechanical injuries to the eyeball.

Gradual painless loss of vision

- Progressive pterygium involving pupillary area
- Corneal degenerations
- Corneal dystrophies
- Developmental cataract
- Senile cataract
- Optic atrophy
- Chorioretinal degenerations
- Age-related macular degeneration
- Diabetic retinopathy
- Refractive errors.

Gradual painful loss of vision

- Chronic iridocyclitis
- Corneal ulceration
- Chronic glaucomas.

Transient loss of vision (amaurosis fugax)

- Carotid artery disease
- Papilloedema
- Giant cell arteritis
- Migraine
- Raynaud's disease
- Severe hypertension
- Prodromal symptom of CRAO.

Night blindness (Nyctalopia)

- Vitamin A deficiency
- Retinitis pigmentosa and other tapetoretinal degenerations
- Congenital stationary night blindness
- Pathological myopia
- Peripheral cortical cataract
- Advanced case of POAG.

Day blindness (Hamarloopia)

- Central nuclear or polar cataracts
- Central corneal opacity
- Central vitreous opacity
- Congenital deficiency of cones (rarely).

Defective vision for near only

- Presbyopia
- Cycloplegia
- Internal or total ophthalmoplegia
- Insufficiency of accommodation.

Black spots in front of the eyes

- Vitreous haemorrhage
- Vitreous degeneration, e.g. senile, pathological myopia
- Lenticular opacity
- Exudates in vitreous.

Flashes of light in front of the eyes (Photopsia)

- Prodromal symptom of retinal detachment
- Vitreous traction on retina
- Retinitis.

Micropsia (small size of objects), macropsia (large size of objects) and metamorphopsia (distorted shape of objects).

- Central chorioretinitis.

Coloured halos

- Acute congestive glaucoma
- Early stages of cataract
- Mucopurulent conjunctivitis.

Diplopia**a. Uniocular diplopia**

- Subluxated lens
- Double pupil
- Incipient cataract
- Keratoconus.

b. Binocular diplopia

- Paralytic squint (paralysis of third, fourth or sixth cranial nerve)
- Myasthenia gravis
- Diabetes
- Thyroid disorders
- Blow-out fracture of floor of the orbit
- Anisometropic glass (e.g. uniocular aphakic glass)
- After squint correction in the presence of abnormal retinal correspondence (paradoxical diplopia).

COMMON OCULAR SIGNS AND THEIR CAUSES**CONJUNCTIVA****Conjunctival follicles**

- Trachoma
- Acute follicular conjunctivitis
- Chronic follicular conjunctivitis
- Benign folliculosis.

Conjunctival papillae

- Trachoma
- Spring catarrh
- Allergic conjunctivitis
- Giant papillary conjunctivitis.

Concretions

- Trachoma
- Degenerative conditions
- Idiopathic.

CORNEA**Decreased corneal sensations**

- Herpes simplex keratitis
- Neuroparalytic keratitis
- Leprosy
- Herpes-zoster ophthalmicus
- Absolute glaucoma
- Acoustic neuroma.

Superficial corneal vascularization

- Trachoma
- Phlyctenular keratoconjunctivitis
- Rosacea keratitis
- Superficial corneal ulcers.

Deep corneal vascularization

- Interstitial keratitis
- Deep corneal ulcers
- Chemical burns
- Sclerosing keratitis
- After keratoplasty.

Increased corneal thickness**(corneal thickness is best measured by pachymeter)**

- Corneal oedema.

Abnormal corneal surface (Placido's disc is used to detect smoothness or irregularities of corneal surface)

- Corneal abrasion
- Corneal ulcer
- Keratoconus.

ANTERIOR CHAMBER**Shallow anterior chamber**

- Primary angle closure glaucoma
- Hypermetropia
- Malignant glaucoma
- Postoperative shallow anterior chamber due to
 - Leaking wound
 - Ciliochoroidal detachment
- Corneal perforation
- Intumescent (swollen cataractous) lens
- Iris bombe formation
- Adherent leucoma.

Deep anterior chamber

- Aphakia
- Total posterior synechiae
- Myopia
- Keratoglobus
- Keratoconus

- Anterior dislocation of lens in the anterior chamber
- Posterior perforation of the globe
- Buphthalmos.

Hyphaema

- Ocular injuries
- Post-operative
- Herpes-zoster iritis
- Gonococcal iritis
- Intraocular tumour
- Spontaneous (from rubeosis iridis).

Hypopyon

- Corneal ulcer
- Iridocyclitis
- Retinoblastoma (pseudohypopyon)
- Endophthalmitis
- Panophthalmitis.

IRIS

Nodules on the iris surface

- Granulomatous uveitis (Koeppe's and Busacca's nodules)
- Melanoma of the iris
- Tuberculoma
- Gumma.

Rubeosis iridis (Neovascularization of iris)

- Diabetes mellitus
- Central retinal vein occlusion
- Chronic iridocyclitis
- Sick cell retinopathy
- Retinoblastoma.

Iridodonesis

- Dislocation of lens
- Aphakia
- Hypermature shrunken cataract
- Buphthalmos.

PUPIL

Normal pupil

- Diameter 3 to 4 mm
- In infancy pupil is smaller than at birth
- Myopes have larger pupil than hypermetropes.

Miosis

- Effect of miotic drugs (Parasympathomimetic drugs, e.g. pilocarpine)
- Effect of systemic morphine
- Iridocyclitis (narrow, irregular non-reacting pupil)
- Horner's syndrome

- Head injury (pontine haemorrhage)
- Senile rigid miotic pupil
- During sleep
- Argyll-Robertson pupil
- Poisonings
 - Alcohol
 - Barbiturates
 - Organophosphorus compounds
 - Morphine
 - Carbolic acid
- Hyperpyrexia.

Mydriasis

- Topical sympathomimetic drugs such as adrenaline and phenylephrine
- Topical parasympatholytic drugs such as atropine, homatropine, cyclopentolate, tropicamide
- Acute congestive glaucoma (vertically oval, large, immobile pupil)
- Absolute glaucoma
- Optic atrophy
- Retinal detachment
- Internal ophthalmoplegia
- Third nerve paralysis
- Belladonna poisoning
- Coma
- Sympathetic stimulation
 - Aortic aneurysm
 - Cervical rib
 - Irritative lesions in neck
 - Mediastinal sarcoma, lymphosarcoma, Hodgkin's disease and pulmonary carcinoma
 - Emotional excitement
- Severe anaemia
- Adie's tonic pupil is larger than its fellow.

Leukocoria (white reflex in pupillary area)

- Congenital cataract
- Retinoblastoma
- Persistent hyperplastic primary vitreous
- Retrolental fibroplasia
- Toxocara endophthalmitis
- Coat's disease.

Marcus Gunn Pupil

(In swinging flash light test, the pupil on the diseased side dilates on transferring light to it)

- Optic neuritis
- Optic atrophy
- Retinal detachment
- Central retinal artery occlusion
- Ischemic central retinal vein occlusion.

LENS***Subluxation of lens***

- Trauma
- Marfan's syndrome (superotemporal)
- Homocystinuria (inferonasal)
- Weil-Marchesani syndrome.

RETINA***Cherry red spot***

- Central retinal artery occlusion
- Commotio retinae (Berlin's oedema)
- Taysach's disease
- Niemann-Pick's disease
- Gaucher's disease
- Sialidosis
- Gangliosidosis
- Metachromatic leukodystrophy
- Multiple sulphates deficiency
- Rarely in Krabbe's disease

Macular oedema

- Trauma
- Intraocular operations
- Uveitis
- Diabetic maculopathy.

Superficial retinal haemorrhages

- Hypertensive retinopathy
- Diabetic retinopathy
- Central retinal vein occlusion
- Anaemic retinopathy
- Leukaemic retinopathy
- Retinopathy of AIDS.

Soft exudates (Cotton wool spots) on the retina

They are due to disturbance in axoplasmic flow

- Hypertensive retinopathy
- Retinopathy of toxemia of pregnancy
- Diabetic retinopathy
- Anaemic retinopathy
- DLE, PAN and Scleroderma, SLE
- Leukaemic retinopathy
- Retinopathy of AIDS
- Eale's disease
- Rarely CMV retinitis in AIDS.

Hard exudates on the retina

They are lipid deposits in retina

- Diabetic retinopathy
- Hypertensive retinopathy
- Coat's disease
- Circinate retinopathy.

- Eale's disease
- Old CRVO

Sub-retinal neovascular membrane

- Wet ARMD
- Presumed ocular histoplasmosis syndrome (POHS)
- Angioid streaks
- Choroidal naevus
- Choroidal rupture
- High myopia
- Inappropriate photocoagulation
- Optic disc drusen.

Bull's eye maculopathy

- Chloroquine toxicity
- Cone dystrophy
- Benign concentric annular macular dystrophy
- Batten's disease
- Bardet-Biedl syndrome
- Occasionally Leber's Amaurosis.

Neovascularization of retina

- Diabetic retinopathy
- Eale's disease.
- Sick cell retinopathy
- Central retinal vein occlusion.

Proliferative retinopathy

- Proliferative diabetic retinopathy
- Sick cell retinopathy
- Eale's disease
- Ocular trauma.

Salt and pepper appearance of fundus

- Prenatal rubella
- Prenatal influenza
- Varicella
- Mumps
- Congenital syphilis.

Arterial pulsations at the disc

- Visible arterial pulsations are always pathological
- True pulse waves are seen in:
 - Aortic regurgitation
 - Aneurysm
 - Exophthalmic goitre
- Pressure pulse is seen in:
 - Glaucoma
 - Orbital tumours.

Venous pulsations at the disc

- Visible in 10-20% of normal people
- Absent in papilledema.

Capillary pulsations

- Are seen in aortic regurgitation as a systolic reddening and diastolic paling of the disc.

VISUAL FIELDS**Enlargement of blindspot**

- Primary open-angle glaucoma.
- Papilloedema
- Medullated nerve fibres
- Drusen of the optic nerve
- Juxtapapillary choroiditis.
- Progressive myopia with a temporal crescent.

Peripheral field contraction

- Papillitis
- Papilloedema
- Optic atrophy
- Glaucoma
- Peripheral retinochoroiditis
- Retinitis pigmentosa
- Quinine or salicylate poisoning.

Tubular vision

- Terminal stage of advanced glaucomatous field defect
- Advanced stage of retinitis pigmentosa.

Ring scotoma

- Glaucoma
- Retinitis pigmentosa.

Central scotoma

- Optic neuritis
- Tobacco amblyopia
- Macular hole, cyst, degeneration.

Bitemporal hemianopia

- Central lesions of chiasma
- Pituitary tumours (common)
- Suprasellar aneurysms
- Craniopharyngioma
- Glioma of third ventricle
- Meningiomas at tuberculum sellae.

Homonymous hemianopia

- Optic tract lesions
- Lateral geniculate body lesions
- Lesions involving total fibres of optic radiations
- Visual cortex lesions (usually sparing of macula).

Binasal hemianopia

- Lateral chiasmal lesions
- Distension of third ventricle
- Atheroma of posterior communicating arteries.

Altitudinal hemianopia

- Loss of upper or more rarely lower halves of field from pressure upon the chiasma
- Early loss in upper half of field—intra or extrasellar tumours
- Early loss in lower half of field—suprasellar tumours.

Quadrantic hemianopia

- Homonymous upper quadrantanopia (pie in the sky)—temporal lobe lesions involving lower fibres of optic radiations.
- Homonymous lower quadrantanopia (pie on the floor)—anterior parietal lobe lesions involving upper fibres of optic radiations.
- Quadrantic hemianopia also occurs due to lesions in the occipital cortex involving the calcarine fissure.

OCULAR EXAMINATION TECHNIQUES AND DIAGNOSTIC TESTS**Loupe and lens examination**

- Power of the corneal loupe is +41 DS
- Magnification of image with corneal loupe is 10 X.

Slit-lamp examination

- Slit-lamp was invented by Gullstrand in 1911
- Aqueous flare and keratic precipitates are best demonstrated by slit-lamp examination.

Testing of visual acuity

- Visual acuity in a child below 2 years of age can be tested by:
 - Opto-kinetic nystagmus (OKN)
 - Preferential looking test
 - Pattern visual evoked potential (STYCAR: Sight Testing for Young Children and Retard).
- Two distant points can be visible as separate only when they subtend an angle of one minute at the nodal point.
- Each individual letter of Snellen's test type subtends an angle of 5 minutes at the nodal point. Whereas, each component part of the letter subtends an angle of 1 minute.

Tonometry (Intraocular pressure measurement)

- Schiotz tonometer is an indentation tonometer
- Concept of applanation was introduced by Goldmann in 1954. It is based on Imbert-Fich law
- Applanation tonometers are: Goldmann tonometer, Perkin's tonometer and Pneumatic tonometer

- Applanation tonometer is more accurate than the Schiotz tonometer because factor of scleral rigidity is not involved in the former
- Central corneal thickness influences applanation tonometry (false high reading in thick cornea >600 μm and false low reading in thin cornea <550 μm)
- Normal range of intraocular pressure is 10–21 mm Hg
- Best accuracy with Schiotz tonometer is attained with that weight with which a scale reading of 3–4 is achieved.

Gonioscopy

- Angle structures cannot be examined directly since the light emitted from here undergoes total internal reflection at the anterior surface of the cornea
- Goldmann and Zeiss gonioscopes are indirect goniolenses and provide a mirror image of the opposite angle
- Koeppe goniolens provides a direct view of the angle.

Direct ophthalmoscopy

- It was invented by Babbage in 1848 and reinvented and popularized by von Helmholtz in 1850
- It should be performed from as close to the patient's eye as possible (ideally 15.4 mm)
- Image formed is erect, virtual and 15 times magnified in emmetropes (more in myopes and less in hypermetropes).

Distant direct ophthalmoscopy

- It is performed from a distance of 20–25 cm
- It is useful in detecting opacities in the media of the eye, a hole in the iris, a detached retina and a subluxated lens
- The black shadow produced by an opacity in the pupillary plane remains stationary, that in front of the pupillary plane moves in the direction of the movement of the eyeball and that behind it will move in opposite direction.

Indirect ophthalmoscopy

- It was invented by Nagel in 1864
- In it the examining eye is made myopic by placing a strong convex lens in front of patient's eye
- It is performed from a distance of an arm's length (60–75 cms)
- Image in indirect ophthalmoscopy is formed in the air between the convex lens and examiner's eye and it is real, inverted and about 5 times magnified with +13D lens

- Magnification of the image does not depend upon the refractive error of the observer's eye but depends upon:
 - Power of convex lens used
 - Refractive error of the observed eye and
 - Position of the convex lens in relation to the eye.

Biomicroscopic examination of the fundus

Biomicroscopic examination of the fundus is performed with the help of any of the following:

- –58.6 D Hruby lens
- +78 D or +90 D small diameter lens (Best method for clinical examination of macular lesions)
- Posterior fundus contact lens
- Goldmann's three mirror contact lens

Amsler grid test

Amsler grid is test for macular degeneration and other visual problems.

Perimetry

- *Normal extent of field of vision* for white colour is:

– Superior	:	60°
– Nasal	:	60°
– Inferior	:	70°
– Temporal	:	90°
- *Field of vision* for blue and yellow colour is roughly 10° less and that for red and green colour is about 20° less than that for white (smallest is with green colour)
- *Red colour perimetry* is particularly useful in the diagnosis of bitemporal hemianopia with chiasmal compression and of central scotoma of retrobulbar neuritis
- *Kinetic perimetry* can be performed with Lister's perimeter, Goldmann perimeter and tangent screen
- *Static perimetry* is performed with adapted Goldmann perimeter, Friedmann perimeter and automated perimeter
- *Campimetry* (scotometry) is performed to evaluate the central and paracentral area (30°) of the visual field on Bjerrum's screen.

Fundus fluorescein angiography

- 5 ml of 10 percent solution of sterile sodium fluorescein dye is injected in the antecubital vein
- In the blood fluorescein is readily bound to the albumin
- Blue light (420–490 nm) is used for exciting the fluorescein present in the blood vessels

- Yellow-green filter is used to receive the fluorescent light (510-530 nm) for photography.
- Hyperfluorescence is seen in:
 - Atrophy of retinal pigment epithelium (RPE)
 - Detachment of RPE
 - Central serous retinopathy
 - Cystoid macular oedema
 - Leakage of dye from neovascularization
 - Drusens
 - Papilloedema
- Hypofluorescence is seen in:
 - Retinal haemorrhages
 - Choroidemia
 - Central retinal artery occlusion.

Electroretinography (ERG) and electro-oculography (EOG)

- *Normal ERG* consists of:
 - a-wave is a negative wave possibly arising from the rods and cones
 - b-wave is a large positive wave which is generated by Muller's cells, but represents the activity of bipolar cells
 - c-wave is a positive wave representing metabolic activity of pigment epithelium.

ERG: 3 waves (Pneumonic: RMP)

R: Rods and cones

M: Mullers cells (glial cell)

P: Retinal Pigment

- ERG is abnormal in patients with:
 - Retinitis pigmentosa and other tapetoretinal degenerations
 - Central retinal artery *occlusion*
 - Total retinal detachment
- *ERG is normal in diseases* involving ganglion cells and higher visual pathways, such as optic atrophy
- *EOG is based on* the resting potential of the eye which exists between the cornea (+ve) and back of the eye (-ve)
- *EOG is abnormal* in diseases such as retinitis pigmentosa, vitamin A deficiency, retinal detachment
- *EOG is more sensitive* than ERG in diagnosis of retinitis pigmentosa
- The ratio the voltage (i.e. light peak divided by dark trough) is known as the *Arden ratio*. In practice, the measurement is similar to the eye movement recordings.

Visually evoked response (VER)

- VER refers to electroencephalography (EEG) recorded at the occipital cortex

- VER assesses the functional state of the visual system beyond the retinal ganglion cells
- Flash VER is based on light perception while pattern reversal VER is based on form sense and thus gives a rough estimate of the visual acuity
- Clinically VER is used to:
 - Assess visual acuity in infants and mentally retarded individuals
 - Confirm malingering
 - Confirm optic nerve diseases like retrobulbar neuritis.

Ultrasonography

- Ophthalmic ultrasound is based upon pulse-echo technique employing frequencies in the range of 10 MHz
- A-Scan (Time amplitude) produces unidimensional image echoes plotted as spikes. The distance between the two echo spikes provides an indirect measurement of tissue such as eyeball length, anterior chamber depth and lens thickness
- B-scan (intensity modulation) produces two-dimensional dotted section of the eyeball
- Uses of ultrasound are:
 - Biometric studies using A-scan to calculate power of the intraocular lens to be implanted
 - Assessment of the posterior segment in the presence of opaque media
 - Study of intraocular and intraorbital tumours
 - Ultrasonographic pachymetry (measurement of corneal thickness).

Optical Coherence Tomography (OCT)

- *OCT gives cross-sectional images* of biological tissues within less than 10 μ axial resolution and transverse resolution in 20 μ
- *Specially useful* in retinal disorders, where it is akin to in vivo histopathology of retina
- *Based on interferometry* and low-coherence light in near infrared range
- *Colour coding*: Red yellow colours represent areas of maximal optical reflection and back scattering. Blue-black colours represent area of minimal signals
- *Clinical applications* include: Posterior segment OCT-macular disorder, optic disc disorders especially glaucomatous damage, anterior segment OCT-angle evaluation, pachymetry, pre and post LASIK information, IOL and implant imaging.

Multiple Choice Questions (MCQs)

1. **All of the following are causes of sudden painless loss of vision except:**
 - A. Central retinal artery occlusion
 - B. Optic atrophy
 - C. Optic neuritis
 - D. Retinal detachment
2. **Sudden, transient and painless loss of vision may be complained by the patients with all of the following diseases except:**
 - A. Carotid transient ischaemic attacks
 - B. Papilloedema
 - C. Papillitis
 - D. Migraine
3. **All of the following may be associated with night-blindness except:**
 - A. Pathological myopia
 - B. Retinitis pigmentosa
 - C. Retinitis punctata albescens
 - D. Retinitis proliferans
4. **Flashes of light before the eyes (photopsia) is a feature of:**
 - A. Impending retinal detachment
 - B. Vitreous traction of the retina
 - C. Retinitis
 - D. All of the above
5. **Snellen's test types are based on the fact that two distant points can be visible as separate only when they subtend at the nodal point of the eye an angle of:**
 - A. 1 minute
 - B. 3 minute
 - C. 5 minute
 - D. 2 minute
6. **Assessment of the visual acuity in children below 2 years of age can be made by the following tests, except:**
 - A. Landolt's charts
 - B. Pattern visual evoked potential
 - C. Preferential looking behaviour
 - D. Optokinetic nystagmus
7. **In microcornea, diameter of cornea is less than:**
 - A. 9 mm
 - B. 10 mm
 - C. 11 mm
 - D. 8 mm
8. **Corneal diameter is increased in:**
 - A. Megalocornea
 - B. Keratoglobus
 - C. Keratoconus
 - D. All of the above
9. **Diseased and devitalized epithelial cells of the conjunctiva and cornea are stained with:**
 - A. Fluorescein dye
 - B. Rose Bengal dye
 - C. Alcian blue dye
 - D. All of the above
10. **Corneal sensations are decreased in all of the following conditions except:**
 - A. Recurrent corneal erosion syndrome
 - B. Herpetic keratitis
 - C. Neuroparalytic keratitis
 - D. Leprosy
11. **The aqueous flare is best demonstrated by:**
 - A. Biomicroscope
 - B. Keratoscope
 - C. Pentoscope
 - D. Ophthalmoscope
12. **Photostress test is positive in:**
 - A. Central serous retinopathy
 - B. Optic neuritis
 - C. Ethambutol toxicity
 - D. Central retinal artery occlusion
 - E. All of the above

13. **Indentation tonometer is based on the fundamental fact that a plunger with indent:**
 - A. More in soft eye
 - B. More in hard eye
 - C. Equal in soft and hard eye
 - D. None of the above
14. **All of the following conditions can be diagnosed on distant direct ophthalmoscopy except:**
 - A. Opacities in the refractive media
 - B. A hole in the iris
 - C. A detached retina
 - D. A hole in the macula
15. **All of the following are characteristics of the image formed on direct ophthalmoscopy, except that it is:**
 - A. Erect
 - B. Real
 - C. Fifteen times magnified in emmetropes
 - D. More magnified in myopes than emmetropes
16. **In indirect ophthalmoscopy the examining eye is made:**
 - A. Myopic
 - B. Hypermetropic
 - C. Emmetropic
 - D. None of the above
17. **All of the following are characteristics of the image formed on indirect ophthalmoscopy except that it is:**
 - A. Virtual
 - B. Inverted
 - C. Magnified
 - D. Formed between the convex lens and the observer
18. **Biomicroscopic examination of the fundus is performed with the help of:**
 - A. -58.6 D Hruby lens
 - B. +78 D small diameter lens
 - C. Both of the above
 - D. None of the above
19. **Small opacities in the media of the eye are best detected by:**
 - A. Distant direct ophthalmoscopy
 - B. Direct ophthalmoscopy
 - C. Indirect ophthalmoscopy
 - D. All of the above
20. **Diameter of the optic disc is:**
 - A. 1.5 mm
 - B. 5.5 mm
 - C. 2.5 mm
 - D. 3.5 mm
21. **The normal extent of temporal field of vision for white colour is about:**
 - A. 60°
 - B. 80°
 - C. 90°
 - D. 110°
22. **In colour perimetry the smallest field of vision is with:**
 - A. Green object
 - B. Blue object
 - C. Yellow object
 - D. Red object
23. **Campimetry (Scotometry) is performed in the visual field area of:**
 - A. 50°
 - B. 30°
 - C. 60°
 - D. 90°
24. **Dark adaptation is delayed in all of the following conditions except:**
 - A. Pigmentary retinal dystrophy
 - B. Vitamin A deficiency
 - C. Primary open-angle glaucoma
 - D. Heredomacular degeneration
25. **In electroretinogram (ERG) the b-wave represents the activity of:**
 - A. Rods and cones
 - B. Bipolar cells
 - C. Ganglion cells
 - D. All of the above
26. **In diagnosis of retinitis pigmentosa ERG is:**
 - A. More sensitive than the EOG
 - B. Less sensitive than the EOG
 - C. Equally sensitive as EOG
 - D. None of the above
27. **Visually-evoked response (VER) is useful in the diagnosis of all of the following except:**
 - A. Retinitis pigmentosa
 - B. Retrobulbar neuritis
 - C. Visual potential in eyes with opaque media
 - D. Optic atrophy
28. **For biometric studies of the eyeball best pulse echo technique on ultrasonography is:**
 - A. A Scan
 - B. B Scan
 - C. C Scan
 - D. All of the above
29. **Kayser-Fleischer ring is pathognomonic of:**
 - A. Keratoconus
 - B. Wilson's disease
 - C. Lowe's syndrome
 - D. All of the above

30. Roth's spots are seen in:

- A. Diabetic retinopathy
- B. Chorioretinitis
- C. Subacute bacterial endocarditis
- D. Retinoblastoma

31. Amaurotic cat's eye reflex is seen in:

- A. Papilloedema
- B. Papillitis
- C. Retinoblastoma
- D. Retinitis pigmentosa

32. Thickness of cornea is best measured by:

- A. Keratometer
- B. Pachymeter
- C. Optometer
- D. Pentoscope

33. Landolt's broken ring test is used for testing:

- A. Form sense
- B. Contrast sense
- C. Central field
- D. Scotopic vision

34. White pupillary reflex is seen in:

- A. Retinoblastoma
- B. Complete retinal detachment
- C. Endophthalmitis
- D. All of the above

35. The image in indirect ophthalmoscopy is:

- A. Erect, virtual, magnified
- B. Erect, real, magnified
- C. Inverted, real, magnified
- D. Inverted, virtual, normal

36. Examination of vitreous is best done by:

- A. Direct ophthalmoscope
- B. Indirect ophthalmoscope
- C. Slit-lamp with contact lens
- D. Oblique illumination

37. In retinal artery angiogram, the dye is injected through the:

- A. Peripheral veins
- B. Aorta
- C. Retinal artery
- D. Retinal vein

38. The distance used in distant direct ophthalmoscopy is:

- A. 10 cm
- B. 15 cm
- C. 25 cm
- D. 100 cm

39. Amaurotic cat's eye is not seen in:

- A. Cataract
- B. Cyclitic membrane

- C. Glaucoma
- D. Retrolental fibroplasia

40. Angiography is the investigation of choice in:

- A. Posterior vitreous detachment
- B. Rhegmatogenous retinal detachment
- C. Retinoschisis
- D. Central serous retinopathy

41. Periphery of retina is best visualised with:

- A. Retinoscopy
- B. USG
- C. Direct ophthalmoscopy
- D. Indirect ophthalmoscopy

42. Campimetry is used to measure:

- A. Squint
- B. Angle of deviation
- C. Pattern of retina
- D. Field charting

43. The electroretinogram may assist in the diagnosis of all of the following, except:

- A. Bilateral disease
- B. Progression of retinal disease
- C. Clinically unsuspected disease in familial degenerations
- D. Complications of glaucoma
- E. Differentiation between peripheral and central retinal disease

44. Anomaloscope is used to detect:

- A. Squint
- B. Retinopathy
- C. Congenital glaucoma
- D. Colour blindness

45. Best diagnostic test for Best disease is:

- A. Dark adaptation
- B. ERG
- C. EOG
- D. Gonioscopy

46. Snellen's chart is used to test:

- A. Vision
- B. Refraction
- C. Presbyopia
- D. Colour blindness

47. Retinoscopy is used for visualising the:

- A. Whole retina
- B. Only the peripheral part of the retina
- C. Detecting errors of refraction
- D. None

48. Magnification of direct ophthalmoscopy is:

- A. Five
- B. Ten
- C. Fifteen
- D. Thirty

- 49. Amsler's grid is used in:**
 A. Detecting colour vision
 B. Retinal function test
 C. Maculopathy
 D. Refractive errors
- 50. Not true about macular function test is:**
 A. Two-point discrimination
 B. Maddox rod
 C. Laser interferometry
 D. Retinogram
- 51. All are seen in increased intracranial tension except:**
 A. Macular oedema
 B. Papilloedema
 C. Normal vision
 D. Afferent pupillary defect
- 52. Which of the following is used for treatment of myopia:**
 A. Nd: YAG laser
 B. Excimer laser
 C. Argon laser
 D. Holmium laser
- 53. Visual acuity test is a test of:**
 A. Light sense
 B. Colour sense
 C. Contrast sense
 D. Form sense
- 54. Hutchinson's pupils:**
 A. Seen in syphilis
 B. Unilateral constricted pupil
 C. Irregular pupil
 D. None of the above
- 55. In retinoscopy for refractive error at 1m we add -1D. If done at a distance of 66 cm, the addition factor will be:**
 A. -2D
 B. -1.5 D
 C. -0.5 D
 D. -5 D
- 56. Shallow anterior chamber is seen in all except:**
 A. Old age
 B. Steroid induced cataract
 C. Hypermetropia
 D. Angle-closure glaucoma
- 57. Optical coherence tomography is akin to in vivo:**
 A. Histopathology
 B. Ultrasonic biomicroscopy
 C. Confocal microscopy
 D. Roentgen examination
- 58. Axial resolution in optical coherence tomography is about:**
 A. 10 μ
 B. 30 μ
 C. 100 μ
 D. 300 μ
- 59. Optical coherence tomography is most useful in disorders of:**
 A. Macula
 B. Crystalline lens
 C. Refractive errors
 D. Intraocular tumours
- 60. Area of fundus seen with direct ophthalmoscope is**
 A. 1 DD
 B. 2 DD
 C. 3 DD
 D. 4 DD

EXTRA EDGE QUESTIONS

- 61. Indocyanine green angiography (ICG Angiography) is most useful in detecting:**
 A. Occult choroidal neovascularization (Occult CNV)
 B. Classic choroidal neovascularization (Classic CNV)
 C. Angioid streaks with choroidal neovascularization (CNV)
 D. Polypoidal choroidal vasculopathy
- 62. A wave in ERG is due to activity of:**
 A. Pigmented epithelium
 B. Rods and cones
 C. Ganglion cell
 D. Bipolar cell
- 63. Arden index is related to:**
 A. ERG (Electroretinogram)
 B. EOG (Electroculogram)
 C. VER (Visual evoked response)
 D. Perimetry
- 64. Perimetry is a test to assess the:**
 A. Visual acuity
 B. Intraocular pressure
 C. Visual field
 D. Depth of the anterior chamber
- 65. Sudden painful loss of vision is seen in:**
 A. Angle closure glaucoma
 B. Central retinal artery occlusion
 C. Acute uveitis
 D. Endophthalmitis
 E. Retinal detachment

Quick Text Review

ELEMENTARY AND PHYSIOLOGICAL OPTICS

LIGHT AND GEOMETRICAL OPTICS

- *Light* is the visible portion (400-700 nm) of the electromagnetic spectrum
- *Cornea absorbs* rays shorter than 295 nm. Lens absorbs rays shorter than 350 nm
- *Critical angle* refers to the angle of incidence in the denser medium, corresponding to which angle of refraction in the rarer medium is 90°
- *Image formed* by a prism is virtual, erect and displaced toward its apex
- *Strum's conoid* refers to the configuration of rays refracted through a toric surface.

OPTICS OF THE EYE

- *Total dioptric power* is about +60 D
- *Principal point* lies 1.5 mm behind the anterior surface of cornea
- *Nodal point* is situated 7.2 mm behind the anterior surface of cornea
- *Anterior focal point* is 15.7 mm in front of the anterior surface of cornea
- *Posterior focal point* (on the retina) is 24.4 mm behind the anterior surface of cornea
- *Anterior focal length* is 17.2 mm ($15.7 + 1.5$)
- *Posterior focal length* is 22.9 mm ($24.4 - 1.5$).

Axis of the eye

1. *Optic axis*. It is the line that passes through centre of the cornea, centre of the lens and meets the retina on the nasal side of the fovea.

In practice it is not possible to measure optic axis. Therefore, it is substituted by pupillary line, which is perpendicular to the cornea at center of pupil.

2. *Visual axis*. It is the line joining the fixation point, nodal point and the fovea.
3. *Fixation axis*. It is the line joining the fixation point and the centre of rotation.

Angles of the eye

1. *Angle alpha*. It is formed between the optic axis and visual axis at the nodal point.
2. *Angle gamma*. It is formed between the optical axis and fixation axis at the centre of rotation of the eyeball.
3. *Angle kappa*. It is formed between the visual axis and central pupillary line. A positive angle kappa results in pseudoexotropia and a negative angle kappa in pseudoesotropia.
4. *Visual angle* is the angle subtended by an object at the nodal point.

Refractive power of the eye

• Total	:	+60 D
• Cornea	:	+44 D
• Lens	:	+16 D

Refractive indices of the media of the eye

• Cornea	:	1.37
• Aqueous humour	:	1.33
• Crystalline lens	:	1.39
• Vitreous humour	:	1.33

Refractive indices of the other media

• Air	:	1
• Water	:	1.33
• Tear fluid	:	1.338
• HEMA	:	1.43
• PMMA	:	1.496
• Spectacle, crown glass	:	1.52
• Flint glass	:	1.61
• Diamond	:	2.52

ERRORS OF REFRACTION

EMMETROPIA

- An emmetropic (optically normal) eye is slightly hypermetropic for red rays and myopic for green rays

- At birth, eye is hypermetropic by +2 to +3 D and usually becomes emmetropic by the age of 5 to 7 years.

HYPERMETROPIA

Hypermetropia (long sightedness) is of following types:

- *Axial hypermetropia* due to decreased axial length of the eye ball is the most common cause. One mm decrease in axial length causes three dioptres of hypermetropia.
- *Curvatural hypermetropia* occurs due to flattening of the cornea. One mm increase in the radius of curvature of cornea causes six dioptres of hypermetropia.
- *Index hypermetropia* occurs due to increase in the refractive index of the cortex of the crystalline lens as seen in early cortical cataract and in diabetics
- *Positional hypermetropia* results due to backward displacement of the lens.

Components of hypermetropia

- *Latent hypermetropia*. It is corrected by the ciliary tone. It is detected when refraction is carried out after abolishing the ciliary tone with atropine.
- *Manifest hypermetropia*. It consists of two components.
 - Facultative hypermetropia. It can be overcome by an effort of accommodation.
 - Absolute hypermetropia. It cannot be overcome by an effort of accommodation.
- Fundus changes in hypermetropes, in hypermetropia pseudopapilledema may be seen.

Optical changes in aphakia

- Eye becomes highly hypermetropic
- Total power of eye is reduced from +60 D to +44 D
- Anterior focal point becomes 23.2 mm in front of the cornea
- Posterior focal point is 31 mm behind the cornea
- Loss of accommodation.

Disadvantages of aphakic glasses

- Produce image magnification by 25 to 30 percent
- Pincushion distortion due to spherical aberration is the most frequently noticed problem
- Limited field of vision
- Roving ring scotoma (Jack in the box phenomenon)
- Chromatic aberration.

Intraocular lens in aphakia

- Exact power is calculated by biometry using keratometer and A-scan ultrasound
- Standard power of +20 D of posterior chamber IOL is equivalent to +10 DS spectacles

- All disadvantages of aphakic glasses are eliminated by intraocular lens use
- Average weight of an IOL in air is 15 mg and in aqueous humour is 5 mg
- Power of an IOL in air is more (+ 60D) than that in the aqueous humour (+20D)
- Equivalent power of an anterior chamber IOL is about +3D less than that of the posterior chamber IOL
- Further details of IOL (See page 42).

Surgical treatment of hypermetropia:

- Hyperopic LASIK is effective in correcting hypermetropia up to +4D
- Other corneal procedures includes hyperopic PRK, Holmium laser thermoplasty and conductive keratoplasty (CK)
- Lens based procedures include phakic refractive lenses (PRL) or implantable collamer lenses (ICL) for hyperopia of between >4D to 10D and refractive lens exchange (RLE) for high hyper-metropia especially in the presbyopic age.

MYOPIA

- *Axial myopia*. One mm increase in axial length produces myopia of 3 D.
- *Curvatural myopia*. One mm decrease in radius of curvature of cornea produces myopia of 6 D.
- *Congenital myopia*. Present since birth, usually unilateral, usually the error is of about 8–10 D which mostly remains constant.
- *Simple or developmental myopia*. It is the commonest type of myopia. It does not progress after adolescence and the error usually does not exceed -6 to -8 D.
- *Pathological (degenerative) myopia*. It results from a rapid axial growth of eyeball (posterior to equator) which is strongly linked with heredity since it is familial and more common in certain races (Chinese, Jews, Japanese). Fundus examination may reveal/patches of chorioretinal degeneration, and *Foster-Fuch's spot* (dark circular area due to intrachoroidal haemorrhage at the macula).

Complications of pathological myopia

- Complicated cataract
- Choroidal haemorrhage
- Tears and haemorrhages in the retina
- Vitreous haemorrhage
- Retinal detachment
- Diseases associated with myopia are microphthalmos, congenital glaucoma, microcornea,

retrolental fibroplasia, Marfan's syndrome, Turner's syndrome, and Ehlers-Danlos syndrome.

Surgical treatment of myopia

- *Radial keratotomy*. Multiple radial incisions are given in the periphery of cornea (leaving central 4 mm optical zone) in order to flatten the curvature of cornea (Not done nowadays).
- *Photorefractive keratectomy (PRK)*. In it reshaping of the cornea is done with excimer laser. (Not preferred presently except in patients with thin corneas).
- *Laser assisted in situ keratomileusis (LASIK)* is presently the preferred surgical technique for correcting myopia of up to -8D. In it, the midstromal tissue is ablated with excimer laser after raising a 130-160 micron thick flap of anterior corneal tissue.

Customized (C) LASIK based on the wavefront technology is useful in correcting the aberrations. *Epi (E) LASIK* is done without stromal flap.

- *Femto-LASIK*, also known as 'All Laser LASIK' or 'No blade LASIK', involves making of corneal flap with the help of femtosecond laser.
- *Refractive Lenticule Extracision (ReLEx)* is a technique for myopia correction in which a lenticule of corneal stroma is extracted with the help of femtosecond laser. The technique is now named SMILE (small incision lenticule extraction)
- *Phakic intraocular lenses (PRL)* also known as implantable collamer lenses (ICL) is being performed in myopia of > -8D.
- *Refractive lens exchange (RLE)* i.e. removal of clear crystalline lens by extracapsular cataract extraction (preferably by phacoemulsification) with IOL implantation of appropriate power is being recommended for surgical treatment of myopia of >12D.
- *Orthokeratology* a non-surgical reversible method of molding the cornea with overnight wear unique rigid gas permeable contact lenses, is also being considered for correction of myopia upto -5D. It can be used even in the patients below 18 year of age.

ASTIGMATISM

Depending upon the axis and the angle between the two principal meridians

- *With-the-rule astigmatism*, wherein the vertical meridian is more curved than the horizontal and the two principal meridians are at right angle to each other. Thus, correction of with-the-rule astigmatism will require a concave cylinder at $180 \pm 20^\circ$ or a convex cylinder at $90 \pm 20^\circ$.

- *Against-the-rule astigmatism*. It is just reverse of with-the-rule astigmatism, i.e. here in the horizontal meridian is more curved than the vertical.
- *Oblique astigmatism*. Here in the two principal meridians are at right angle to each other but these are not the horizontal and vertical, e.g. these may be 45° and 135° .
- *Bioblique astigmatism*. In this condition the two principal meridians are not at right angle to each other e.g. these may be 30° and 100° .

Depending upon the type of refractive error

- *Simple astigmatism*. Here in the rays of light are focused on the retina in one meridian and either in front (simple myopic astigmatism) or behind (simple hypermetropic astigmatism) the retina in the other meridian.
- *Compound astigmatism*. In this type light rays are focused in both the principal meridians either in front (compound myopic astigmatism) or behind (compound hypermetropic astigmatism) the retina.
- *Mixed astigmatism*. Here the light rays are focused in front of the retina in one meridian and behind the retina in the other meridian. Thus, eye is myopic in one meridian and hypermetropic in the other. Such patients have comparatively less visual symptoms as circle of least diffusion is formed on the retina.

Irregular astigmatism

- It is seen in patients with irregular corneal scars and keratoconus. In it there are multiple meridians which admit no geometrical analysis.
- It can be best treated by rigid gas permeable contact lens which replaces the anterior surface of cornea for refraction.
- Penetrating keratoplasty is indicated in extensive corneal scarring.

ANISOMETROPIA

In this refractive condition, degree of error is unequal in two eyes.

- *Simple anisometropia*. One eye is emmetropic and the other either myopic or hypermetropic.
- *Compound anisometropia*. Both eyes are either hypermetropic (compound hypermetropic anisometropia) or myopic (compound myopic anisometropia) but error in one eye is higher than the other.
- *Mixed anisometropia*. One eye is myopic and the other hypermetropic.

- *Simple astigmatic anisometropia*. One eye emmetropic and the other has either simple myopic or simple hypermetropic astigmatism.

ANISEIKONIA

In this condition the images projected on to the visual cortex from the two retinæ are abnormally unequal in size and/or shape.

- *Optical aniseikonia* occurs in high anisometropia.
- *Retinal aniseikonia* may develop due to stretching or oedema of the retina in macular area.
- *Cortical aniseikonia* refers to asymmetrical simultaneous perception inspite of equal size of the images formed on the two retinæ.

ACCOMMODATION AND ITS ANOMALIES

ACCOMMODATION

- *Near point or punctum proximum*. It is the nearest point at which small objects can be seen clearly. It varies with age, being about 7 cms at the age of 10 years, 25 cms at 40 years and 33 cms at 45 years.
- *Far point (punctum remotum)*. It is the farthest point from where objects can be seen clearly. In an emmetropic eye far point is infinity, in a hypermetropic eye it is virtual and lies behind the eye, and in myopia it is real and lies in front of the eye.
- *Range of accommodation*. It is the distance between the near point and the far point of an eye.
- *Amplitude of accommodation*. It is the difference between the dioptric power needed to focus at near point and far point. It varies with age, being about 14D at 10 years, 4D at 40 years and 2D at 50 years of age.

PRESBYOPIA

It is not an error of accommodation but a condition of age related physiological insufficiency of accommodation, leading to failing vision for near (usually after the age of 40 years).

Causes of presbyopia

- Decrease in the elasticity and plasticity (hardening) of lens with age.
- Age-related decrease in the power of ciliary muscle.

Causes of premature presbyopia

- Hypermetropia
- Primary open-angle glaucoma
- General debility, causing presenile weakness of ciliary muscle
- Premature sclerosis of the crystalline lens
- Excessive close work.

Surgical treatment of presbyopia

The techniques still under trial are:

- Monovision LASIK
- Presbyopic bifocal LASIK (LASIK - PRAM)
- Anterior ciliary sclerotomy (ACL) with tissue barrier
- Bifocal or multifocal or accommodating IOLs
- Conductive keratoplasty (CK).

DETERMINATION AND CORRECTION OF REFRACTIVE ERRORS

Retinoscopy (Skiascopy or shadow test)

When a plane mirror retinoscope is used at a distance of 1 m, depending upon the movement of the red reflex (shadow) the results are interpreted as below:

- No movement : Myopia of 1 D
- With movement : Either emmetropia or hypermetropia or myopia less than 1 D
- Against movement : Myopia more than 1 D

Auto-refractometry

- Auto-refractometry is an objective method of finding out the error of refraction by using computerized autorefractometers
- These are based on the principle of indirect ophthalmoscopy
- Autorefractometer quickly gives information about the refractive error in terms of sphere, cylinder with axis and inter-pupillary distance
- It is a good alternative to retinoscopy for busy practice, mass screening and epidemiological studies
- Subjective refraction is must even after auto-refractometry.

Tests for confirmation of subjective refraction

- *Duochrome test*. It is based on the principle of chromatic aberration. When red letters are more clear than the green it indicates that patient is slightly myopic.
- *Jackson's cross-cylinder test*. It is used to verify the strength and axis of the cylinder prescribed. The cross cylinder is a combination of two cylinders of equal strength but with opposite sign, placed with their axis at right angles to each other. It is formed by a spherical lens (e.g., +0.5 DS) with a cylinder of the opposite sign and double power (e.g., -1.0 DC).
- *Astigmatic fan test*. It is used to confirm the cylindrical correction. In the presence of astigmatism, some lines will be seen more sharply defined.

- *Pin-hole test.* An improvement in the visual acuity while looking through a pin hole indicates that optical correction in the trial frame is incorrect.

Spectacles

- *Crown glass* of refractive index 1.5223 is most commonly used for making spectacles.
- *Resin lenses* are made of 'allyl diglycol carbonate'. These are light weight, unbreakable and scratch resistant.
- *Meniscus lenses* are used to make spectacles of small to moderate power. Periscopic lenses have a concave posterior surface of -1.2 D. Deep meniscus type lenses have a concave posterior surface of -6 D. Spherical correction added to the anterior surface of the meniscus lenses.
- *Lenticular form lenses* are used for high plus and high minus lenses.
- *Aspheric lenses* are also used to make high power (e.g. aphakic) lenses.

Contact lenses

- *Hard contact lenses* are made up of PMMA (Polymethyl methacrylate) which is a light weight and non-toxic but hydrophobic material, durable, cheap and of high optical quality. *Disadvantages:* can cause corneal hypoxia and corneal abrasions (not used).
- *Soft contact lenses* are made up of presently HEMA (hydroxy ethyl methacrylate) which is hydrophilic. *Advantages:* Being soft and oxygen permeable, they are most comfortable and so well tolerated. *Disadvantages:* These include problems of proteinaceous deposits, getting cracked, limited life, inferior optical quality, more chances of corneal infections and can not correct astigmatism of more than 1 D.
- *Rigid gas permeable (RGP) contact lenses* are classically made up of copolymer of PMMA and silicone containing vinyl monomer and fluoropolymers (which is permeable to O_2).

Advantages are O_2 permeability and their ability to correct astigmatism.

Disadvantages include difficult fitting technique and tolerance problems in early stages.

SOME SALIENT POINTS

- Astigmatism is the most common refractive error.
- Refractive errors are the most common cause of defective visual acuity.
- *Commonest problem associated with aphakic glasses* is pin-cushion distortion.
- *Commonest type of astigmatism* encountered in general population is against-the-rule astigmatism.
- *Curvatural myopia* and hypermetropia occur commonly as a factor of astigmatism.
- The retinal image of the aphakic eye is about a quarter larger than the emmetropic retinal image.
- Pathological curvatural myopia is seen typically in conical cornea.
- Visual angle is the angle subtended by the object at the nodal point.
- Basic principle of stenopaeic slit is pin-hole phenomenon.
- All accommodation is lost in aphakia.
- S, G, H, and B are the easiest letters to recognize on the Snellen chart, whereas L, T, U, V and C are the five most difficult ones.
- The pigment epithelium on the back of the iris and the retinal pigmentary epithelium at the back of the eye absorb radiation of all wavelengths.
- The eye is normally myopic for blue and green rays and hypermetropic for red rays.
- Distant vision is often found to be surprisingly good with mixed astigmatism due to circle of least diffusions.
- *Asthenopia* is worse in lower degree of astigmatism than the higher degrees of astigmatism due to circle of least diffusion.
- *Image jump* occurs with the use of bifocal lenses.

Multiple Choice Questions (MCQs)

1. **Crystalline lens absorbs light rays shorter than:**
 - A. 295 nm
 - B. 350 nm
 - C. 390 nm
 - D. 490 nm
2. **The prism produces displacement of the objects seen through it towards the:**
 - A. Apex
 - B. Base
 - C. Sideways
 - D. None of the above
3. **The critical angle refers to the angle of incidence in the denser medium, corresponding to which angle of refraction in the rarer medium is:**
 - A. Less than 90°
 - B. 90°
 - C. More than 90°
 - D. Equal to angle of incidence
4. **The refractive power of an emmetropic eye is about:**
 - A. +50D
 - B. +55D
 - C. +60D
 - D. +65D
5. **In the media of the eye, highest refractive index is of the:**
 - A. Cornea
 - B. Aqueous humour
 - C. Lens
 - D. Vitreous humour
6. **The anterior focal length of the schematic eye is:**
 - A. 15.7 mm
 - B. 17.2 mm
 - C. 13 mm
 - D. None of the above
7. **The posterior focal point of the reduced eye situated on the retina is how many millimetre behind the anterior surface of cornea:**
 - A. 22.9 mm
 - B. 24.4 mm
 - C. 23 mm
 - D. 21 mm
8. **The optical axis of the eye meets the retina at a point which:**
 - A. Coincides with the fovea centralis
 - B. Is nasal to the fovea centralis
 - C. Is temporal to the fovea centralis
 - D. Is nasal to optic disc
9. **Visual axis of the eye meets the retina at a point which:**
 - A. Coincides with the fovea centralis
 - B. Is nasal to fovea centralis
 - C. Is nasal to optic disc
 - D. Is temporal to fovea centralis
10. **At birth eye is usually:**
 - A. Hypermetropic
 - B. Myopic
 - C. Emmetropic
 - D. Aniseikonic
11. **The most common type of refractive error is:**
 - A. Hypermetropia
 - B. Myopia
 - C. Astigmatism
 - D. None of the above
12. **One millimeter decrease in axial length of the eyeball leads to hypermetropia of:**
 - A. 6 dioptries
 - B. 2 dioptries
 - C. 3 dioptries
 - D. 4 dioptries

- 13. One millimeter increase in the radius of curvature of cornea leads to hypermetropia of:**
 A. 3 dioptres
 B. 4 dioptres
 C. 5 dioptres
 D. 6 dioptres
- 14. In an aphakic eye the anterior focal point from the anterior surface of cornea is about:**
 A. 15 mm
 B. 21 mm
 C. 23 mm
 D. 31 mm
- 15. In an aphakic eye posterior focal point from the back of cornea is about:**
 A. 23 mm
 B. 25 mm
 C. 31 mm
 D. 21 mm
- 16. The standard power of an intraocular lens implanted in the posterior chamber is:**
 A. 18 dioptres
 B. 20 dioptres
 C. 23 dioptres
 D. 25 dioptres
- 17. An aphake wearing aphakic glasses will most commonly notice:**
 A. Pincushion distortion
 B. Spherical aberration
 C. Barrel distortion
 D. Chromatic aberration
- 18. Sturm's conoid refers to configuration of the rays refracted through:**
 A. Concave spherical surface
 B. Convex spherical surface
 C. Toric surface
 D. Irregular surface
- 19. Because of circle of least diffusion, the distant vision is comparatively good in:**
 A. Simple myopic astigmatism
 B. Compound myopic astigmatism
 C. Mixed astigmatism
 D. Compound hypermetropic astigmatism
- 20. A difference in the size of two retinal images which can be well tolerated is:**
 A. 2 percent
 B. 3 percent
 C. 5 percent
 D. 10 percent
- 21. In Against-the-rule astigmatism:**
 A. Vertical meridian is more curved than the horizontal
 B. Horizontal meridian is more curved than the vertical
 C. Both meridia are equally curved
 D. None of the above
- 22. Radial keratotomy corrects myopia by causing:**
 A. Steepening of cornea
 B. Flattening of cornea
 C. Shortening of cornea
 D. Pin-hole effect
- 23. Range of accommodation is the distance between:**
 A. Far point and near point of the eye
 B. The eyes and the near point
 C. The eyes and the far point
 D. The retina and the near point
- 24. Causes of premature presbyopia include all of the following except:**
 A. General debility
 B. Primary open-angle glaucoma
 C. Uncorrected myopia
 D. Premature sclerosis of the lens
- 25. During accommodation, there occurs decrease in the radius of curvature of the:**
 A. Anterior surface of the lens
 B. Posterior surface of the lens
 C. Both surfaces of the lens
 D. None of the above
- 26. Near point of the eye varies with:**
 A. The age of the patient
 B. The static refraction of the eye
 C. Both of the above
 D. None of the above
- 27. Far point of the eye varies with:**
 A. The age of the patient
 B. The static refraction of the eye
 C. Both of the above
 D. None of the above
- 28. Bilateral paralysis of accommodation can occur in patients with:**
 A. Diabetes
 B. Syphilis
 C. Diphtheria
 D. All of the above
 E. None of the above

- 29. During retinoscopy with a plane mirror from a distance of 1 M, no movement of pupillary red reflex with the movement of the mirror indicates:**
- Emmetropia
 - Myopia of 1 D
 - Hypermetropia of less than 1 D
 - All of the above
- 30. The end point of streak retinoscopy is:**
- Neurtalization of the red reflex
 - Streak disappears and the pupil appears completely light or dark
 - Just reversal of the red reflex
 - All of the above
- 31. The fastest acting cycloplegic drug is:**
- Atropine
 - Tropicamide
 - Cyclopentolate
 - Homatropine
- 32. All of the following are true about auto-refractometry except:**
- Quick procedure
 - Gives information about spherical and cylindrical error
 - Measures interpupillary distance
 - Subjective verification of refraction is not required
- 33. While performing duochrome test, if the patient reports that he sees red letters more clear than green, it indicates that he is slightly:**
- Myopic
 - Hypermetropic
 - Presbyopic
 - None of the above
- 34. While performing subjective verification of refraction, the cross cylinder is used to check:**
- Axis of the cylinder to be prescribed
 - Power of the cylinder to be prescribed
 - Both of the above
 - None of the above
- 35. The principle of the stenopaic slit test is based on:**
- Astigmatic fan
 - The circle of least diffusion
 - Pin-hole phenomenon
 - Sturn's conoid
- 36. Preferably presbyopia should be:**
- Fully corrected
 - Under corrected
 - Over corrected
 - None of the above
- 37. Soft contact lenses are made of:**
- Polymethyl methacrylate
 - Hydroxymethyl methacrylate
 - Glass
 - Silicone
 - All of the above
- 38. Consistency of the gas permeable contact lenses is:**
- Hard
 - Soft
 - Semisoft
 - None of the above
- 39. Contact lens is best used in:**
- High myopia
 - Irregular astigmatism
 - Aphakia
 - Regular astigmatism
- 40. Excessive accommodation causes:**
- Hypermetropia
 - Myopia
 - Pseudomyopia
 - Pseudohypermetropia
- 41. Haemorrhage at macular spot in high myopia is called:**
- Lacquer's lines
 - Foster-Fuchs fleck
 - Dalen-Fuchs nodules
 - Berlin's oedema
- 42. Over correction is preferable in:**
- Myopia
 - Presbyopia
 - Hypermetropia
 - Aphakia
- 43. Kappa angle is the angle between the:**
- Pupillary axis and visual axis
 - Visual axis and optical axis
 - Centre of eyeball rotation and line of fixation
 - None of the above is correct
- 44. Alpha angle is the angle between the:**
- Pupillary axis and optical axis
 - Visual axis and optical axis
 - Centre of eyeball rotation and line of fixation
 - None of the above is correct
- 45. Unit of light emitted from a surface is:**
- Lambert
 - Candella
 - Lux
 - Lumen

46. Astigmatism is considered to be:

- A. Spherical aberration
- B. Curvatural ametropia
- C. Axial ametropia
- D. Index ametropia

47. Presbyopia is due to:

- A. Loss of elasticity of lens capsule
- B. Weakness of ciliary muscle
- C. Weakness of suspensory ligament
- D. All of the above

48. The term anisometropia indicates:

- A. Refractive error
- B. Long vision
- C. Short vision
- D. Ageing process

49. Facultative hypermetropes manage to see because of:

- A. Wrinkling of eye
- B. Ciliary muscle contraction
- C. Accommodation
- D. Use of cycloplegics

50. Constantly changing refractive error is seen in:

- A. Traumatic cataract
- B. Diabetic cataract
- C. Morgagnian cataract
- D. Intumescent cataract

51. Maximum refractive power is due to the:

- A. Anterior surface of lens
- B. Posterior surface of lens
- C. Anterior surface of cornea
- D. Posterior surface of cornea

52. The most accepted method for treatment of a myopic with refractive error of 2D is:

- A. Spectacles
- B. Contact lens
- C. Radial keratotomy
- D. Excimer laser

53. Which is the most common complication of high myopia:

- A. Glaucoma
- B. Cataract
- C. Haemorrhage
- D. Retinal detachment

54. Lattice degeneration is seen in:

- A. Myopia
- B. Hypermetropia
- C. Aphakia
- D. Presbyopia

55. The power of reduced eye is:

- A. 17 D
- B. 45 D
- C. 59 D
- D. 66 D

56. Aniseikonia refers to:

- A. Difference in the corneal diameter
- B. Difference in the image size (retinal image)
- C. Difference in the refractive power
- D. Difference in image colour

57. A female patient wants LASIK surgery for her eye. She asks for your opinion. All the following things are suitable for performing LASIK surgery except:

- A. Myopia of 4 diopters
- B. Age of 15 years
- C. Stable refraction for 1 year
- D. Corneal thickness of 600 microns

58. Accommodation is maximum at the age of:

- A. 25 years
- B. 5 years
- C. 14 years
- D. 30 years

59. Image formed by a prism is:

- A. Virtual, erect and displaced towards its apex
- B. Real, erect and displaced towards its base
- C. Real, inverted and displaced towards its apex
- D. Virtual, inverted and displaced towards its base

60. Presently surgical treatment of choice in a 22 year male with - 10D myopia is:

- A. Phakic refractive lens
- B. Refractive lens exchange
- C. Wavefront guided LASIK
- D. LASIK with femtosecond laser

61. Visual axis is:

- A. Center of cornea to retina
- B. Object to fovea
- C. Center of lens to cornea
- D. None

62. Foster's fusch's spots are seen in:

- A. Hypermetropia
- B. Myopia
- C. Astigmatism
- D. None

63. Jack in box scotoma is seen after correction of Aphakia by:

- A. IOL
- B. Spectacles
- C. Contact Lens
- D. None

64. Accommodation is due to:

- A. Relaxation of ciliary muscles
- B. Contraction of ciliary muscles
- C. Contraction of dilator pupillae
- D. None

65. Objective assessment of the refractive state of the eye is termed:

- A. Retinoscopy
- B. Gonioscopy
- C. Ophthalmoscopy
- D. Keratotomy

EXTRA EDGE QUESTIONS**66. Which component of the eye has maximum refractive Index:**

- A. Anterior surface of the lens
- B. Posterior surface of the lens
- C. Centre of the lens
- D. Cornea

67. A 55-years-old male with a limbal scar presents to the ophthalmology clinic with markedly defective vision for near and far. Clinical examination reveals a wide and deep anterior chamber, iridodonesis and a dark pupillary reflex. A vision of 6/6 is achieved with correcting lens of +11D. Which of the following is the most likely diagnosis:

- A. Aphakia
- B. Pseudophakia
- C. Hypermetropia
- D. Posterior dislocation of lens

68. On performing refraction using a plane mirror on a patient who has a refractive error of -3D sphere with -2D cylinder at 90 degree from a distance of 1 metre under no cycloplegia, the reflex would be seen to move:

- A. With the movement in the horizontal axis and against the movement in the vertical axis
- B. With the movement in both the axes
- C. Against the movement in both the axes
- D. With the movement in the vertical axis and against the movement in horizontal axis.

69. A lady want LASIK surgery for her daughter. She asks for your opinion. All the following things are suitable for performing LASIK surgery except:

- A. Myopia of 4 Diopters
- B. Age of 15 years
- C. Stable refraction for 1 year
- D. Corneal thickness of 600 microns

70. Best corrected Visual Acuity is 6/18 of a patient with a corneal scar which improves with pin hole to 6/9. Best explanation is:

- A. Spherical aberration
- B. Myopic astigmatism
- C. Irregular astigmatism
- D. Cataract

71. Maximum refraction takes place between:

- A. Air tear film
- B. Tear film and cornea
- C. Cornea and aqueous
- D. Aqueous lens

Diseases of Conjunctiva

Quick Text Review

CONJUNCTIVITIS

Normal flora of the conjunctiva include coagulase-negative staphylococcus and diphtheroids.

Common causative organisms for different types of conjunctivitis are:

- Purulent (hyperacute conjunctivitis) : *Gonococci, Neisseria meningitides*
- Angular conjunctivitis : *Moraxella-Axenfeld (Haemophilus lacunatum)*
- Swimming pool conjunctivitis (inclusion conjunctivitis) : *Chlamydia trachomatis* serotypes D to K
- Epidemic keratoconjunctivitis : Adenovirus type 8,19
- Acute haemorrhagic conjunctivitis (Apollo conjunctivitis) : Enterovirus type 70
- Beal's conjunctivitis (Pharyngoconjunctival fever) : Adenovirus type 3 & 7
- Egyptian ophthalmia (Trachoma) : *Chlamydia trachomatis* serotype A, B, Ba, C
- Acute membranous conjunctivitis : *Corynebacterium diphtheriae* and *streptococcus haemolyticus*
- Ophthalmia neonatorum : *Gonococci, Chlamydia trachomatis* (D to K), staphylococci, herpes simplex
- Acute follicular conjunctivitis : Adenovirus, Chlamydia oculogenitalis, herpes simplex
- Ophthalmia nodosa : Caterpillar hair.

BACTERIAL CONJUNCTIVITIS

- *Staphylococcus aureus* is the most common cause of bacterial conjunctivitis and blepharoconjunctivitis.
- *Pneumococcal conjunctivitis* is usually associated with petechial subconjunctival haemorrhages.
- *Streptococcus pyogenes* usually produces pseudo-membranous conjunctivitis.
- *Haemophilus influenzae* (*H. aegyptius* or Koch-Weeks Bacillus) classically causes epidemics of mucopurulent conjunctivitis (red-eye).
- *Moraxella-Axenfeld* bacillus is most common cause of blepharoconjunctivitis.
- *Neisseria gonorrhoeae* produce acute purulent conjunctivitis.
- *Corynebacterium diphtheriae* causes acute membranous conjunctivitis.

Acute mucopurulent conjunctivitis

- **Most common** type of acute bacterial conjunctivitis.
- **Common causative organisms:** *Staphylococcus aureus* (commonest), *H. aegyptius* (Koch-Weeks bacillus), pneumococcus and streptococcus.

Acute purulent conjunctivitis

- Commonest causative organism is gonococcus, rarely it may be *Staphylococcus aureus* or pneumococcus.
- May be associated with urethritis and arthritis.
- In gonococcal conjunctivitis, when cornea is not involved, a single IM injection of ceftriaxone 1 gm is effective.
- When cornea is involved a 5 days course of ceftriaxone 1-2 gm daily is needed.

Acute membranous conjunctivitis

- A rare disease, typically caused by *corynebacterium diphtheriae* and occasionally by virulent type of *streptococcus haemolyticus*.

- *Corneal ulceration* is frequent complication. The bacteria may even invade the intact corneal epithelium.
- *Other Complications are:* Symblepharon, trichiasis, entropion, and conjunctival xerosis.

Treatment: Topical penicillin and antidiaphtheric serum (ADS) and I/M injections of penicillin and ADS.

Pseudomembranous conjunctivitis

Acute conjunctivitis with pseudomembrane formation, does not bleed on peeling.

Cause: Severe Adenoviral infection, Ligneous conjunctivitis, Gonococcal conjunctivitis, Auto-immune conjunctivitis, *Streptococcus haemolyticus*, Staphylococci, and low virulent diphtheria infection.

Treatment: Topical antibiotics and anti-inflammatory drugs.

Angular conjunctivitis

Caused by Moraxella-Axenfeld (MA) diplococci, so also called as diplobacillary conjunctivitis.

- Source of infection is usually nasal cavity.
- M.A. bacillus produces proteolytic enzyme which macerates epithelium of the conjunctiva, lid margin and the skin surrounding angles of the eye.

CHLAMYDIAL CONJUNCTIVITIS

Chlamydia lie midway between bacteria and viruses. Like viruses, they are obligate intracellular and filterable, whereas like bacteria they contain both DNA and RNA, divide by binary fission and are sensitive to antibiotics.

Trachoma

- Also called *Egyptian ophthalmia* is caused by *Chlamydia trachomatis*. Serotypes, A,B, Ba and C are associated with hyperendemic (blinding) trachoma.
- *Chlamydia trachomatis* is epitheliotropic and produces intracytoplasmic inclusion bodies called H.P. (Halberstaedter Prowazeke) bodies.
- Most common mode of trachoma spread is through fomites and flies. Reservoir of infection are children with active disease
- Prevalence of trachoma is worldwide (affecting about 500 million people), but is highly prevalent in North-Africa, Middle-East and certain regions of South-East Asia.
- It is responsible for 15-20 percent of the world's blindness. Leading cause of preventable blindness in the world.

- Incubation period varies from 5 to 21 days.
- *Conjunctival reaction in trachoma* is both follicular (conjunctival follicles) and papillary (papillary hyperplasia).
- Herbert follicles refer to typical trachoma follicles present in the limbal area (pathognomic).
- Pathognomic features of trachoma follicles are presence of Leber's cells and areas of necrosis.
- Trachomatous pannus initially is seen in the upper part. In progressive pannus infiltration is ahead of vascularization while in regressive pannus it stops short of limbus.

Herbert's pits: Cicatrized follicles at the superior limbus.

Note: Arlt's line: It is a thick band of scar tissue in the palpebral conjunctiva of the eye, near the lid margin seen in cicatrizing trachoma.

McCallan classification of trachoma

- Stage I (Incipient trachoma)—Hyperaemia of upper palpebral conjunctiva with immature follicles
- Stage II (Established trachoma)—Mature follicles, papillae and progressive pannus
- Stage III (Cicatrizing trachoma)—Conjunctival scarring, Herbert's pit
- Stage IV—Stage of sequelae.

WHO classification (FISTO)

- *Trachomatous inflammation follicular (TF):* Five or more follicles (each bigger than 0.5 mm) on the upper tarsal conjunctiva.
- *Trachomatous inflammation intense (TI):* Inflammatory thickening of the upper tarsal conjunctiva obscures more than half of the normal deep tarsal vessels.
- *Trachomatous scarring (TS):* Scarring on the tarsal conjunctiva.
- *Trachomatous trichiasis (TT):* When at least one eye lash rubs the eye.
- *Trachomatous corneal opacity (CO):* Easily visible corneal opacity present over the pupil.

Sequelae of trachoma

- *Lids:* Trichiasis, entropion, tylosis, ptosis, madarosis, ankyloblepharon.
- *Conjunctiva:* Concretions, pseudocyst, xerosis, symblepharon.
- *Cornea:* Opacity, xerosis, total corneal pannus.

WHO criteria for trachoma elimination

- TF prevalence 5% in 1-9 years children
- TI prevalence 1% per 1000 in total population.

Complication: The only complication of trachoma is corneal ulceration leading to corneal opacity.

Treatment: Topical tetracycline or systemic azithromycin, constitute treatment of choice.

- **Other drugs:** Topical erythromycin eye ointment or topical sulphonamides eye drops or ointment. Systemic tetracycline or erythromycin can also be given if needed.

Adult inclusion conjunctivitis

- Caused by serotypes D to K of *Chlamydia trachomatis*
- Source of infection is urethritis in males and cervicitis in females
- Mode of infection is through contaminated fingers or more commonly through contaminated water of swimming pool (hence the name swimming pool conjunctivitis).

VIRAL CONJUNCTIVITIS

Acute haemorrhagic conjunctivitis

- Caused by picorna viruses (enterovirus type 70)
- Also known as 'Apollo conjunctivitis' or 'epidemic haemorrhagic conjunctivitis (EHC).

Epidemic keratoconjunctivitis (EKC)

- Caused by adenovirus 8 and sometimes by 19
- Acute follicular conjunctivitis associated with preauricular lymphadenopathy
- Superficial punctate keratitis which appears after one week of onset is a distinctive feature of EKC.

Pharyngoconjunctival fever (Beat's conjunctivitis)

- Caused by adenovirus 3 and 7
- Primarily affects children and appears as epidemics
- Acute follicular conjunctivitis associated with pharyngitis, fever and pre-auricular lymphadenopathy.

OPHTHALMIA NEONATORUM

- Bilateral inflammation of conjunctiva occurring during first 30 days of life
- Any discharge or watering from the eyes in the first week of life should arouse its suspicion since tears are not formed till then.

Etiology

- *Gonococcal infection* is most common cause in developing countries
- *Neonatal inclusion conjunctivitis* caused by serotypes D to K of *chlamydia trachomatis* is emerging as the most important cause

- *Staphylococcal/streptococcal* infection
- *Chemical conjunctivitis* induced by silver nitrate or antibiotics used as prophylaxis
- *Herpes simplex infection* by type II virus is a rare cause.

Incubation period

Causative agent	Incubation period
Chemicals	4-6 hours
Gonococcus	2-4 days
Other bacterial	4-5 days
Neonatal inclusion conjunctivitis	5-14 days
Herpes simplex	5-7 days

Drug prophylaxis

Drug prophylaxis for ophthalmia neonatorum includes use of Providine-iodine 2.5% solution, tetracycline eye ointment, erythromycin eye ointment or i.e 1 percent silver nitrate eye drops Crede's method (not used now).

ALLERGIC CONJUNCTIVITIS

Spring catarrh (Vernal keratoconjunctivitis)

- A hypersensitivity reaction to exogenous allergens
- It is thought to be an atopic allergic disorder in many cases, in which there occurs Th2 lymphocyte alteration and secondarily the IgE mediated mechanisms play important role
- More common in boys than girls between 4 and 20 years of age
- Intense itching is a characteristic symptom
- Cobble stone arrangement of papillae on the upper tarsal conjunctiva, Homer Tranta's spots and ropy discharge are pathognomic.
- Palpebral form is more common than bulbar and mixed types.
- Vernal keratopathy occurs in following forms:
 - Punctate epithelial keratitis involving upper cornea
 - Ulcerative vernal keratitis (shield ulcer)
 - Vernal corneal plaques
 - Subepithelial scarring
 - Pseudogerontoxon (Cupids bow)
- Keratoconus may be associated with spring catarrh.

Atopic keratoconjunctivitis (AKC)

- It can be thought of as an adult equivalent of vernal keratoconjunctivitis
- Often associated with atopic dermatitis
- Associations may be keratoconus and atopic cataract (posterior subcapsular).

Giant papillary conjunctivitis (GPC)

- A localised allergic response to a physically rough or deposited surface such as contact lens, prosthesis, leftout nylon sutures
- Papillae are 1 mm or more in diameter.

Phlyctenular keratoconjunctivitis

- Phlycten is a pinkish white nodule (1 to 3 mm in size), surrounded by hyperaemia on the bulbar conjunctiva, usually near the limbus
- It is believed to be a delayed hypersensitivity (type IV-cell mediated) response to endogenous microbial proteins such as: tubercular, staphylococcal (most common), moraxella bacillus, and parasites (worm infestation)
- More common in girls than boys between 3 and 15 years of age
- Corneal involvement (phlyctenular keratitis) may be in the form of scrofulous ulcer, fascicular ulcer and miliary ulcer.

Contact dermoconjunctivitis

A delayed hypersensitivity (type IV) response to prolonged contact with chemicals and drugs, such as, atropine, penicillin, neomycin, soframycin, and gentamicin.

MISCELLANEOUS CONJUNCTIVITIS

Acute follicular conjunctivitis is a feature of:

- Adult inclusion conjunctivitis
- Epidemic keratoconjunctivitis (EKC)
- Pharyngoconjunctival fever (PCF)
- New-castle conjunctivitis
- Acute herpetic conjunctivitis.

Pseudomembranous conjunctivitis is a feature of:

- Severe adenoviral infection
- Ligneous conjunctivitis
- Gonococcal conjunctivitis
- Autoimmune conjunctivitis.

Conjunctivitis associated with skin diseases such as acne rosacea, Stevens-Johnson syndrome, epidermolysis bullosa, and pemphigoid. Ligneous conjunctivitis is a cicatrizing conjunctivitis in which membrane is cast off and recurs again and again.

Ophthalmia nodosa is a granulomatous inflammation of the conjunctiva in response to irritation caused by the retained hair of caterpillar.

Parinaud's oculoglandular syndrome is a group of conditions characterised by unilateral granulomatous conjunctivitis, pre-auricular lymphadenopathy, and fever. Its common causes are cat

scratch disease, tuberculosis, syphilis, lymphogranuloma venereum, sarcoidosis and tularemia.

DEGENERATIONS AND XEROSIS**DEGENERATIVE CONDITIONS****Pterygium**

- It is a combined elastotic degeneration with hyperplasia of the subconjunctival tissue in the form of vascularised granulation tissue.
- Exposure to ultraviolet rays of sunlight is implicated in the etiology.
- Fully developed pterygium has three parts—head, neck and body.
- Deposition of iron seen sometimes in corneal epithelium anterior to advancing head is called *stocker's line*.
- Recurrence after surgical removal is 30-50 percent.
- Measures to reduce recurrence include: transplantation in lower fornix (McReynold's operation) old technique not used now, postoperative beta irradiation, postoperative use of antimitotic drops (mitomycin-C or thioTEPA), and mucous membrane grafts. Conjunctival limbal autograft (CLAU) is the best and preferred method.
- Lamellar keratectomy and lamellar keratoplasty is indicated in recurrent recalcitrant cases.

Concretions

- These are formed due to accumulation of inspissated mucus and dead epithelial cell debris into the conjunctival depressions called *loops of Henle*.
- These are not calcareous deposits.
- Causes are trachoma, age-related degeneration and idiopathic.

CONJUNCTIVAL XEROSIS

Parenchymatous xerosis occurs following cicatricial disorganization of the conjunctiva due to local causes, such as:

- Trachoma
- Diphtheric membranous conjunctivitis
- Stevens-Johnson syndrome
- Pemphigus
- Pemphigoid
- Thermal, chemical or radiational burns of conjunctiva
- Prolonged exposure due to lagophthalmos.

Epithelial xerosis occurs due to hypovitaminosis-A. It typically occurs in children and is characterised by varying degree of conjunctival thickening, wrinkling and pigmentation.

CYSTS AND TUMOURS

- *Commonest cysts* of the conjunctiva are lymphatic cysts and implantation cysts
- *Commonest congenital tumour* of the conjunctiva is epibulbar dermoid
- In *Goldenhar's syndrome* epibulbar dermoid is associated with preauricular skin tag, hemifacial hypoplasia and vertebral anomalies
- *Epithelioma* (epidermoid squamous cell carcinoma) of the conjunctiva usually occurs at limbus
- *Premalignant conditions* of conjunctiva are intraepithelial epithelioma (Bowen's disease), superficial spreading melanoma, lentigomaligna (Hutchinson's freckle)
- *Naevus of Ota* refers to oculodermal melanosis.

SOME SALIENT POINTS

- *Bandage* should not be *applied* in acute catarrhal or mucopurulent conjunctivitis
- *Topical steroids* are contraindicated in acute bacterial conjunctivitis
- *Hyperaemia* is the most conspicuous clinical sign of acute conjunctivitis
- *Unilateral chronic conjunctivitis* should suggest the presence of a foreign body retained in the fornix, trichiasis or inflammation of the lacrimal sac
- *Trachoma and other conjunctival inflammation in the newborn* cannot produce a follicular reaction; because the adenoid layer is devoid of lymphoid tissue until 2-3 months postnatally
- *Preauricular lymphadenopathy* is a feature of viral and chlamydial conjunctivitis which is rarely present in bacterial conjunctivitis, but seldom in allergic conjunctivitis
- *Conjunctival ulceration* should always suggest either the presence of an embedded foreign body or a tuberculous or syphilitic lesion.
- *Epidemic keratoconjunctivitis* is the only serious eye disease known to be transmissible by tonometry.

Multiple Choice Questions (MCQs)

1. **Epidemics of conjunctivitis are known to occur with:**
 - A. Bacterial infections
 - B. Viral infections
 - C. None of the above
 - D. Both of the above
2. **Most common bacteria associated with conjunctivitis is:**
 - A. *Staphylococcus aureus*
 - B. *Streptococcus pneumoniae*
 - C. *Haemophilus influenzae*
 - D. *Neisseria gonorrhoea*
3. **Preauricular lymph nodes may be enlarged in all except:**
 - A. Bacterial conjunctivitis
 - B. Viral conjunctivitis
 - C. Allergic conjunctivitis
 - D. Chlamydial conjunctivitis
4. **Commonest causative organism for angular conjunctivitis is:**
 - A. *Moraxella axenfeld*
 - B. *Klebsiella pneumoniae*
 - C. *Haemophilus influenzae*
 - D. None of the above
5. **Form the normal bacterial flora of the conjunctiva:**
 - A. *Corynebacterium xerosis*
 - B. *E. Coli*
 - C. *Streptococci*
 - D. All of the above
6. **Pathognomic features of trachoma follicle are:**
 - A. Presence of Leber's cells
 - B. Areas of necrosis
 - C. Both of the above
 - D. None of the above
7. **Trachoma inclusion bodies in conjunctival smear are detected by:**
 - A. Giemsa stain
 - B. Iodine stain
 - C. Immunofluorescent staining
 - D. All of the above
8. **Swimming pool conjunctivitis is caused by:**
 - A. *Chlamydia trachomatis*
 - B. *Adenovirus type 8*
 - C. *Picornavirus*
 - D. *Gonococcus*
9. **Acute haemorrhagic conjunctivitis is caused by:**
 - A. Enterovirus
 - B. Adenovirus
 - C. *Pseudomonas*
 - D. *Streptococcus haemolyticus*
10. **Occur in epidemics:**
 - A. Enterovirus conjunctivitis
 - B. Staphylococcal conjunctivitis
 - C. Adenovirus conjunctivitis
 - D. All of the above
 - E. None of the above
11. **Ophthalmia neonatorum is:**
 - A. Inflammation of the conjunctiva occurring in an infant less than 30 days old
 - B. Any discharge/watering from the eye in first week of life
 - C. Always caused by gonococci
 - D. All of the above
12. **Incubation period of gonococcal ophthalmia neonatorum is:**
 - A. 24 hours
 - B. 5-7 days
 - C. 7-10 days
 - D. None of the above

13. Intense itching is pathognomic feature of:

- A. Spring catarrh
- B. Trachoma
- C. Follicular conjunctivitis
- D. Angular conjunctivitis
- E. All of the above

14. Spring catarrh may be associated with:

- A. Anterior subcapsular cataract
- B. Keratoconus
- C. Interstitial keratitis
- D. All of the above

15. Associations of atopic keratoconjunctivitis include all except:

- A. Keratoconus
- B. Atopic cataract
- C. Atopic dermatitis
- D. Interstitial keratitis

16. Giant papillary conjunctivitis occurs as an allergic response to all except:

- A. Contact lens
- B. Intraocular lens
- C. Prosthesis
- D. Nylon sutures

17. All are true about phlyctenular conjunctivitis except:

- A. It is type-IV cell mediated hypersensitivity
- B. Allergens are endogenous as well as exogenous
- C. Incidence is higher in girls than boys
- D. Nodular lesion usually occurs near the limbus

18. Ophthalmia nodosa occurs due to:

- A. Leprotic conjunctivitis
- B. Syphilitic conjunctivitis
- C. Sarcoidosis conjunctivitis
- D. Irritation by hair of caterpillar
- E. All of the above

19. All are known to cause conjunctival xerosis except:

- A. Trachoma
- B. Membranous conjunctivitis
- C. Angular conjunctivitis
- D. Ocular pemphigoid

20. All are known to produce parenchymatous conjunctival xerosis except:

- A. Vitamin A deficiency
- B. Diphtheric membranous conjunctivitis
- C. Trachoma
- D. Stevens-Johnson syndrome

21. Goldenhar syndrome is associated with which prominent ocular manifestation:

- A. Microcornea
- B. Megalocornea
- C. Sclerocornea
- D. Epibulbar dermoids

22. Follicle formation may be seen in all of the following except:

- A. Trachoma
- B. Vernal keratoconjunctivitis
- C. Inclusion conjunctivitis
- D. Epidemic keratoconjunctivitis

23. Acute haemorrhagic conjunctivitis is seen with:

- A. Adenovirus
- B. Staphylococcus
- C. Pneumococcus
- D. Haemophilus

24. Pseudomembranous conjunctivitis is caused by:

- A. Gonococcus
- B. Staphylococcus
- C. Streptococcus
- D. Keratoconjunctivitis sicca

25. Conjunctivitis in newborn is commonly caused by:

- A. Streptococcus
- B. Gonococcus
- C. Pseudomonas
- D. Chlamydia

26. Unilateral conjunctivitis is commonly seen in:

- A. Blepharitis
- B. Vernal conjunctivitis
- C. Dacryocystitis
- D. Trachoma

27. Ligneous conjunctivitis is caused by:

- A. Purulent conjunctivitis
- B. Membranous conjunctivitis
- C. Angular conjunctivitis
- D. Phlyctenular conjunctivitis
- E. Any of the above

28. Horner Tranta's spots are seen in:

- A. Vernal conjunctivitis
- B. Phlyctenular conjunctivitis
- C. Angular conjunctivitis
- D. Follicular conjunctivitis

29. H.P. inclusion bodies in trachoma are seen to be:

- A. Extracellular
- B. Intracytoplasmic
- C. Intranuclear
- D. None

30. Pathognomonic feature of trachoma is:

- A. Bulbar papillae
- B. Palpebral papillae
- C. Bulbar follicles
- D. Palpebral follicles

- 31. "Safe strategy" has been developed for the control of:**
- Conjunctivitis
 - Trachoma
 - Refractive error
 - Ocular trauma
- 32. Subconjunctival haemorrhage can occur in all conditions except:**
- Passive venous congestion
 - Pertusis
 - Trauma
 - High intraocular tension
- 33. Unilateral chronic conjunctivitis may be associated with**
- Habit of smoking
 - Use of uniocular microscope
 - Foreign body retained in the fornix
 - Unilateral aphakia
- 34. Trachoma in a newborn cannot produce follicular reaction because:**
- Antibodies are transferred from mother
 - Adenoid layer is devoid of lymphoid tissue
 - Immunity is not developed
 - Incubation period is one year
- 35. Conjunctival ulceration may suggest:**
- Embedded foreign body
 - Tuberculosis
 - Syphilis
 - Any of the above.
- 36. Commonest congenital tumour of conjunctiva is:**
- Epibulbar dermoid
 - Benign melanoma
 - Papilloma
 - Capillary haemangioma
- 37. Inclusion body conjunctivitis true is all except:**
- Self limiting
 - Present only in infants
 - Occurs while passage from birth canal
 - Caused by chlamydia
- 38. Pathognomonic of trachoma is:**
- Bulbar papillae
 - Palpebral papillae
 - Bulbar follicles
 - Palpebral follicles
- 39. All are seen in stage III trachoma except:**
- Tarsal epitheliofibrosis
 - Trachomatous pannus
 - Herbert's pits
 - Disappearance of Bowman's membrane
- 40. Follicles of a diameter of 5 mm are typically seen in:**
- Pharyngoconjunctival fever
 - Trachoma
 - Drug induced follicular conjunctivitis
 - Ophthalmia neonatorum
- 41. Tetracycline ointment for mass prophylaxis:**
- 0.1%
 - 0.5%
 - 1%
 - 5%
- 42. Spring catarrh is:**
- Type I hypersensitivity reaction
 - Type II
 - Type III
 - Type IV
- 43. Complication of vernal kerato conjunctivitis:**
- Cataract
 - Keratoconus
 - Retinal detachment
 - Vitreous hemorrhage
- 44. Treatment of vernal keratoconjunctivitis includes all except:**
- Steroids
 - Chromoglycate
 - Olopatadine
 - Antibiotics
- 45. The histology of pterygium includes:**
- Elastotic degeneration
 - Epithelial inclusion bodies
 - Precancerous changes
 - Squamous metaplasia of the epithelium
- 46. Subconjunctival cyst is seen in:**
- Toxoplasmosis
 - Cysticercosis
 - Leishmaniasis
 - Chaga's disease.

EXTRA EDGE QUESTIONS

- 47. In the grading of trachoma, trachomatous inflammation-follicular is defined as the presence of:**
- 5 or more follicles in the lower tarsal conjunctiva
 - 3 or more follicles in the lower tarsal conjunctiva
 - 5 or more follicles in the upper tarsal conjunctiva
 - 3 or more follicles in the upper tarsal conjunctiva
- 48. Inclusion conjunctivitis is caused by:**
- Chlamydia trachomatis
 - Chlamydia psittaci
 - Herpes
 - Gonorrhea

31 : B 32 : D 33 : C 34 : B 35 : D 36 : A
37 : B 38 : C 39 : B

40 : B 41 : A 42 : A 43 : B 44 : D 45 : A
46 : B 47 : C 48 : A

49. Features of vernal conjunctivitis are:

- A. Shield ulcer
- B. Horner-Tranta's spots
- C. Papillary hypertrophy
- D. Herbert pits
- E. Pannus

50. Features of vernal keratoconjunctivitis are:

- A. Papillary hypertrophy
- B. Shield's ulcer
- C. Herbert's pits
- D. Trantra's spot
- E. Ropy discharge

51. Topical sodium cromoglycate is used in treatment of:

- A. Phlyctenular conjunctivitis
- B. Vernal catarrh
- C. Subconjunctival haemorrhage
- D. Trachoma

52. A Malnourished child from a poor socioeconomic status, residing in overcrowded and dirty areas present with a nodule around the limbus with hyperemia of surrounding conjunctiva in his left eye. He is also observed to have axillary and cervical lymphadenopathy. Which of the following is the most likely diagnosis:

- A. Phlyctenular conjunctivitis
- B. Foreign body granuloma
- C. Vernal keratoconjunctivitis
- D. Episcleritis

53. Follicular conjunctivitis are found in all except:

- A. Herpes simplex conjunctivitis
- B. Drug induced
- C. Adult inclusion conjunctivitis

- D. Allergic conjunctivitis
- E. Molluscus contagiosum

54. Pterygium all are true except:

- A. Arise from any part of conjunctiva
- B. Can cause astigmatism
- C. Surgery is treatment of choice
- D. UV exposure is risk factor
- E. Stromal defect seen
- F. A connective tissue degeneration

55. Stocker's line is seen in:

- A. Pinguecula
- B. Pterygium
- C. Congenital Ocular Melanosis
- D. Conjunctival epithelial melanosis

56. Neonatal conjunctivitis is caused by all except:

- A. *Gonococcus*
- B. *Chlamydia*
- C. *Aspergillus*
- D. *Pseudomonas*

57. A patient complains of pain in both eyes with congestion. Blurring of vision, photophobia and mucopurulent discharge since one day. Many cases have been reported from the same community. The causative agent is probably:

- A. Adenovirus
- B. Enterovirus 70
- C. Herpes simplex
- D. Hemophilus

58. All are features of Trachoma stage III, except:

- A. Herbert's pits
- B. Pannus
- C. Necrosis in scar
- D. Scar on tarsal conjunctiva

Quick Text Review

CONGENITAL ANOMALIES

Megalocornea

- The horizontal diameter of cornea at birth is 10 mm. The adult size of 11.7 is attained by the age of 2 years.
- Megalocornea is labelled when the horizontal diameter of cornea is of adult size at birth or 13 mm or greater after the age of 2 years. Cornea is clear with normal thickness and normal vision. Megalocornea is often associated with Marfan's syndrome.

Microcornea

- In microcornea, the horizontal diameter is less than 10 mm since birth.
- The condition may occur as an isolated anomaly (rarely) or in association with nanophthalmos (normal small eyeball) or microphthalmos (abnormal small eyeball). Eye is usually hypermetropic.

Congenital cloudy cornea

The conditions responsible can be denoted by the eponym STUMPED as follows:

- Sclerocornea
- Tears in descemet's membrane
- Ulcer
- Metabolic conditions
- Posterior corneal defect
- Endothelial dystrophy
- Dermoid.

KERATITIS

CORNEAL ULCER (ULCERATIVE KERATITIS)

Bacterial corneal ulcer

Commonest causative organisms are *pneumococcus*, others are *Staphylococcus*, *pseudomonas* and *gonococcus*.

Pathogens which can invade the normal intact corneal epithelium are: *Neisseria gonorrhoea*, *Neisseria meningitis*, *Corynebacterium diphtheriae*, *Listeria* and *Haemophilus*.

Commonest organisms/etiological agents responsible for different corneal ulcers are:

- Hypopyon corneal ulcer : *Pneumococcus*
- Mycotic corneal ulcer : *Aspergillus fumigatus*
- Marginal corneal ulcer (Catarrhal corneal ulcer) : Koch-Weeks bacillus (*Haemophilus aegyptius*)
- Typical dendritic corneal ulcer : Herpes simplex virus
- Very rapidly progressive sloughing corneal ulcer : *Pseudomonas*
- Ulcus serpens : *Pneumococcus*
- Fascicular ulcer : Phlyctenulosis
- Atheromatous ulcer : Degenerative change in old leucoma

Hypopyon corneal ulcer

- *Staphylococci*, *Streptococci*, *Gonococci* and *Moraxella* may produce hypopyon; but by far the most dangerous are *Pseudomonas pyocyanea* and the *Pneumococcus*
- Characteristic hypopyon ulcer caused by *Pneumococcus* is called *ulcus serpens* which has a tendency to creep over the cornea
- Commonest cause of failure in treatment is secondary glaucoma.

Mycotic corneal ulcer

- **Common causative** fungi are *Aspergillus* (most common), *Candida* and *Fusarium*
- **Common mode of infection** is injury by vegetative material, e.g. thorn, branch of a tree, etc.

- *Injudicious use of antibiotic and steroids* increase the incidence of fungal infections
- *Typical fungal ulcer* is dry looking, greyish white with finger-like extensions into the surrounding stroma under the intact epithelium. A sterile immune ring (Immune ring of Wessely) and multiple satellite lesions are characteristic. Usually a big hypopyon (pseudohypopyon) which is non-sterile, infective presents even if the ulcer is very small. Corneal vascularization is conspicuously absent.
- *Drug of choice for filamentous infections* is natamycin and for Candida is Amphoterecin B (0.15%).

Herpes simplex corneal ulcer

Herpes simplex virus (HSV) is a DNA virus. Ocular infection is more common with HSV-1 and rare with HSV type II

Primary ocular herpes occurs in non-immune children. Lesions are vesicles of skin of the lids, acute follicular conjunctivitis. Fine or coarse punctate epithelial keratitis occurs in 50 percent cases

Recurrent ocular herpes is caused by periodic reactivation of virus (which lies dormant in the trigeminal ganglion) by following precipitating stimuli: Fever such as malaria or flu, general ill health, exposure to ultraviolet rays (sunlight), immunocompromised patients, e.g. in AIDS, and excessive use of topical or systemic steroids

Lesions of recurrent ocular herpes are:

- *Punctate epithelial keratitis* is initial lesion
- *Dendritic ulcer* is pathognomonic lesion
- *Geographical (amoeboid) ulcer* is formed when branches of dendritic ulcer enlarge and coalesce
- *Disciform keratitis* is a delayed hypersensitivity reaction to HSV antigen, characterised by a focal disc-shaped patch of stromal oedema without necrosis
- *Metaherpetic ulcer* is a sterile trophic ulceration which occurs due to healing defect at the site of previous herpetic ulcer.

Antiviral drugs effective against HSV are:

- *5-iodo-2 deoxyuridine (IDU)* - 1 percent drops 1 hourly during day and 2 hourly at night
- *Trifluorothymidine (TFT)* - 1 percent drops 2 hourly
- *Acyclovir* - 3 percent ointment 5 times a day. It is the only drug effective in stromal keratitis.

Herpes zoster ophthalmicus

- *Varicella-zoster virus* is a neurotropic DNA virus which produces acidophilic intranuclear inclusion bodies

- *Herpes zoster virus* is the most common virus causing the corneal ulcer
- *Lesions* are strictly limited to one side of the midline of the head
- *Frontal nerve* is more frequently affected than the lacrimal and nasociliary
- *Cutaneous lesions* in the area of distribution of the involved nerve appear after 3–4 days of onset of disease
- *Ocular lesions* occur in 50 percent cases
- *Hutchinson's rule* which implies that ocular involvement is frequent if the side or tip of the nose presents vesicles is useful but not infallible
- *Superficial punctate epithelial keratitis* is the most common feature
- *Nummular keratitis* may occur as multiple tiny granular deposits surrounded by a halo of stromal haze
- *Iridocyclitis* occurs in 50 percent cases of Zoster keratitis
- *Neuroparalytic keratitis* occurs as a complication of Gasserian ganglion destruction
- *Episcleritis and scleritis* occur in 50 percent cases
- *Palsy of 3rd, 6th and 7th cranial nerve* may occur in severe infection
- *Optic neuritis* occurs in 1 percent cases
- *Post-herpetic neuralgia* may persist for months or years
- *Oral acyclovir* 800 mg 5 times a day × 10 days is effective
- *Systemic steroids* are indicated in cranial nerve palsies and optic neuritis.

Acanthamoeba keratitis

- *Acanthamoeba* is found in soil, fresh water, well water, sea water, sewage and air.
- Occurs both in immunocompetent and immunosuppressed
- *Keratitis* is more common in contact lens wearers using home-made saline
- *Severe pain*, out of proportion to the degree of inflammation is typical feature
- Typical lesions are central or paracentral ring shaped stromal infiltrates with overlying epithelial defects with associated radial keratoneuritis
- *KOH and lactophenol cotton blue* stained film may demonstrate cysts
- *Culture medium*: Non-nutrient agar with *E.coli* and does not depend on host for completion of life cycle.
- *Treatment* consists of 0.1 percent propamidine isethionate (Brolene) and neomycin eye drops. Keratoplasty is required in resistant cases.

Neuroparalytic keratitis

- Occurs due to paralysis of sensory nerve supply of the cornea. Most typically as a result on 5th nerve paralysis and as a result of radical treatment of trigeminal neuralgia
- Typical features are absence of pain, lacrimation and complete loss of corneal sensations.

Exposure keratitis

- It occurs in conditions producing lagophthalmos such as extreme proptosis, facial nerve palsy, coma, overcorrection of ptosis, etc.
- Initial dessication due to exposure occurs in the interpalpebral area leading to fine punctate epithelial keratitis followed by frank ulceration and vascularization.

Rosacea keratitis

- *Rosacea*, a disease of sebaceous glands of the skin, occurs in elderly women as facial eruptions
- *Ocular lesions* include blepharoconjunctivitis, acne rosacea keratitis, corneal vascularization and iritis in severe cases
- *Treatment* consists of topical steroids and systemic tetracycline.

Mooren's ulcer

(Chronic serpiginous or rodent ulcer)

- *Exact etiology* is not known, probably it is an autoimmune disease
- *Typical ulcer* is a shallow furrow with whitish overhanging edge, vascularized base accompanied by severe pain
- *Immunosuppression* with cyclosporin is useful.

Non-healing corneal ulcer

Local causes

- Raised intraocular pressure
- Misdirected cilia
- Large concretions
- Chronic dacryocystitis
- Impacted foreign body
- Lagophthalmos
- Inadequate therapy
- Wrong therapy.

General causes

- Diabetes mellitus
- Severe anaemia
- Malnutrition
- Vitamin-A deficiency
- Immunocompromised patients.

SUPERFICIAL PUNCTATE KERATITIS

Characterised by multiple spotty lesions in superficial layers of cornea associated with acute pain, photophobia and lacrimatoxin.

Etiology of SPK includes: Viral infections, chlamydial infections, toxic due to *Staphylococcal* toxins, exposure keratitis and neuroparalytic keratitis, allergic lesions, keratoconjunctivitis sicca, Thygeson's SPK, and photophthalmia.

Treatment: Topical weak steroids have suppressive effect.

Photophthalmia

Superficial punctate keratitis which occurs due to effect of ultraviolet rays (especially 290–311 nm) associated with exposure to:

- Naked arc light, as in industrial welding and cinema operators
- Bright light of short circuiting
- Reflected ultraviolet rays from snow surface (snow blindness)

Characteristic features are severe burning pain, lacrimation, marked photophobia and blepharospasm occurring 4–5 hours after exposure to the ultraviolet rays.

Superior limbic keratoconjunctivitis

- Occurs with greater frequency in female patients with hyperthyroidism.
- Conjunctiva in region of superior limbus and adjoining parts of bulbar and tarsal conjunctiva are congested. Cornea shows superficial punctate keratitis which stains both with fluorescein and rose bengal.

Thygeson's superficial punctate keratitis

- It is a chronic, recurrent, bilateral, superficial keratitis characterised by coarse punctate epithelial lesions (snow flake)
- Each lesion is a cluster of heterogeneous granular grey dots.

Filamentary keratitis

- *Superficial punctate keratitis associated with formation of epithelial filaments* which are freely movable over the cornea, firmly attached at the base and stain both with fluorescein and rose bengal
- *Common causes are:* Keratoconjunctivitis sicca, superior limbic keratoconjunctivitis, prolonged patching, following epithelial erosions as in herpes simplex, Thygeson's keratitis, recurrent corneal erosion syndrome and trachoma.

INTERSTITIAL KERATITIS

An inflammation of the corneal stroma without primary involvement of the epithelium or endothelium.

Common causes are syphilis, tuberculosis, Cogan's syndrome, trypanosomiasis, malaria, leprosy, and sarcoidosis.

Syphilitic (leutic) interstitial keratitis

- Ninety percent cases are associated with congenital syphilis
- In congenital syphilis, manifestations are usually bilateral and develop between 5 and 15 years of age
- In acquired syphilis, manifestations are usually unilateral
- Interstitial keratitis may occur alone or as a part of *Hutchinson's triad* which also includes: Hutchinson's teeth and vestibular deafness
- Disease is a result of antigen-antibody reaction
- Ground glass appearance of cornea and 'Salmon patches' are typical features
- After healing, corneal opacities and ghost vessels are left behind.

Tubercular interstitial keratitis

- It is more frequently unilateral and sectorial.

Cogan's syndrome

It comprises interstitial keratitis of unknown etiology, acute tinnitus, vertigo and deafness typically occurring in middle-aged adults. It is often bilateral.

DEGENERATIONS, DYSTROPHIES AND ECTATIC CONDITIONS

CORNEAL DEGENERATIONS

Arcus senilis

- Annular lipid infiltration of corneal periphery is seen in elderly people. The ring of opacity is separated from the limbus by a clear zone (lucid interval of vogt)
- Most commonly encountered peripheral corneal opacity.

Arcus juvenilis

- Condition similar to arcus senilis occurring in young persons (below 40 years of age).

Calcific degeneration (Band keratopathy)

- Characterised by deposition of calcium salts in Bowman's membrane and most superficial part of stroma
- It is associated with chronic uveitis in adults, children with Still's disease, phthisis bulbi, chronic glaucoma, chronic keratitis, and ocular trauma

- *Presents as* band-shaped opacity in the interpalpebral area
- Surface of the opaque band is stippled due to holes in the calcium plaques in the area of nerve canals of Bowman's membrane
- *Treatment* consists of chemical removal of calcium salts with 0.01 molar solution of EDTA. Phototherapeutic keratectomy (PTK) with excimer laser is very effective in clearing the cornea.

Salzmann's nodular degeneration

- *Occurs* in eyes with recurrent attacks of phlyctenular keratitis, rosacea keratitis or trachoma
- *Cornea shows* one to ten bluish white nodules arranged in a circular fashion, due to deposition of hyaline plaques between epithelium and Bowman's membrane.

Spheroidal degeneration (climatic droplet keratopathy)

- *Occurs* in men who work outdoors, especially in hostile climates. Its occurrence has been related to exposure to ultraviolet rays and/or ageing.
- *Cornea shows* amber-coloured spheroidal granules accumulated at the level of Bowman's membrane and anterior stroma in the interpalpebral area.

CORNEAL DYSTROPHIES

Classification

1. *Anterior dystrophies* (superficial dystrophies), primarily affecting epithelium and Bowman's layer:
 - Epithelial basement membrane dystrophy
 - Reis-Bückler's dystrophy
 - Meesman's dystrophy
 - Recurrent corneal erosion syndrome
 - Stocker-Halt dystrophy.
2. *Stromal dystrophies*
 - Granular (Groenouw's type I) dystrophy
 - Lattice dystrophy
 - Macular (Groenouw's type II) dystrophy
 - Crystalline (Schnyder's dystrophy).
3. *Posterior dystrophies*, affecting primarily the corneal endothelium and Descemet's membrane:
 - Cornea guttata
 - Fuchs' epithelial endothelial dystrophy (late hereditary endothelial dystrophy)
 - Posterior polymorphous dystrophy of Schlichting
 - Congenital hereditary endothelial dystrophy (CHED).
4. *Ectatic dystrophies*
 - Keratoconus (anterior)
 - Posterior keratoconus
 - Keratoglobus.

Autosomal dominant dystrophies

- Lattice dystrophy is the most common stromal corneal dystrophy (lattice type 1)
- Granular dystrophy
- Fleck dystrophy
- Meesmann dystrophy
- Reis-Bückler dystrophy
- Avellino dystrophy.

Autosomal recessive dystrophies

- Macular dystrophy: Least common stromal dystrophy
- Lattice type 3.

Salient points

- *Cogan's microcystic dystrophy* is the most common of all corneal dystrophies seen in working-age adults.
- *Reis-Bückler's dystrophy* primarily involves Bowman's membrane.
- In *macular dystrophy*, acid mucopolysaccharides are deposited in the cornea.
- *Cornea guttata* may occur independently or as a part of early stage of Fuchs' dystrophy.
- Primary open-angle glaucoma is a common association of *Fuchs' dystrophy*.
- *Epithelial basement membrane* dystrophy is the most common anterior corneal dystrophy
- *Fuch's endothelial dystrophy* is the most common posterior endothelial dystrophy.
- *Posterior polymorphous dystrophy*. It is dominantly inherited and is associated with corectopia (abnormal location of pupil).

ECTATIC CONDITIONS OF CORNEA

Keratoconus

Non-inflammatory ectatic condition of cornea giving it a conical shape with resultant irregular myopic astigmatism. It is usually bilateral (85%). It is more common in girls after puberty.

Classification: Morphologically divided into:

- a. Nipple cone (5 mm)
- b. Oval cone (5-6 mm) displaced inferotemporally
- c. Globus cone (>6 mm) may involve over 75% of cornea.

Its important signs and symptoms are:

- *Impaired vision* due to progressing myopia and irregular astigmatism.
- *Munson's sign* i.e., localised bulging of lower lid when patient looks down, is positive in late stages.
- *Vogt's Striae*: Stress lines parallel to sleep axis of cornea
- *Increased visibility of nerves*: It is due to thinning of the cornea and not due to thickening of nerves
- *Reduced corneal sensation*

- *Hurricane keratopathy*: Whorl pattern of SPK due to effect of contact lens
- *Fleischer's ring* seen at the base of cone is perhaps due to hemosiderin deposition in epithelium
- *Applanation tonometry*: Pulsation of mires is visible due to thin cornea
- *An annular dark shadow* is seen on distant direct ophthalmoscopy
- *Scissors reflex* on retinoscopy
- *Irregular astigmatism* on keratometry
- *Irregularity of circles* on placido disc examination
- *Acute hydrops*: Sudden hydration of corneal stroma due to rupture of Desemet's membrane.
- *Corneal topography* makes early diagnosis.

Keratoglobus

- It is a familial and hereditary (autosomal recessive) bilateral congenital disorder characterised by thinning and hemispherical protrusion of the entire cornea
- It should be differentiated from buphthalmos where increased corneal size is associated with raised intraocular pressure, angle anomaly and cupping of the disc.

MISCELLANEOUS AND SYMPTOMATIC CONDITIONS

MISCELLANEOUS KERATOPATHIES

Vortex keratopathy

- Also called *cornea verticillata*
- *Characterised by* bilateral, symmetrical, grayish or golden corneal epithelial deposits
- *Occurs* in patients taking chloroquine, amiodarone, amodiaquine, meperidine, indomethacin, chlorpromazine and tamoxifen. Also seen in patients with Fabry's disease (glycolipidosis).

Crystalline keratopathy

Chrysiasis refers to deposition of gold in corneal stroma following prolonged administration in patients with rheumatoid arthritis.

Cystinosis refers to widespread deposition of cysteine crystals in conjunctiva, cornea, iris, lens and retina. A hereditary disorder (autosomal recessive) leading to defect in its lysosomal transport.

Monoclonal gammopathy refer to deposition of crystal in corneal epithelium and stroma seen in patients with:

- Multiple myeloma
- Waldenstrom's macroglobulinemia
- Lymphoma.

SYMPTOMATIC CONDITIONS OF CORNEA

Vascularization of cornea

Superficial corneal vascularisation

- The vessels are arranged in an arborizing pattern, present below the epithelial layer and their continuity can be traced with the conjunctival vessels.
- Causes: Trachoma, phlyctenular kerato-conjunctivitis, superficial corneal ulcers, contact lens user, cornea graft rejection and rosacea keratitis.

Deep corneal vascularisation

- The vessels are derived from the anterior ciliary arteries and lie in the corneal stroma. These vessels are usually straight, not anastomosing and their continuity cannot be traced beyond the limbus.
- Causes: Interstitial keratitis, disciform keratitis, deep corneal ulcer, chemical burns, sclerosing keratitis and corneal graft.

Corneal Opacity

- *Nebular corneal opacity* is a faint opacity resulting from superficial scars involving Bowman's layer and superficial stroma. A nebular opacity covering the pupil produces more discomfort and blurring of vision (owing to irregular astigmatism) than a leucoma which completely cuts off the light rays.
- *Adherent leucoma* is a leucomatous opacity in which iris tissue is incarcerated. It results following corneal perforation.
- *Kerectasia* refers to bulged-out thin corneal scar.
- *Anterior staphyloma* is bulging out of ectatic opaque cornea (pseudocornea) with iris tissue plastered behind it. Pseudocornea is a scar formed from organized exudates and fibrous tissue covered with epithelium. It results following total sloughing of the cornea.

SOME SALIENT POINTS

- *Rheumatoid arthritis* is the most common collagen vascular disorder to affect the peripheral cornea
- The most common ocular complication of SLE is punctate epithelial keratopathy
- *Staphylococcus aureus* is the commonest organism responsible for corneal ulceration

- *Pseudomonas* is the most common organism causing keratitis/corneal ulcer in a contact lens wearers
- *Macular dystrophy* is the least common corneal dystrophy in clinical practice
- Pseudocornea has only two layers—the connective tissue lined with epithelium
- Poor antigenicity of corneal stroma is due to avascularity, sparse cell count and separation of cells by ground substance
- *Lamellar keratoplasty* is the treatment of choice for Mooren's ulcer
- Therapeutic keratoplasty is the treatment of choice for impending corneal perforation
- In Keratoconus, the cone is situated just below the centre of the cornea
- *Pachymetry* refers to measurement of corneal thickness
- *Specular microscopy* is useful for study of endothelial cells
- *Keratometry* is measurement of corneal curvature
- *Corneal topography* is the study of corneal shape
- *Deep anterior lamellar keratoplasty* (DALK) is indicated where endothelium and Descemet's membrane are normal e.g., keratoconus
- *Descemet's striping endothelial keratoplasty* (DSEK) is indicated where only endothelium is defective e.g., post-operative endothelial decompensation.
- *Enlarged corneal nerves* are seen in Herpes simplex keratitis, MEN 2B, keratoconus, neurofibromatosis, leprosy, advanced age, keratoconjunctivitis sicca, congenital glaucoma and trauma.
- *Photorefractive keratometry (PRK)* causes ablation of the superficial layers of the cornea resulting in flattening of the anterior cornea to reduce myopia, so it can also be used to remove superficial corneal opacities such as those associated with band keratopathy and treat superficial corneal disease such as recurrent corneal erosions.
- *Pigment deposition in cornea* is of two types: Superficial (Amiodarone, chloroquine, indomethacin) and stromal (phenothiazine).
- *Cornea Verticillata* are asymptomatic, whorl like opacities in the corneal epithelium seen in patients on long term medication such as amiodarone, chloroquine, indomethacin, phenothiazine and reversible on stopping drugs. It is also seen in disease like Fabry's disease.

Multiple Choice Questions (MCQs)

1. **The organism which can invade the intact corneal epithelium and produce purulent corneal ulcer is:**
 - A. Neisseria meningitidis
 - B. Pseudomonas pyocyanea
 - C. Pneumococcus
 - D. Streptococcus haemolyticus
2. **Hypopyon ulcer may be produced by:**
 - A. Pneumococcus
 - B. Pseudomonas
 - C. Gonococcus
 - D. All of the above
3. **Ulcus serpens is caused by:**
 - A. Pneumococcus
 - B. Pseudomonas
 - C. Gonococcus
 - D. All of the above
4. **All are the causes of a non-healing corneal ulcer except:**
 - A. Raised intraocular pressure
 - B. Associated iridocyclitis
 - C. Chronic dacryocystitis
 - D. Diabetes mellitus
5. **Marginal catarrhal corneal ulcer is caused by:**
 - A. Staphylococcus
 - B. Moraxella
 - C. Haemophilus
 - D. All of the above
6. **Satellite lesions in the cornea may be seen in:**
 - A. Fungal corneal ulcer
 - B. Bacterial corneal ulcer
 - C. Viral corneal ulcer
 - D. None of the above
7. **Immune ring in the cornea is a feature of:**
 - A. Bacterial corneal ulcer
 - B. Fungal corneal ulcer
 - C. Ring ulcer of the cornea
 - D. Disciform keratitis
8. **Viral infections usually cause:**
 - A. Conjunctivitis
 - B. Kerato conjunctivitis
 - C. Keratitis
 - D. Blepharo conjunctivitis
9. **Is not the clinical presentation of herpes simplex keratitis:**
 - A. Diffuse stromal necrotic keratitis
 - B. Punctate epithelial keratitis
 - C. Disciform keratitis
 - D. Nummular keratitis
10. **Ocular complications in herpes zoster ophthalmicus usually appear:**
 - A. At the subsidence of skin eruptions
 - B. Simultaneous with cutaneous lesions
 - C. Two days after the skin eruptions
 - D. During stage of erythematous skin lesions
11. **Secondary glaucoma in early stage of herpes zoster ophthalmicus occurs due to:**
 - A. Trabeculitis
 - B. Iridocyclitis
 - C. Haemorrhagic hypopyon
 - D. Hypersecretion of aqueous humour
 - E. All of the above
12. **Systemic acyclovir in herpes zoster is useful:**
 - A. When started immediately after the onset of rash
 - B. For post-herpetic neuralgia
 - C. For ocular lesions only
 - D. All of the above
13. **Systemic corticosteroids in herpes zoster ophthalmicus are indicated when associated with:**
 - A. Facial nerve palsy
 - B. Optic neuritis
 - C. Post-herpetic neuralgia
 - D. All of the above

- 14. The nerve which is most frequently involved in herpes zoster ophthalmicus is:**
 A. Frontal nerve
 B. Nasociliary nerve
 C. Lacrimal nerve
 D. Facial nerve
- 15. Hutchinson's rule in relation to herpes zoster ophthalmicus:**
 A. Implies that ocular involvement is infrequent if the side or tip of the nose presents vesicles
 B. Is based on involvement of nasociliary nerve
 C. Is 100 percent predictor of ocular involvement
 D. All of the above
- 16. Radial keratoneuritis is a feature of:**
 A. Acanthamoeba keratitis
 B. Herpes zoster keratitis
 C. Neuroparalytic keratitis
 D. All of the above
- 17. Exposure keratitis is not associated with:**
 A. 7th nerve paralysis
 B. 5th nerve paralysis
 C. Symblepharon
 D. Ectropion
- 18. All are features of rosacea keratitis except:**
 A. Corneal vascularisation
 B. Associated blepharoconjunctivitis
 C. Central superficial ulcer
 D. Progresses to involve the whole cornea
- 19. All are true for Mooren's ulcer except:**
 A. Peripheral ulcerative keratitis
 B. Advancing edge is undermined
 C. Perforation is common
 D. Floor of ulcer is quickly vascularised
- 20. Photo-ophthalmia results from exposure to:**
 A. Ultraviolet rays
 B. Infrared rays
 C. b-irradiation
 D. All of the above
- 21. In photophthalmia site of lesions is:**
 A. Cornea
 B. Retina
 C. Optic nerve
 D. All of the above
- 22. Filamentary keratitis may occur:**
 A. In trachoma
 B. In kerato conjunctivitis sicca
 C. Following cataract surgery
 D. All of the above
- 23. Hutchinson's triad includes all except:**
 A. Interstitial keratitis
 B. Hutchinson's teeth
 C. Vestibular deafness
 D. Flat nose bridge
- 24. Interstitial keratitis may be associated with:**
 A. Congenital syphilis
 B. Malaria
 C. Sarcoidosis
 D. All of the above
- 25. Commonest causative organism of corneal ulcer is:**
 A. Pneumococcus
 B. Staphylococcus
 C. Streptococcus
 D. Fungi
- 26. Metabolically active corneal layer is:**
 A. Epithelium
 B. Stroma
 C. Descemet's membrane
 D. None of the above
- 27. Fascicular ulcer is seen in:**
 A. Phlyctenular keratitis
 B. Rosacea keratitis
 C. Riboflavin deficiency
 D. All of the above
- 28. Corneal dystrophy associated with acid mucopolysaccharidosis is:**
 A. Lattice
 B. Granular
 C. Macular
 D. Peripheral
- 29. All of the following result in loss of corneal sensations except:**
 A. Acute congestive glaucoma
 B. Dendritic ulcer
 C. Absolute glaucoma
 D. Exposure keratitis
- 30. The earliest symptom to occur in corneal ulcer is:**
 A. Pain
 B. Photophobia
 C. Loss of sensation
 D. Diminished vision
- 31. Corneal reflex is lost in the disease of:**
 A. Ophthalmic nerve
 B. Ciliary ganglion
 C. Supra orbital nerve
 D. Motor nucleus of 5th cranial nerve

32. The commonest cause of hypopyon is:

- A. Moraxella
- B. Gonococcus
- C. Pneumococcus
- D. Staphylococcus
- E. C. diphtheriae

33. Keratomalacia includes the following except:

- A. Night blindness
- B. Severe pain in the eye
- C. Xerosis of the cornea
- D. Perforation of cornea

34. Kayser Fleischer ring is found in which layer of cornea ?

- A. Bowman's membrane
- B. Substantia propria
- C. Descemet's membrane
- D. Endothelium

35. Corneal transparency is due to all except:

- A. Normal IOP
- B. $\text{Na}^+ \text{K}^+$ pump
- C. Hypercellular stroma
- D. Peculiar arrangement of stromal lamella

36. Condition which is always bilateral:

- A. Infantile glaucoma
- B. Megalocornea
- C. Acute congestive glaucoma
- D. All of the above
- E. None of the above

37. Commonest causative organism of corneal ulcer is:

- A. Pneumococci
- B. Streptococci
- C. Staphylococci
- D. Fungal

38. Corneal ulceration may be caused by injury to which cranial nerve:

- A. Third
- B. Fifth
- C. Sixth
- D. All of the above

39. What type of corneal dystrophy is associated with acid mucopolysaccharidosis:

- A. Granular
- B. Lattice
- C. Macular
- D. Peripheral

40. The colour of fluorescein staining in corneal ulcer is:

- A. Yellow
- B. Blue

- C. Royal blue
- D. Green

41. Metabolically most active layer of cornea is:

- A. Endothelium
- B. Stroma
- C. Descemet's membrane
- D. Epithelium

42. Earliest symptom in corneal ulcer is:

- A. Loss of sensation
- B. Diminished vision
- C. Photophobia
- D. Pain

43. Munson's sign is seen in:

- A. Keratoconus
- B. Keratoglobus
- C. Microcornea
- D. All

44. "Orange skin" cornea results due to:

- A. Chalcosis
- B. Siderosis
- C. Ammonia burn
- D. Mustard gas

45. Anterior lenticonus is seen in:

- A. Marfan's syndrome
- B. Ehler Danlos syndrome
- C. Weil-Marchessani syndrome
- D. Homocystinuria

46. For transplantation, cornea is preserved in:

- A. Modified MK medium
- B. Glycerine medium
- C. Wet medium
- D. All of the above

47. Microscopy of corneal ulcer showed branching septate hyphae. The probable diagnosis is:

- A. Candida
- B. Mucormycosis
- C. Aspergillus
- D. Histoplasma

48. Corneal epithelium is composed of:

- A. Stratified keratinized epithelium
- B. Stratified non-keratinized epithelium
- C. Columnar epithelium
- D. Pseudostratified epithelium
- E. Transitional epithelium

49. Keratomalacia is associated with:

- A. Measles
- B. Mumps
- C. Rubella
- D. Chicken pox

50. Herpes zoster ophthalmicus is a predictor of:

- A. Leukemia
- B. Lymphoma
- C. HIV
- D. All of the above

51. All are true about keratoconus except:

- A. Increased curvature of cornea
- B. Astigmatism
- C. K.F ring cornea
- D. Thick cornea

52. Thinning of cornea occurs in:

- A. Megalocornea
- B. Bullous keratopathy
- C. Endothelial dystrophy
- D. Keratoconus

53. Treatment of choice for photophobia is:

- A. Irrigation with antibiotics
- B. Irrigation with local anaesthesia
- C. Irrigation with saline
- D. Patching the eye

54. Deep anterior lamellar keratoplasty is indicated in:

- A. Disease of deeper cornea e.g. endothelial damage
- B. Full thickness corneal opacities
- C. Bullous keratopathy
- D. Superficial corneal opacities

55. Recurrent corneal erosion seen in:

- A. Corneal dystrophy
- B. Keratoglobus
- C. Keratoconus
- D. Peutz-anaomalies

56. Posterior polymorphous dystrophy

- A. Causes corectopia
- B. Is inherited in an autosomal recessive fashion
- C. Causes blindness in over 90% of sufferers
- D. Can be treated with lamellar corneal grafts

57. To prevent keratoconus what is used:

- A. Antibiotics
- B. Cycloplegics
- C. Glasses
- D. None

58. Interstitial keratitis is seen in all except:

- A. Syphilis
- B. Acanthamoeba
- C. Chlamydia trachomatis
- D. HSV
- E. HZV

59. Band shaped keratopathy seen in:

- A. JRA
- B. RA

- C. SLE
- D. DLE

60. Following corneal transplantation, most common infection occur:

- A. Staph epidermidis
- B. Streptococcus
- C. Klebsiella
- D. Pseudomonas

61. Enlarged corneal nerves may be seen in all of the following except:

- A. Keratoconus
- B. Herpes simplex keratitis
- C. Leprosy
- D. Neurofibromatosis

62. A 28-year-old male complains of glare in both eyes. The cornea shows whorl like opacities of the epithelium. He also gave a history of long term treatment with amiodarone. The most likely diagnosis is:

- A. Terrain's marginal degeneration
- B. Cornea verticillata
- C. Band shaped keratopathy
- D. Arcus juvenalis

63. Dellen is:

- A. Localized thinning of peripheral cornea
- B. Raised lesions in corneo limbal junction
- C. Age related macular degeneration
- d. Marginal keratitis

EXTRA EDGE QUESTIONS**64. True about anatomy of adult cornea:**

- A. Horizontal diameter is 12 mm
- B. Horizontal diameter is 10 mm
- C. In megalocornea diameter is >12 mm
- D. In microcornea diameter <10 mm
- E. Vertical diameter > Horizontal diameter

65. True about cornea:

- A. Power is 43 D
- B. Majority of refraction occur at air-tear interface
- C. With the rule astigmatism is present because vertical meridian more steep than horizontal meridian
- D. Spherical structure
- E. Refractive index 1.334.

66. Corneal transparency is maintained by all except:

- A. Relative dehydration
- B. Increased mitotic figures in centre of cornea
- C. Unmyelinated nerve fibers
- D. Uniform spacing of collagen fibrils

- 67. Ionic pump in corneal endothelium is necessary for maintaining deturgescence of the cornea and thus transparency. It can be blocked by:**
- Inhibition of anaerobic glycolysis
 - Activation of anaerobic glycolysis
 - Inhibition of Krebs's cycle
 - Inhibition of HMP pathway
- 68. A young man aged 30 years, presents with difficulty in vision in the left eye for the last 10 days. He is a rural community and gives history of trauma to his left eye with vegetative matter 10–15 days back. On examination, there is an ulcerative lesion in the cornea, whose base has raised soft creamy infiltrate. Ulcer margin is feathery and hyphate. There are a few satellite lesions also. The most probable etiological agent is:**
- Acanthamoeba
 - Corynebacterium diphtheria
 - Fusarium
 - Streptococcus pneumonia
- 69. Kallu, a 25 year male patient presented with a red eye and complains of pain, photophobia, watering and blurred vision. He gives a history of trauma to his eye with a vegetable matter. Corneal examination shows a dendritic ulcer. A corneal scraping was taken and examined. Microscopy showed macrophages like cells on culturing the corneal scrapings over a non-nutrient agar enriched with *E.coli*, there were plaque formations. Which organism is most likely:**
- Herpes simplex
 - Acanthamoeba
 - Candida
 - Adeno virus
- 70. Corneal dystrophies are usually:**
- Primarily unilateral
 - Primarily bilateral
 - Primarily unilateral without systemic disease
 - Primarily bilateral with systemic disease
- 71. Corneal dystrophies are:**
- Macular
 - Granular
 - Lattice
 - Moorens
 - Fuchs
- 72. Which of the following is the least common corneal dystrophy:**
- Macular dystrophy
 - Lattice type I
 - Lattice type III
 - Granular corneal dystrophy
- 73. Which one of the following stromal dystrophy is a recessive condition?**
- Lattice dystrophy
 - Granular dystrophy
 - Macular dystrophy
 - Fleck dystrophy
- 74. Corneal vascularisation is/are caused by:**
- Graft rejection
 - Chemical burn
 - Contact lens use
 - Vitreous haemorrhage
 - Viral injection
- 75. The central nebular corneal opacity is easily treated with:**
- Lamellar keratoplasty
 - Penetrating keratoplasty
 - Gas permeable contact lens
 - Soft contact lens
- 76. Which of the following statements regarding corneal transplantation is true:**
- Whole eye needs to be preserved in tissue culture
 - Donor not accepted if age >60 years
 - Specular microscopy analysis is used to assess endothelial cell count
 - HLA matching is mandatory
- 77. Pigment deposition on cornea seen in:**
- Chloroquine
 - Digoxin
 - Ranitidine
 - Amiodarone.
- 78. Corneal transplantation:**
- Donor >60 years not allowed
 - Whole eye preserved in culture
 - Specular microscopy done for corneal endothelial count
 - HLA matching required
- 79. Corneal tattooing is done by:**
- Iron
 - Silver
 - Copper
 - Platinum
- 80. Neuroparalytic keratitis is due to which cranial nerve:**
- 3rd nerve
 - 5th nerve
 - 6th nerve
 - 7th nerve

Quick Text Review

INFLAMMATORY DISORDERS

EPISCLERITIS

- Typically affects young adults, being twice as common in women than men
- *Etiology* in most cases is not known. Occurs in association with gout, rosacea, psoriasis and as hypersensitivity reaction to endogenous tubercular or streptococcal proteins
- *Types*: Diffuse episcleritis, nodular episcleritis
- In nodular episcleritis, a pink or purple flat nodule surrounded by congestion is usually situated 2-3 mm away from the limbus
- *Episcleritis periodica* refers to a fleeting type of disease
- *Treatment* in severe cases is with topical steroids and systemic indomethacin 50 mg twice daily.

SCLERITIS

- Usually occurs in elderly patients (40–70 years), involving females more than the males. More rare than episcleritis.
- About 50 percent cases are associated with some systemic disease including connective tissue disease.
- About 0.5 percent of patients with seropositive rheumatoid arthritis develop scleritis.
- Causes of non-pyogenic scleritis are syphilis, tuberculosis, and leprosy.
- In scleritis pain is moderate to severe, deep and boring in character.

Classification

I. *Anterior scleritis*

- Non-necrotizing: Diffused or nodular
- Necrotizing: With or without inflammation

II. *Posterior scleritis*

Salient features

- Non-necrotizing anterior diffuse scleritis is the most common clinical variety

- Patients of particularly necrotizing scleritis may have one of the following systemic diseases: Rheumatoid arthritis, connective tissue vascular disorders like polyarteritis nodosa, SLE, Wegener's granulomatosis and miscellaneous diseases like relapsing polychondritis, herpes zoster and surgically induced scleritis.
- *Scleromalacia perforans* refers to anterior necrotizing scleritis without inflammation. It is common in women with long-standing seropositive rheumatoid arthritis. There is no effective treatment for this condition
- *Posterior scleritis* is frequently misdiagnosed. Its features are proptosis, limitation of ocular movements, exudative retinal detachment, macular oedema
- *Cornea and uveal tract are frequently involved in scleritis and not in episcleritis.*

MISCELLANEOUS CONDITIONS AND SALIENT POINTS

BLUE SCLERA

- *A typical association* of blue sclera is osteogenesis imperfecta
- *Other associations* are Marfan's syndrome, Ehlers-Danlos syndrome, pseudoxanthoma elasticum, congenital glaucomas, scleritis and Werner's syndrome.

STAPHYLOMA

- *Staphyloma* refers to bulging of the ectatic cicatricial outer coat of the eyeball lined by uveal tissue
- *Anterior staphyloma* results after total sloughing of the cornea
- *Intercalary staphyloma* (ectasia of sclera with incarceration of root of iris). It may occur after

scleritis, perforating injury, peripheral corneal ulceration

- *Ciliary staphyloma* may occur following scleritis, perforating injury or absolute glaucoma
- *Equatorial staphyloma* commonly occurs at the regions of sclera which are perforated by vortex veins
- *Posterior staphyloma* may occur due to pathological myopia (most common cause), posterior scleritis, posterior perforating injury.

CAUSES OF SCLERAL THINNING

- Uveitis
- Scleritis
- Tuberculoma
- Congenital glaucoma.

SOME SALIENT POINTS

- *Diseases of the sclera are chronic* because of relative avascularity of sclera.
- *Sclera is thickest* at the posterior pole and thinnest at the lamina cribrosa.

Multiple Choice Questions (MCQs)

1. All of the following are features of episcleritis except:
 - A. Redness
 - B. Marked pain
 - C. Photophobia
 - D. Lacrimation
2. Scleritis is most commonly associated with:
 - A. Polyarteritis nodosa
 - B. Tuberculosis
 - C. Rheumatoid arthritis
 - D. Sarcoidosis
3. The most common variety of scleritis is:
 - A. Non-necrotizing anterior diffuse
 - B. Non-necrotizing anterior nodular
 - C. Anterior necrotizing with inflammation
 - D. Anterior necrotizing without inflammation
4. The clinical variety of scleritis associated with collagen diseases is:
 - A. Necrotizing nodular scleritis
 - B. Non-necrotizing nodular scleritis
 - C. Scleromalacia perforans
 - D. All of the above
5. Ciliary staphyloma occurs due to all of the following except:
 - A. Scleritis
 - B. Perforating injury
 - C. Absolute glaucoma
 - D. Episcleritis
6. Blue sclera is seen in:
 - A. Alkaptonuria
 - B. Osteogenesis imperfecta
 - C. Lowe's syndrome
 - D. All of the above
7. Sclera is thinnest at:
 - A. Posterior pole
 - B. Equator
 - C. Corneoscleral junction
 - D. Points of muscular attachments
8. Commonest cause of posterior staphyloma is:
 - A. Glaucoma
 - B. Retinal detachment
 - C. Iridocyclitis
 - D. High myopia
9. Episcleritis periodica refers to:
 - A. Fleeting type of episcleritis
 - B. Complicated episcleritis
 - C. Intermediate stage between episcleritis and scleritis
 - D. None of the above
10. Scleritis is associated with some systemic disease including connective tissue disorder in:
 - A. 35% of cases
 - B. 50% of cases
 - C. 66% of cases
 - D. 85% of cases
11. Staphyloma involvement:
 - A. Iris with conjunctiva
 - B. Conjunctiva with cornea
 - C. Choroid with retina
 - D. Iris with cornea
12. Most common cause of posterior staphyloma:
 - A. Trauma
 - B. Glaucoma
 - C. Myopia
 - D. Scleritis
13. In scleritis all are true except:
 - A. Scleromalacia perforans are more commonly associated with systemic diseases than posterior scleritis
 - B. Pain is not a prominent feature
 - C. Retinal detachment is a known complication
 - D. Glaucoma is a known complication.

EXTRA EDGE QUESTIONS

14. The most common systemic association of scleritis is:
 - A. Ehlers-Danlos syndrome
 - B. Disseminated systemic sclerosis
 - C. Rheumatoid arthritis
 - D. Giant cell arteritis

Quick Text Review

UVEITIS (INFLAMMATIONS OF UVEA)

IRIDOCYCLITIS

Etiology

- *Allergic uveitis* is the most common variety hypersensitivity to tubercular proteins is an important cause in developing countries (most common)
- *HLA associated uveitis*
 - HLA-B27: Acute anterior uveitis associated with ankylosing spondylitis and Reiter's syndrome
 - HLA-B5: Behcet's disease
 - HLA-DR4: Vogt-Koyanagi-Harada syndrome
- *Reiter's syndrome* is being considered to be caused by chlamydial infection.
- *Granulomatous uveitis* is seen in:
 - Tuberculosis
 - Syphilis
 - Sarcoidosis
 - Toxoplasmosis
 - Sympathetic ophthalmia
 - Vogt-Koyanagi-Harada syndrome
- *Common systemic disorders associated with acute non-granulomatous anterior uveitis* are: sacroilitis, ankylosing spondylitis, Reiter's syndrome, psoriasis, ulcerative colitis and Crohn's disease.
- *Masquerade uveitis* is seen in retinal detachment, intraocular tumours, CNS lymphomas and multiple sclerosis.
- *Fungal uveitis* is most commonly due to candida.

Clinical features

- *Endothelial bedewing* of the cornea is the earliest sign of iritis
- *Keratic precipitates* (KPs), i.e. proteinaceous cellular deposits at the back of the cornea are an important feature of cyclitis. They may be the only sign in insidious cases of cyclitis. KPs are seldom present in simple iritis

- Mutton fat KPs are pathognomonic of granulomatous iridocyclitis
- Small and medium KPs are seen in nongranulomatous iridocyclitis
- Very fine KPs occur in Fuch's heterochromic cyclitis
- KPs are arranged in a triangular fashion due to convection current
- *Aqueous flare* is the earliest sign of iridocyclitis. It is best seen with slit lamp examination. Occurs due to leakage of proteins and leucocytes into the anterior chamber as a result of breakdown of blood-aqueous barrier
- *Aqueous cells* are sign of active inflammation
- *Iris nodules* are a feature of granulomatous iridocyclitis. Koeppe's nodules are situated at the pupillary border. Bussaca's nodules are situated near the collarette
- *Small and irregular pupil* in iridocyclitis results from sphincter irritation due to toxins and engorgement of the radial blood vessels of the iris
- *Iris bombe* results from annular posterior synechiae. In it, anterior chamber becomes funnel shaped.

Complications of uveitis

Acute anterior uveitis: Complicated cataract, secondary glaucoma and CME.

Chronic anterior uveitis: Rhegmatogenous retinal detachment, phthisis bulbi (end result of chronic uveitis, in which intraocular tension is reduced due to decreased aqueous formation). Histopathology shows marked scleral thickening and intraocular ossification.

Granulomatous versus non-granulomatous uveitis

Feature	Granulomatous	Non-granulomatous
Onset	Insidious	Acute
Keratic precipitates (KPs)	Mutton fat	Small
Iris nodules	Usually present	Absent
Posterior synechiae	Thick and broad based	Thin and tenuous
Fundus	Nodular lesions	Diffuse involvement

Treatment

- *Atropine* is the most important topical drug (of choice) for the management of a case of acute iridocyclitis
- *Steroids*, topical as well as systemic are effective in most cases
- *Immunosuppressive drugs* are specially useful in severe cases of Behcet's disease, sympathetic ophthalmitis, pars planitis, and Vogt-Koyanagi-Harada syndrome.

CHOROIDITIS (POSTERIOR UVEITIS)

- *Diffuse choroiditis* refers to a large spreading lesion involving most of the choroidal tissue. It is usually tubercular or syphilitic in origin
- *Disseminated choroiditis* is characterised by multiple small areas of inflammation scattered over the greater part of choroid, usually tubercular or syphilitic in origin
- *Central choroiditis* involves macular area, common causes are: Toxoplasmosis, histoplasmosis, tuberculosis, syphilis, visceral larva migrans (oncocerca) and rubella.
- *Juxtacaecal choroiditis* involves the area adjoining optic disc, typical example is jensen's choroiditis
- *Anterior peripheral choroiditis* is usually syphilitic in origin
- *In late stages of choroiditis*-negative scotoma occurs in field of vision.
- Drug of choice—Systemic steroids.

ENDOPHTHALMITIS

- *Inflammation of inner structure* of the eyeball (which include; uveal tissue, retina, vitreous and sclera is spared) with pouring of exudates into the anterior and posterior chamber of the eye.
- *Exogenous infection* is the most common mode for purulent endophthalmitis. Most common cause is intraocular surgery.

- *Most common organisms causing endophthalmitis* are divided into two groups:

1. *Surgeon fault*: Staphylococcus epidermidis, Staphylococcus aureus and pseudomonas.
2. *Patient fault*: Propionibacterium acnes.

- *Puff ball opacities* in the vitreous are pathognomonic of fungal endophthalmitis
- *Intravitreal injection*, if antibiotic is treatment of choice. *Vitreous samples collected* in emergency should be stored at 4° C.
- *Antibiotics* should be given by all the routes viz. topical, subconjunctival, intravitreal (treatment of choice) and intravenously in bacterial endophthalmitis
- *Steroids* should be started after 12-24 hours of intensive antibiotic therapy
- *Vitrectomy* is the treatment of choice for fungal endophthalmitis. In bacterial endophthalmitis, it should be performed when the condition does not improve with intensive conservative therapy for 48 hours.
- On examination—Amaurotic cat's eye reflex.

SPECIFIC CLINICOETIOLOGICAL VARIETIES OF NON-SUPPURATIVE UVEITIS**I. Uveitis in chronic systemic bacterial infections****Tubercular uveitis**

- Accounts for 1 percent of uveitis patients in developed countries. However, it is a very common cause of uveitis in developing countries
- Most frequent feature is chronic granulomatous uveitis
- Isoniazid test (300 mg/day for 3 weeks) for suspected ocular involvement is a useful diagnostic test
- Systemic treatment consists of a course of isoniazid, pyridoxine and rifampicin for 12 months.

Acquired syphilitic uveitis

- *Acute plastic iritis*, typically occurs in secondary syphilis
- *Gummatous anterior uveitis* occurs in late secondary syphilis and is characterised by yellowish red highly vascularized nodules arranged near the pupillary or ciliary border of iris
- *Chorioretinitis* may be peripheral, disseminated or diffuse
- *Neuroretinitis* may cause optic atrophy.

Leprotic uveitis

- Uveitis (predominantly anterior) occurs more commonly in lepromatous than the tuberculoid form of leprosy

- *Chronic granulomatous iritis* is characterised by presence of small glistening '*iris pearls*' near the pupillary margin in necklace form.

II. Uveitis in non-infectious systemic diseases

Sarcoid uveitis

Sarcoid uveitis accounts for 2 percent cases of uveitis and may occur as:

- *Acute unilateral non-granulomatous* anterior uveitis occurs in young patients with acute sarcoidosis
- *Chronic bilateral granulomatous* iridocyclitis occurs in older patients with chronic lung disease
- *Uveoparotid fever* (Heerfordt's syndrome): Bilateral granulomatous panuveitis, painful enlargement of parotid glands, cranial nerve palsies, skin rashes, fever and malaise
- *Fundus changes* include:
 - Periphlebitis—advanced stage of vascular sheathing leads to Candle-wax drippings.
 - Retinal granulomata
 - Pre-retinal nodules (*Lander's sign*)
 - Retinal haemorrhages (in acute sarcoid retinopathy)
 - Choroidal granulomata
 - Optic disc may show granuloma, neovascularization, papilledema or optic atrophy.

Behcet's disease

- *Typically affects* young men who are positive for HLA-B5
- *Ocular features* are bilateral, recurrent, acute non-granulomatous iridocyclitis associated with transient hypopyon.

Vogt-Koyanagi-Harada (VKH) syndrome

It is more common in Japanese who are usually positive for HLA-DR4. Clinical features include:

- *Cutaneous lesions*—alopecia, poliosis, and vitiligo
- *Neurological lesions* are meningism, encephalopathy, tinnitus, vertigo, and deafness
- *Ocular features* are chronic granulomatous anterior uveitis, posterior uveitis, and exudative retinal detachment.

III. Uveitis with arthritis

Uveitis with ankylosing spondylitis

- Ankylosing spondylitis is a common, chronic, sero-negative inflammatory arthritis which usually involves sacroiliac and posterior intervertebral joints
- Typically affects HLA-B27 positive young males
- About 30% cases develop a recurrent, unilateral, non-granulomatous, acute anterior uveitis.

Reiter's syndrome

- *Characterised by a triad* of urethritis, arthritis and conjunctivitis
- Acute non-granulomatous iridocyclitis occurs in 20-30 percent cases
- Typically affects young males, 70 percent of whom are positive for HLA-B27.

Juvenile chronic arthritis (JCA)

- *Anterior uveitis* associated with JCA is chronic bilateral non-granulomatous with insidious onset
- Bilateral in 70% cases (white uveitis)
- Uveitis is much more common in pauciarticular JCA than polyarticular JCA
- About half of the cases are positive for HLA-DW5 and 75 percent are positive for antinuclear antibodies (ANA)
- *Complications* include posterior synechiae, complicated cataract and *band-shaped keratopathy* (commonest).

IV. Parasitic uveitis

Toxoplasmosis

Congenital toxoplasmosis

- Fetus gets infestation from the involved mother through transplacental route.
- *Characteristic triad* includes convulsions, calcification (intracranial), and chorioretinitis.
- Chorioretinitis at birth may be: (1) Inactive (more common)—bilateral punched out heavily pigmented scar at macula, or (2) Active (rare) - necrotic granulomatous retinochoroiditis.

Acquired toxoplasmosis

- Very rare
- Most of the cases are subclinical (asymptomatic).

Recurrent toxoplasmic retinochoroiditis

- Most common cause of a focal retinochoroiditis
- Characterised by a whitish-yellow, slightly raised area near the margin of old punched out scar of healed chorioretinitis
- There may be associated non-granulomatous type of mild anterior uveitis.

Antitoxoplasmic drugs

- Clindamycin
- Spiramycin
- Pyrimethamine
- Sulphadiazine.

Toxocariasis

Infestation occurs in childhood by accidental ingestion of ova of *toxocara canis* shed in faeces of cats.

Visceral larva migrans produces following ocular lesions (usually unilateral):

- *Toxocara chronic endophthalmitis* which presents between 2 and 10 years of age as leukocoria
- *Posterior pole granuloma*—between 5 and 15 years of age
- *Peripheral granuloma*—between 6 and 40 years of age.

V. Fungal uveitis

Presumed ocular histoplasmosis syndrome (POHS)

- Presumed to be caused by histoplasma capsulatum
- Lesions (usually bilateral) include:
 - *Histospots*: Atrophic spots scattered in the midretinal periphery
 - *Neovascular maculopathy* ending in disciform scarring.

Candidiasis

An opportunistic infection occurring in:

- Immuno-compromised patients (e.g., those suffering from AIDS or malignancies)
- Patients with long-term indwelling catheter
- Drug addicts using infected needles.

Ocular lesions

- Anterior uveitis associated with hypopyon
- Multifocal chorioretinitis with Roth's spots
- Endophthalmitis—characterised by 'puff ball' or 'cotton ball' colonies, which joined by exudative strands form a 'string of pearls'.

VI. Viral uveitis

Herpes zoster uveitis

- Unilateral non-granulomatous acute anterior uveitis occurs in about 50 percent cases with herpes zoster ophthalmicus
- Complications include:
 - Large segmental iris atrophy in 20 percent
 - Secondary glaucoma due to trabeculitis in 10 percent
 - Complicated cataract may occur in late stages.

Acquired cytomegalovirus (CMV) retinitis

- Occurs in immunocompromised patients (e.g., patients with AIDS and those on cytotoxic therapy for malignancies etc.)
- *Ocular lesions* includes: Cotton-wool spots, areas of retinal necrosis, and areas of vasculitis and haemorrhage (sauce and cheese retinopathy)
- *Complications* are exudative retinal detachment, retinal atrophy and optic atrophy.

VII. Idiopathic specific uveitis syndromes

Fuch's uveitis syndrome (Heterochromic iridocyclitis)

Unilateral mild grade, non-granulomatous, anterior uveitis occurring between 20 and 40 years of age, characterised by:

- Heterochromia of iris due to diffuse stromal atrophy
- Fine KPs
- Paint aqueous flare
- No posterior synechiae
- Neovascularization of the angle
- Early development of the complicated cataract (usually the presenting sign)
- Secondary glaucoma (uncommon).

Intermediate uveitis (pars planitis)

- Patients presents with floaters or defective vision
- Eye usually looks quiet
- 'Snow ball' vitreous opacities in the inferior quadrant, which may coalesce to form 'snow banking'.

Glaucomatocyclitis crisis

(Posner Schlossman syndrome)

Etiology

Typically affects young adults, 40 percent of whom are positive for HLA-BW 54.

Clinical features

- *White eye* (no or minimal congestion)
- *Cornea* usually clear/mild epithelial oedema
- *Fine KPs* but no synechiae
- *Dilated pupil*.
- *IOP*: Recurrent attacks of acute rise of the intra-ocular pressure (40-50 mm Hg) without shallowing of anterior chamber.
- *Gonioscopy*: open-angle glaucoma
- *Fundus* shows no optic nerve cupping
- *Visual field* is normal.

Treatment

- Anti-glaucoma drugs
- NSAIDs and rarely
- Steroids.

HETEROCHROMIA

Congenital causes

- Waardenburg's syndrome
- Horner's syndrome
- Naevus of ota
- Congenital ocular melanocytosis.

Acquired causes

- Chronic iritis
- Fuch's heterochromic cyclitis
- Iris naevus or melanoma

- Siderosis
- Rubeosis
- Topical latanoprost.

WHITE-DOT SYNDROME

Characterized by multiple white dots in fundus.

Inflammatory causes

- Presumed ocular histoplasmosis syndrome (POHS)
- Multiple evanescent white dot syndrome (MEWDS)
- Bird-shot retinochoroidopathy
- Multifocal choroiditis
- VKH syndrome
- Sympathetic ophthalmitis
- Serpiginous choroidopathy
- HIV retinopathy
- Acute posterior multifocal placoid pigment epitheliopathy (APMPPE).

Degenerative/dystrophic causes

- Stargardt's disease
- Retinitis punctata albescens
- Cystinosis
- Drusen.

Neoplastic causes

- Leukemic retinopathy
- Metastatic tumours
- Large-cell lymphoma (Non-Hodgkin's lymphoma).

Traumatic causes

- Purtscher's retinopathy.

Miscellaneous causes

- Choroquine or tamoxifen toxicity
- Photocoagulation spots.

MALIGNANT MELANOMA OF CHOROID

- Of the tumours of uveal tract the malignant melanoma is the most common primary intraocular tumour of the adults
- Extremely rare in Negroes
- Commonly seen between 6th and 9th decade of life
- It arises from the pigment cells derived from the neural crest (neuroectodermal)
- May arise from the pre-existing naevus or de-novo from the mature melanocytes present in the stroma
- Earliest pathognomic sign is appearance of orange patch due to accumulation of lipofuscin in the retinal pigment epithelium
- Associated are intraretinal or vitreous haemorrhage.

Glaucoma may develop with or without uveitis due to any of the following causes:

- Obstruction of vortex veins
- Angle blockage by forward displacement of the lens iris diaphragm
- Neovascularization of the angle
- Infiltration of the angle by tumour cells.

MISCELLANEOUS POINTS

- *Patients with aniridia* have a higher prevalence of Wilms' tumour
- *Coloboma of the uveal tract* is the commonest congenital anomaly of the eye
- *Typical iris coloboma* occurs in the inferonasal quadrant. It results from failure of closure of the embryonic fissure
- *Albinism* results from tyrosinase deficiency
- *Blue iris* occurs due to the absence of pigment in the iris stroma
- *Sarcoidosis and Behcet's syndrome* show increased IgA levels
- *Persistent pupillary membrane* is a remnant of anterior vascular sheath of the lens. It is characterised by the stellate-shaped shreds of the pigmented tissue attached at the collarette
- *Lesions in the choroid* are restricted to isolated areas because of segmental blood supply to choroid
- *Anterior uveitis*: Drug of choice is topical steroid and second drug of choice is mydriatic and cycloplegic
- *Intermediate and posterior uveitis*: Drug of choice is systemic steroids
- *Management of uveitic glaucoma includes*: Topical steroids, mydriatics and cycloplegics
 - Topical beta blockers (first drugs of choice), epinephrine or dipivefrine, apraclonidine (alpha 2 agonist), carbonic anhydrase, inhibitors, hyperosmotic agents
 - Laser iridotomy when medical therapy fails.
- *Juvenile Rheumatoid arthritis* (pauciarticular) is associated with uveitis, cataract, ANA positive, rheumatoid factor negative. After cataract operations IOLs is contraindicated in JRA because it act as a foreign body. In other type of uveitis, we put heparin coated IOLs which retard the pigment from iris.

- *Choroidal neovascularisation* is associated with angioid streaks, choroidal rupture (trauma) and pathological myopia.
- *Choroidal effusion syndrome* (ciliochoroidal effusion) is characterized by:
 - Thick sclera (main feature), ciliochoroidal detachment (abnormal accumulation of serous fluid in outer layer of ciliary body and choroid).
 - Absence of inflammation and neoplastic disease.
 - Eyes may be nanophthalmic or hypermetropic.
 - Leopards spots i.e mottling of pigment epithelium.
- Polypoidal choroidal vasculopathy: It is a peculiar hemorrhagic disorder involving macula. It is characterized by recurrent sub-retinal and sub-retinal pigment epithelium bleeding in middle aged black women. Indocyanine green angiography and subsequently optical coherent tomography is used for diagnosis.
- Choroideremia: Degenerative disease, involving choriocapillaries, retinal pigment epithelium and photoreceptors. X linked recessive, so, only males are affected. First symptoms is night blindness.

Multiple Choice Questions (MCQs)

1. Most common etiological variety of uveitis is:

- A. Infective
- B. Allergic
- C. Toxic
- D. Metabolic

2. All of the following HLA-phenotypes are associated with uveitis except:

- A. HLA-B27
- B. HLA-B5
- C. HLA-BW54
- D. HLA-10

3. All of the following are features of granulomatous iridocyclitis except:

- A. Minimal ciliary congestion
- B. Mutton fat KPs
- C. Marked aqueous flare
- D. Nodules on the iris

4. All of the following are features of acute non-granulomatous iridocyclitis except:

- A. Marked ciliary congestion
- B. Numerous small keratic precipitates
- C. Minimal aqueous flare
- D. No iris nodules

5. Aqueous flare seen in anterior chamber is due to:

- A. Leakage of protein particles into the aqueous humour following breakdown of blood aqueous barrier
- B. Leakage of leukocytes into anterior chamber
- C. Both of the above
- D. None of the above

6. Koeppe's nodules:

- A. Are a feature of nongranulomatous iridocyclitis
- B. Are situated at the pupillary border
- C. Consist of polymorphonuclear cells
- D. Do not initiate posterior synechiae formation

7. Busacca's nodules:

- A. Are a feature of nongranulomatous uveitis
- B. Are situated at the pupillary border
- C. Usually initiate posterior synechiae formation
- D. Consists of lymphocytes, plasma cells, epitheloid and giant cells

8. Festooned pupil results from:

- A. Irregular dilatation of pupil with atropine in the presence of segmental posterior synechiae
- B. Annular synechiae
- C. Occlusion pupillae
- D. All of the above

9. Role of atropine in iridocyclitis includes all of the following except:

- A. It dilates the pupil, prevents the formation of synechiae and may break the already formed synechiae
- B. Gives comfort and rest to the eye by relieving ciliary muscle spasm
- C. It reduces exudation by decreasing hyperaemia
- D. It lowers the intraocular pressure increasing aqueous outflow facility

10. Granulomatous uveitis is seen in all of the following except:

- A. Uveitis with ankylosing spondylitis
- B. Sympathetic ophthalmitis
- C. Tubercular uveitis
- D. Uveitis in sarcoidosis

11. Dalen Fuch's nodules are pathognomic of:

- A. Pathological myopia
- B. Sympathetic ophthalmitis
- C. Fuch's uveitis syndrome
- D. Sarcoidosis

12. **A healed patch of chorioretinitis gives rise to:**
 - A. Negative scotoma
 - B. Positive scotoma
 - C. Both of the above
 - D. None of the above
13. **'Snow ball' opacities near the ora-serrata are pathognomonic of:**
 - A. Fungal endophthalmitis
 - B. Pars planitis
 - C. Diabetic retinopathy
 - D. Anterior choroiditis
14. **Sign of activity in chronic iridocyclitis is:**
 - A. Aqueous cells
 - B. Aqueous flare
 - C. Pigmented KPs
 - D. All of the above
15. **The pathognomonic sign of acute iridocyclitis is:**
 - A. Small pupil
 - B. Aqueous flare
 - C. Keratic precipitates
 - D. All of the above
16. **'Puff-balls' opacities in the vitreous are pathognomonic of:**
 - A. Fungal endophthalmitis
 - B. Pars planitis
 - C. Exudative retinopathy of Coats
 - D. Sympathetic ophthalmitis
17. **In bacterial endophthalmitis systemic steroids should be**
 - A. Started immediately
 - B. Started after 12–24 hours of intensive antibiotic therapy
 - C. Deferred
 - D. Given after 7 days of intensive antibiotic therapy
18. **The cell type most typically seen in the Keratic precipitates of non-granulomatous uveitis is:**
 - A. Polymorphonuclear cells
 - B. Lymphocytes
 - C. Plasma cells
 - D. Epitheloid cells
19. **Iritis roseata is seen in:**
 - A. Leprosy
 - B. Syphilis
 - C. Tuberculosis
 - D. Sarcoidosis
20. **Heterochromia iridis is a feature of:**
 - A. Malignant melanoma of iris
 - B. Sympathetic paralysis
 - C. Glaucomatocyclitis crisis
 - D. Siderosis bulbi
 - E. All of the above
21. **The following features of panophthalmitis differentiate it from endophthalmitis except:**
 - A. Presence of pus in the anterior chamber
 - B. Proptosis
 - C. Limited and painful ocular movements
 - D. Complete loss of vision
22. **In a patient with suspected tubercular anterior uveitis the diagnosis is confirmed by:**
 - A. Positive Mantoux test
 - B. Associated findings suggestive of old systemic tuberculosis
 - C. A positive response to isoniazid test
 - D. All of the above
23. **'Iris-pearls' are seen in:**
 - A. Syphilis
 - B. Leprosy
 - C. Sarcoidosis
 - D. Tuberculosis
24. **Heerfordt's disease is characterised by all of the following except:**
 - A. Unilateral non-granulomatous panuveitis
 - B. Painful enlargement of parotid glands
 - C. Cranial nerve palsies
 - D. Skin rashes, fever and malaise
25. **Behcet's disease is characterised by all of the following except:**
 - A. Unilateral granulomatous uveitis
 - B. Recurrent hypopyon
 - C. Aphthous ulceration
 - D. Genital ulcerations
26. **All of the following are true for Vogt-Koyanagi-Harada syndrome except:**
 - A. More common in Japanese people, who are usually positive for HLA-B27
 - B. Ocular features are; Chronic granulomatous anterior uveitis, posterior uveitis and exudative retinal detachment
 - C. Cutaneous lesions are alopecia, poliosis and vitiligo
 - D. Neurological lesions include, meningism, encephalopathy, tinnitus, vertigo and deafness
27. **Reiter's syndrome is typically characterised by:**
 - A. Urethritis, conjunctivitis and iridocyclitis
 - B. Arthritis, conjunctivitis and iridocyclitis
 - C. Urethritis, arthritis and conjunctivitis with or without iridocyclitis
 - D. All of the above
28. **Recurrent toxoplasmic retinochoroiditis, all are true except:**
 - A. Manifests at an average age of 25 years
 - B. The infestation is acquired by eating the under-cooked meat of intermediate host containing cyst of the parasite

- C. Typical lesion is a patch of focal necrotizing retinochoroiditis adjacent to a pigmented scar
D. There may be associated iritis
- 29. All of the following are true for the acquired cytomegalo inclusion disease except:**
A. It occurs only in immunosuppressed patients
B. The infection is acquired from the infected cervix of the partner during sexual intercourse
C. Typical lesion is acute necrotizing retinitis
D. Exudative retinal detachment may occur
- 30. Granulomatous uveitis with involvement of parotid gland is seen in:**
A. Tuberculosis
B. Syphilis
C. Mumps
D. Sarcoidosis
- 31. All of the following are true for colloid bodies (drusens) except:**
A. Are hyaline excrescences of Bruch's membrane
B. Are secreted by pigment epithelial cells
C. Are usually associated with marked loss of vision
D. Are a precursor of disciform macular degeneration in some eyes
- 32. In clinical aniridia all of the following are true except:**
A. Iris is completely absent
B. Usually familial condition
C. May be associated with congenital glaucoma
D. Ciliary processes may be visible
- 33. Typical coloboma of iris occurs:**
A. Inferonasally
B. Superonasally
C. Inferotemporally
D. Superotemporally
- 34. Malignant melanoma of conjunctiva is usually of:**
A. Spindle A type
B. Spindle B type
C. Mixed cell type
D. Epithelioid cell type
E. All of the above
- 35. Malignant change in a choroidal nevus is evidenced by:**
A. Increased pigmentation or height of the nevus
B. Appearance of orange patches of lipofuscin over the surface
C. Appearance of serous detachment in the area of nevus
D. All of the above
E. None of the above
- 36. Malignant melanoma of the choroid of following histological features has got the best prognosis:**
A. Epithelioid cell melanoma
B. Spindle - A melanoma
C. Spindle - B melanoma
D. Mixed cell melanoma
- 37. Malignant melanoma of the choroid with following histopathological features has got the worst prognosis:**
A. Epithelioid cell melanoma
B. Spindle - A melanoma
C. Spindle - B melanoma
D. Mixed cell melanoma
- 38. The most common histopathological type of malignant melanoma of choroid is:**
A. Spindle - A cell
B. Spindle-B cell
C. Epithelioid cell
D. Mixed cell
- 39. Essential atrophy of the choroid is due to inborn error of metabolism of which amino acid?**
A. Cystine
B. Cysteine
C. Arginine
D. Ornithine
E. Lysine
- 40. The earliest symptom of sympathetic ophthalmitis is:**
A. Pain
B. Decreased distant vision
C. Photophobia
D. Diplopia
- 41. The most earliest sign of anterior uveitis is:**
A. Aqueous flare
B. Keratic precipitates
C. Constriction of pupil
D. Raised intraocular pressure
- 42. Separation of rods and cones due to exudative choroiditis causes:**
A. Photopsia
B. Micropsia
C. Macropsia
D. Metamorphopsia
- 43. Commonest cause of endogenous uveitis in India is:**
A. Tuberculosis
B. Leprosy
C. Syphilis
D. Diabetes mellitus

44. The most frequent bacterial agent causing non-granulomatous uveitis is:

- A. Staphylococcus
- B. Streptococcus
- C. Pneumococcus
- D. Influenza bacillus
- E. None of the above

45. Peripheral anterior synechiae after an attack of acute congestive glaucoma occur earliest in the:

- A. Lower part
- B. Upper part
- C. Lower and inner part
- D. Lower and outer part
- E. Medial part

46. In complete albinism the colour of iris is:

- A. White
- B. Black
- C. Pink
- D. Blue
- E. Green

47. Iris bombe occurs is:

- A. Ring synechiae
- B. Anterior synechiae
- C. Posterior synechiae
- D. All

48. Drug of choice for acute iridocyclitis is:

- A. Steroids
- B. Acetazolamide
- C. Atropine
- D. Antibiotics

49. The correct statement regarding the duration after which sympathetic ophthalmitis develops is:

- A. 3 wks–12 wks after trauma
- B. Within 1 week of trauma
- C. After 2 months of trauma
- D. Typically at 10 days after trauma

50. One of the most common complication of iridocyclitis is:

- A. Scleritis
- B. Secondary glaucoma
- C. Band-shaped keratopathy
- D. Corneal ulcer

51. First sign of sympathetic ophthalmitis is:

- A. Keratic precipitates
- B. Miosis
- C. Aqueous flare
- D. Retrolental flare

52. The investigations of anterior uveitis for a 25 years old boy are all except:

- A. HLA-B27
- B. X-ray sacroiliac joint

- C. TORCH agent test
- D. USG abdomen
- E. ELISA for HIV

53. Uveitis is caused by all except:

- A. T.B.
- B. Staphylococcus
- C. Streptococcus
- D. Klebsiella

54. Photopsia occurs in:

- A. Iritis
- B. Choroiditis
- C. Cyclitis
- D. Scleritis

55. 'Snow banking' is typically seen in:

- A. Pars planitis
- B. Endophthalmitis
- C. Coat's disease
- D. Eales' disease

56. May masquerade as uveitis:

- A. Choroidal detachment
- B. Retinal detachment
- C. Age related macular degeneration
- D. Central retinal artery occlusion

57. Commonest cause of fungal uveitis is:

- A. Candida
- B. Aspergillus
- C. Fusarium
- D. Mucor mycosis

58. All are causes of white-dot syndrome except:

- A. Fuch's heterochromic uveitis
- B. VKH syndrome
- C. HIV retinopathy
- D. Sympathetic ophthalmitis

59. Most common cause of anterior uveitis associated with arthritis:

- A. Ankylosing spondylitis
- B. Rheumatoid arthritis
- C. Syphilis
- D. Tuberculosis

60. 1st sign of anterior uveitis:

- A. Keratic precipitate
- B. Aqueous flare
- C. Hypopyon
- D. Miosis

61. Keratic precipitates are on which layer of cornea:

- A. Epithelium
- B. Endothelium
- C. Stroma
- D. Bowman's membrane

62. Which of the following indicates activity of ant uveitis:

- A. Cells in anterior chamber
- B. Circumcorneal congestion
- C. Keratic precipitate
- D. Corneal edema

63. True about heterochromic uveitis:

- A. Involves posterior surface of iris
- B. Involves anterior part of iris
- C. Involves posterior chamber
- D. Posterior synechiae

64. Vogt-Koyanagi-Harada (VKH) syndrome is:

- A. Chronic granulomatous uveitis
- B. Chronic non-granulomatous uveitis
- C. Acute purulent uveitis
- D. None

65. Histological changes in lens induced uveitis include:

- A. Ghost cells
- B. Giant cell reaction
- C. Amyloid in the Cornea
- D. Vasculitis

66. Drug used in LUMINATE program for non-infectious uveitis is:

- A. Cyclosporine
- B. Voclosporin
- C. Methotrexate
- D. Infliximab

EXTRA EDGE QUESTIONS**67. Granulomatous uveitis is seen in:**

- A. Vogt-Koyanagi-Harada disease
- B. Fuch's disease
- C. Bechet's syndrome
- D. Sarcoidosis
- E. Psoriasis

68. A 10 year boy present with b/l chronic uveitis. Which investigation should be ordered:

- A. Hemogram
- B. X-ray of sacroiliac joint
- C. HIV test
- D. Mantoux test

69. The investigation of anterior uveitis of a young boy are:

- A. HLA B 27
- B. X-ray of sacroiliac joint
- C. TORCH agents
- D. ELISA for HIV
- E. USG abdomen

70. Signs of uveitis:

- A. Generalized conjunctival congestion
- B. Circumciliary congestion
- C. Cells and flare in aqueous
- D. Keratic precipitate

71. A 25 year old lady presents with severe sudden onset of pain, corneal congestion, photophobia and deep anterior chamber in the right eye. The left eye is normal. X-ray pelvis shows sacroilitis. The diagnosis is:

- A. Anterior uveitis
- B. Posterior uveitis
- C. Intermediate uveitis
- D. Scleritis

72. In patients with anterior uveitis, decrease in vision due to posterior segment involvement can occur because of:

- A. Visual floaters
- B. Inflammatory disc edema
- C. Exudative retinal detachment
- D. CME

73. Mutton for keratic precipitate and Busacca's nodules is seen in:

- A. Granulomatous uveitis
- B. Non-granulomatous uveitis
- C. Posterior uveitis
- D. Choroiditis

74. Uveal effusion syndrome may be associated with all of the following except:

- A. Myopia
- B. Ciliochoroidal detachment
- C. Structural defect in Sclera
- D. Nanophthalmos

75. In heterochromic cyclitis:

- A. 60% of patients develop glaucoma
- B. Show a good response when treated with steroids
- C. Lens implantation following cataract surgery is contraindicated
- D. Hyphaema during cataract surgery is due to iris neovascularization

76. A young patient presents to the ophthalmic outpatient department with gradual blurring of vision in the left eye. Slit lamp examination reveals fine stellate keratatic precipitates and aqueous flare and a typical complicated posterior subcapsular cataract. No posterior synechiae were observed. The most likely diagnosis is:

- A. Intermediate Uveitis (Pars plants)
- B. Heerford's disease
- C. Heterochromic iridocyclitis of Fuch's
- D. Subacute Iridocyclitis

77. Which of the following drug is currently used for the prophylaxis of non infectious uveitis in LUMINATE program:

- A. Cyclosporine
- B. Vaclosporine
- C. Methotrexate
- D. Infliximib

78. Amsler's sign is seen in:

- A. Posner-Schlossman syndrome
- B. Pars planitis

- C. Macular degeneration
- D. Fuch's uveitis

79. The use of highly active anti-retroviral therapy (HAART) is associated with the development of:

- A. Keratitis
- B. Uveitis
- C. Retinitis
- D. Optic neuritis

Quick Text Review

CATARACT

CONGENITAL AND DEVELOPMENTAL CATARACT

1. *Cataracta centralis pulverulenta*

- It is also known as embryonic nuclear cataract
- Bilateral small rounded opacity with powdery appearance lying in the centre (embryonic nucleus)
- Hereditary with dominant genetic trait.

2. *Lamellar (Zonular) cataract*

- Commonest type, accounting for 50 percent of visually significant cases
- Usually bilateral, opacity involves a zone of foetal nucleus around the embryonic nucleus with peripheral riders (spokes of a wheel).
- May be genetic or due to vitamin-D deficiency or maternal rubella between 7 and 8 weeks of gestation. Hypoparathyroidism during pregnancy may also cause this type of cataract.

3. *Sutural cataract*

Usually static, bilateral, punctate opacities scattered around the Y-shaped sutures, of different patterns, (floriform, coralliform, spear shaped and anterior axial embryonic cataract).

4. *Anterior polar cataract*

- It is also known as *pyramidal cataract*
- Occurs due to delayed formation of anterior chamber or acquired following corneal perforation in childhood or ophthalmia neonatorum.
- Morphological types are: Thickened white plaque, anterior pyramidal cataract and reduplicated cataract or double cataract (the buried opacity is called 'Imprint').

5. *Posterior polar cataract*

Occurs due to persistence of posterior vascular capsule of the lens.

6. *Coronary cataract*

- Occurs at puberty and thus involves the adolescent nucleus or deeper cortex
- Characterised by club-shaped radiating opacities involving the periphery (so vision is usually unaffected).

7. *Blue-dot cataract (Cataracta-punctata cerulea)*

Stationary, rounded, bluish, punctate opacities involving adult nucleus or deep cortex. In minute degrees, it is almost universal in occurrence. Develops in second decade of life. It does not involve vision.

8. *Total cataract*

It may be hereditary or associated with rubella, either unilateral or bilateral.

9. *Congenital membranous cataract*

Occurs due to partial or total absorption of lens matter.

Management of Congenital cataract

Surgical treatment in the form of lens aspiration or lensectomy with posterior capsulotomy and anterior vitrectomy is the procedure of choice.

Timing of surgery

- Bilateral cataract, in dense early surgery by 4-6 weeks of age and in partial, it may not be required until later if at all.
- Unilateral cataract. In dense cataract, urgent surgery within days is required. Partial cataract can be observed and treated nonsurgically by part time occlusion to prevent amblyopia.

Visual prognosis is very poor in unilateral advanced cataract because of dense stimulus deprivation amblyopia.

Correction of paediatric aphakia above two years with posterior chamber intraocular lens

implantation, and below two years with extended wear contact lens, or spectacles in bilateral cases.

ACQUIRED CATARACTS

I. Senile cataract (age-related cataract)

- It is the most common form of cataract.
- *Senile cataract is an age change*. Factors affecting its onset and maturation include: Heredity, exposure to ultraviolet radiations from sunlight, diet, and dehydrational crisis in childhood.
- The main *biochemical features* of cortical senile cataract are decreased levels of total proteins, amino acids and potassium associated with increased concentration of sodium and marked hydration of the lens. While nuclear cataract is accompanied by a significant increase in water insoluble proteins which give brown colour to nucleus. Intensification of age-related nuclear sclerosis associated with dehydration and compaction of nucleus resulting in hard cataract.
- *In a fully developed cataract*, glutathione, ascorbic acid and riboflavin are deficient or absent. These are the principal agents mediating the auto-oxidative system of the lens.
- *Cuneiform cataract accounts for 70 percent cases*, cupuliform cataract for 5 percent cases and Nuclear cataract for 25 percent cases of senile cataract.
- *Monoocular diplopia or polyopia* (incipient stage) occurs in cuneiform cataract.
- *Cupuliform* (posterior subcapsular) cataract lies right in the pathway of axial rays, and thus, causes an early loss of vision.
- *Second sight or myopic shift* is seen in nuclear cataract.

II. Metabolic cataracts

1. Diabetic cataract: The true diabetic cataract, usually occurring in young adults is characterised by acute onset, often bilateral, 'snow-flake opacities'. Accumulation of 'Sorbitol' due to NADPH+ dependent aldose reductase pathway is primarily responsible for development of true diabetic cataract. Fluctuating refractive error is a feature of diabetic cataract.

2. Galactosaemic cataract (oil droplet cataract)

is associated with inborn error of galactose metabolism due to deficiency of galactose-1-phosphate uridylyltransferase (GPUT). A related disorder occurs due to deficiency of galactokinase causing lamellar cataract. Accumulation of 'dulcitol' is primarily responsible for development of galactosaemic cataract. Development of cataract

may be prevented by early diagnosis and elimination of milk from the diet.

3. Hypocalcaemic cataract may be associated with parathyroid tetany.

4. Sunflower cataract may be associated with inborn error of copper metabolism (Wilson's disease).

5. Cataract may be seen in Lowe's (oculocerebral-renal) syndrome; an inborn error of amino acid metabolism. Other ocular features are microphakia, posterior lentiglobus and glaucoma.

III. Complicated cataract

- It may occur secondary to uveitis, retinitis pigmentosa, myopic chorioretinal degeneration and long standing retinal detachment.
- Posterior subcapsular cataract is typically characterised by polychromatic lustre and breadcrumb appearance.

IV. Toxic cataracts

1. *Corticosteroid-induced cataract:* Posterior subcapsular opacities may be associated with the use of topical as well as systemic steroids.
2. *Miotics-induced cataract:* Anterior subcapsular granular cataract may be associated with the use of long acting miotics such as echothiophate and demecarium bromide.
3. *Other causes* of toxic cataracts are chlorpromazine, amiodarone, gold (used for treatment of rheumatoid arthritis, and busulphan (used for treatment of chronic myeloid leukaemia).

V. Radiational cataract

1. *Infra-red (heat) cataract.* It typically occurs as discoid posterior subcapsular opacities in workers of glass industry, hence the name 'glass-blower's cataract'.
 2. *Irradiation cataract:* It may follow exposure to X-rays, γ -rays or neutron.
 3. *Ultraviolet radiation* has been linked with senile cataract.
- Most common type of radiational cataract is posterior subcapsular cataract (PSC).

VI. Electric cataract

It may occur following passage of powerful electric current through the body. Punctate subcapsular opacities which mature rapidly.

VII. Syndermatotic cataract

It is associated with skin disorders like atopic dermatitis, scleroderma and keratosis.

VIII. Traumatic cataract

Traumatic cataract is flower rosette shaped cataract.

IX. Miscellaneous cataract

- Christmas tree cataract is seen in myotonic dystrophy
- Shield cataract occurs in atopic keratoconjunctivitis
- Neurofibromatosis (NF2) is associated with posterior subcapsular cataract.

Management of cataract in adults

Extracapsular cataract extraction (ECCE) with posterior chamber IOL is the treatment of choice.

- *Incidence of post-operative complications* such as endophthalmitis, cystoid macular oedema and retinal detachment is comparatively low with extracapsular cataract extraction (ECCE) as compared to intracapsular cataract extraction (ICCE).
- *Phacoemulsification* is a technique of ECCE. *Surgical steps* include a 3.2 mm clear corneal volvular incision, continuous curvilinear capsulorhexis, hydrodissection, emulsification and aspiration of nucleus using ultrasonic phacoprobe. The phaco needle vibrates longitudinally at an ultrasonic speed of 40,000 times per second.
- *Femtosecond laser assisted cataract surgery (FLACS)* is the most advanced technique of MICS.
- *Manual small incision cataract surgery (SICS)* is a low-cost alternative to phacoemulsification which offers the advantages of sutureless cataract surgery with the added advantages of having wider applicability and an easier learning curve.

Intraocular lens implantation is the best method for correction of aphakia.

- *Anterior chamber IOLs*: These lie entirely in front of the iris and are supported in the angle. These are not much popular due to comparatively higher incidence of bullous keratopathy. Commonly used IOL is Kelman multiflex lens.
- *Iris supported lenses*: These are fixed on the iris with the help of sutures, loops or claws. These are also not popular due to higher rate of complications.
- *Posterior chamber lenses*: These lie behind the iris and may be supported by ciliary sulcus or capsular bag. These are very popular and are available in modified C-loop and other designs.

Three types of PCIOLs available are:

- *Rigid IOLs* are made of PMMA
- *Foldable IOLs* are made of silicone, acrylic or hydrogel for implantation through a small (3.2 mm) incision.

- *Rollable IOLs* are ultrathin lenses for implantation through microincision (1 mm) after phakonit technique.

- *Primary IOL* implantation refers to the use of IOL during surgery for cataract, while secondary IOL is implanted to correct aphakia in previously operated eye.
- *Calculation of IOL power* is done by SRK formula: $P = A - 2.5L - 0.9K$; where P = IOL power in diopters. A = specific constant of IOL, L = axial length of eyeball in mm and K = average keratometric reading.

DISPLACEMENTS OF LENS

- *On distant direct ophthalmoscopy*, edge of the clear subluxated lens is seen dark due to total internal reflection of the light.
- *Anterior dislocation* (in anterior chamber): Clear lens is seen as an oil drop in the aqueous.
- *Posterior dislocation* (in vitreous humor): lens may be floating in the vitreous (lens nutans) or fixed to the retina (*lens fixata*).
- *Simple ectopia lentis*: Displacement is bilaterally symmetrical and usually upwards. Autosomal dominant inheritance.
- *Ectopia lentis et pupillae*: Displacement of lens is associated with slit-shaped pupil. Other associations may be cataract, glaucoma and retinal detachment.
- *Ectopia lentis with systemic anomalies include*: Marfan's syndrome: Lens is subluxated upward and temporally in both eyes.
- *Homocystinuria*: Lens is subluxated downward.
- *Well-Marchesani syndrome*: Characterised by spherophakia and anterior subluxation of lens.
- *Ehlers-Danlos syndrome*. Subluxated lens may be associated with blue sclera, keratoconus and angioid streaks.
- *Consecutive or spontaneous displacements* as seen in hypermature cataract, buphthalmos, high myopia, intraocular tumours, and chronic cyclitis.

CONGENITAL ANOMALIES OF LENS

- *Coloboma of the lens*: A notch usually seen in the inferior quadrant of the equator. Occurs due to defective development of the suspensory ligament in that part.
- *Anterior lenticonus*: Cone-shaped anterior axial bulge. May occur in Alport's syndrome.
- *Posterior lenticonus*: Posterior axial bulge may occur in Lowe's syndrome.

- *Micro-spherophakia*: A small spherical lens may occur as an isolated finding or as a feature of Well Marchesani's or Marfan's syndrome.
- *Microphakia* is a small lens which occur in Lowe's syndrome.
- *Lentiglobus*: Generalized hemi-spherical deformity.
- *Zonular or lamellar cataract* is the commonest congenital cataract causing visual impairment (otherwise blue dot cataract is the commonest congenital cataract).
- *Most common postoperative complication* of extra-capsular cataract extraction is posterior capsule thickening.
- The best method to decide about the immaturity and maturity of senile cataract is distant direct ophthalmoscopy.
- The visual loss in posterior polar cataract is much more than the anterior polar cataract, because the former is close to the nodal point of the eye.
- Cryoextraction is the safest method for intra-capsular technique in intumescent cataract.
- Cupuliform or posterior cortical cataract seldom matures.
- *Down syndrome*. Ocular features include: Kerato-conus, bruchfield spot, and blue dot cataract.

SOME SALIENT POINTS

- The lens is incapable of becoming inflamed due to the capsule.
- The most common manifestation of developmental cataract is punctate cataract (blue dot cataract).
- *Presenile cataract* occurs in patients with atopic dermatitis (stellate opacities mostly posterior), dystrophica myotonia (christmas tree cataract), and GPUT and GK enzyme deficiency.

Multiple Choice Questions (MCQs)

1. Is the most common type of congenital cataract:

- A. Lamellar cataract
- B. Cataracta centralis pulverulenta
- C. Coronary cataract
- D. Coralliform cataract

2. Visual prognosis is poor in:

- A. Bilateral congenital cataract
- B. Unilateral congenital cataract
- C. Zonular cataract
- D. Cataract pulverulenta

3. The most common type of senile cataract is:

- A. Cuneiform cataract
- B. Cupuliform cataract
- C. Nuclear cataract
- D. None of the above

4. Complete unilateral congenital cataract should preferably be operated:

- A. Within a few weeks of birth
- B. At the age of 6 months
- C. At the age of 2 years
- D. At the age of 5 years

5. Immature senile cataract can be best differentiated from mature senile cataract by:

- A. Iris shadow test
- B. Oblique illumination examination
- C. Visual acuity testing
- D. Distant direct ophthalmoscopy
- E. Pin-hole test

6. A true diabetic cataract is also known as:

- A. Sunflower cataract
- B. Rosette-shaped cataract
- C. Snow-storm cataract
- D. Coronary cataract

7. The early changes in corticosteroid-induced cataract are in the form of:

- A. Central posterior subcapsular lens changes
- B. Anterior cortical lens changes
- C. Nuclear changes

- D. Diffuse lens changes
- E. None of the above

8. The type of cataract seen in Wilson's disease is:

- A. Sunflower cataract
- B. Snowflake cataract
- C. Posterior subcapsular cataract
- D. Coronary cataract

9. All are the causes of complicated cataract except:

- A. Pars planitis
- B. Retinitis pigmentosa
- C. Retinal detachment
- D. Posterior vitreous detachment

10. In a patient with senile cataract the macular functions can be tested by all except:

- A. Two-light discrimination test
- B. Swinging flash light test
- C. Maddox rod test
- D. Laser interferometry

11. Elschnig's pearls are a sign of:

- A. Chronic uveitis
- B. Secondary cataract
- C. Cystoid macular oedema
- D. All of the above

12. Lens subluxation occurs in all except:

- A. Homocystinuria
- B. Ehlers-Danlos syndrome
- C. Congenital syphilis
- D. Congenital rubella

13. All are true except:

- A. The infantile nucleus is completely formed by one year of age
- B. The embryonic nucleus is situated between the two Y sutures
- C. Congenital blue dot cataracts are associated with development of senile cataract at an early stage
- D. Zonular cataracts typically affect the outer part of the fetal or the inner part of the adult nucleus

- 14. Anterior lenticonus may be associated with:**
 A. Alport's syndrome
 B. Lowe's syndrome
 C. Marfan's syndrome
 D. Homocystinuria
- 15. During IOL implantation, corneal endothelial damage can be prevented by use of:**
 A. Methyl cellulose
 B. Sodium hyaluronate
 C. Chondroitin sulfate
 D. All of the above
- 16. Is responsible for presenile cataract:**
 A. Atopic dermatitis
 B. Blue dot congenital cataract
 C. Dystrophica myotonica
 D. None of the above
 E. All of the above
- 17. Hyperlysinemia may be associated with:**
 A. Subluxation of the lens
 B. Spherophakia
 C. Strabismus
 D. All of the above
- 18. Most common complication following extra-capsular cataract extraction is:**
 A. After cataract
 B. Corneal endothelial decompensation
 C. Secondary glaucoma
 D. Cystoid macular oedema
- 19. Expulsive choroidal haemorrhage is caused by rupture of:**
 A. Retinal vessels
 B. Short posterior ciliary arteries
 C. The choriocapillaris
 D. Long posterior ciliary arteries
- 20. Cataract in newborn is:**
 A. Zonular
 B. Coronary
 C. Snowflake
 D. Cortical
- 21. During cataractogenesis lens stria appear at first in:**
 A. Upper nasal quadrant
 B. Lower nasal quadrant
 C. Upper temporal quadrant
 D. Lower temporal quadrant
- 22. A mature unioocular cataract in a 3-year-old child:**
 A. Will require refraction
 B. May be absorbed
 C. Should be removed
 D. Should be left as such
- 23. Lens capsule is thinnest at the:**
 A. Central anteriorly
 B. Laterally
 C. Superior pole of the lens
 D. Posterior pole of the lens
- 24. Cataract brunescens result due to deposition of:**
 A. Melanin
 B. Copper
 C. Iron
 D. Silver
 E. Gold
- 25. Polyopia is a symptom of:**
 A. Cortical cataract
 B. Cupuliform cataract
 C. Radiational cataract
 D. Electrical cataract
- 26. All of the following are features of Ehler-Danlos syndrome except:**
 A. Blue sclera
 B. Long stature
 C. Subluxation of lens
 D. Epicanthal folds
 E. Keratoconus
- 27. Ideal site for intraocular lens implantation is:**
 A. Anterior to the pupil
 B. Behind the cornea
 C. In the lens capsule
 D. Behind the lens capsule
- 28. Developmental cataract is seen in:**
 A. Rubella
 B. Galactosemia
 C. Mongolian idiocy
 D. Cretinism
 E. All of the above
- 29. Rosette cataract is seen due to:**
 A. Trauma
 B. Copper foreign body
 C. Diabetes
 D. Hyperparathyroidism
- 30. True about zonular cataract is:**
 A. Bilateral
 B. Stationary
 C. Autosomal dominant
 D. Association with hypocalcemia
 E. All of the above
- 31. The commonest type of cataract in adults is:**
 A. Nuclear cataract
 B. Cortical cataract
 C. Morgagnian cataract
 D. None of the above

- 32. The commonest side effect of lens implant surgery is:**
 A. Vitreous haemorrhage
 B. Glaucoma
 C. Iridocyclitis
 D. Panophthalmitis
- 33. Most common type of cataract following radiation is:**
 A. Posterior subcapsular
 B. Anterior subcapsular
 C. Tear-drop cataract
 D. Diffuse cataract
- 34. Lens has a respiratory quotient of:**
 A. 1
 B. 0.6
 C. 0.7
 D. 0.9
- 35. Causes of early onset of cataract are all except:**
 A. Diabetes mellitus
 B. Smoking
 C. Trauma
 D. Recurrent episodes of diarrhoea
- 36. Cataract is responsible for what percentage of blindness in India:**
 A. 62%
 B. 55%
 C. 80%
 D. 75%
- 37. Most common complication of extracapsular cataract surgery is:**
 A. Retinal detachment
 B. Opacification of posterior capsule
 C. Vitreous haemorrhage
 D. Bullous keratopathy
- 38. Dislocation of lens is seen in:**
 A. Retinoblastoma
 B. Medulloblastoma
 C. Neuroblastoma
 D. None of the above
- 39. In a patient, highest visual morbidity is seen in:**
 A. Nuclear cataract
 B. Intumescent cataract
 C. Posterior subcapsular cataract
 D. Anterior subcapsular cataract
- 40. Commonest type of cataract is:**
 A. Blue dot
 B. Zonular
 C. Cupuliform
 D. Cuneiform
- 41. Christmas tree cataract is seen in:**
 A. Down's syndrome
 B. Rubella
 C. Myotonic dystrophy
 D. Diabetes
- 42. All are the advantages of leaving the capsule behind in cataract surgery except:**
 A. Prevents cystoid macular edema
 B. Decreases endothelial damage
 C. Progressively improves vision
 D. Decreases chance of retinal detachment
 E. Decreases chance of endophthalmitis
- 43. Cataract is caused by all except:**
 A. Ultraviolet radiation
 B. MRI
 C. Infrared radiation
 D. Microwave radiation
 E. Ionizing radiation
- 44. In preoperative assessment of cataract patient following is to be done:**
 A. Axial length of cornea
 B. Corneal thickness
 C. Thickness of the lens
 D. Corneal curvature
- 45. Modern IOL is not made up of:**
 A. Acrylic acid
 B. PMMA
 C. Silicon
 D. Glass
- 46. Second sight phenomenon is seen in:**
 A. Nuclear cataract
 B. Cortical cataract
 C. Senile cataract
 D. Iridocyclitis
- 47. A child has got a congenital cataract involving the visual axis which was detected by the parents right at birth. This child should be operated:**
 A. Immediately
 B. At 2 months of age
 C. At 1 year of age when the globe becomes normal sized
 D. After 4 years when entire ocular and orbital growth becomes normal
- 48. Best site for IOL implant is:**
 A. Endocapsular
 B. Scleral fixation
 C. Anterior chamber
 D. Iris claw implant
- 49. Congenital morgagnian cataract is a feature of:**
 A. Rubella cataract
 B. Lowe's syndrome
 C. Hereditary cataract
 D. Galactosemic cataract

- 50. IOL preferred in children in:**
 A. Foldable acrylic lens
 B. Foldable silicon lens
 C. Three piece PMMA lens
 D. Single piece PMMA lens
- 51. The capsule of the crystalline lens is thinnest at:**
 A. Anterior pole
 B. Posterior pole
 C. Equator
 D. None
- 52. The crystalline lens derives its nourishment from:**
 A. Blood vessels
 B. Connective tissue
 C. Aqueous and vitreous
 D. Zonules
- 53. The major function of major intrinsic protein-26 (MIP-26) is:**
 A. Glucose transport in lens
 B. Transport of water in lens
 C. Diffusion barrier
 D. Capsule of lens
- 54. Most common type of congenital cataract is:**
 A. Capsular
 B. Zonular
 C. Coralliform
 D. Blue dot
- 55. In Cataract, spectacles are advised for following number of weeks after operation:**
 A. 6 weeks
 B. 10 weeks
 C. 12 weeks
 D. 14 weeks
- 56. Which laser is used in the management of after cataracts:**
 A. Argon
 B. Krypton
 C. Nd-YAG
 D. Excimer
- 58. Which of the following is the most important factor in the prevention of the endophthalmitis in cataract surgery?**
 A. Preoperative preparation with povidone iodine
 B. One week antibiotic therapy prior to surgery
 C. Trimming of eyelashes
 D. Use of intravitreal antibiotics
- 59. A patient presents to the emergency department with unocular diplopia. Examination with oblique illumination shows golden crescent while examination with co-axial illumination show a dark crescent line. Which of the following is the most likely diagnosis:**
 A. Lenticonus
 B. Coloboma
 C. Microspherophakia
 D. Ectopia lentis
- 60. In Mafan's syndrome lens dislocation is commonly seen:**
 A. Upwards
 B. Downwards
 C. Supero-temporally
 D. Nasally
- 61. Which of the following is the only reversible cataract:**
 A. Senile cataract
 B. Cataract in galactosemia
 C. Congenital cataract
 D. None
- 62. Minimum vision loss with which cataract:**
 A. Blue dot cataract
 B. Zonular cataract
 C. Anterior polar cataract
 D. Posterior polar cataract
- 63. In preoperative assessment of cataract patient following is to be done:**
 A. Axial length of eyeball
 B. Corneal thickness
 C. Keratometry
 D. Thickness of the lens
 E. Corneal curvature
- 64. Modern IOL is:**
 A. Acrylic acid
 B. PMMA
 C. PML
 D. Silicon
 E. Glass

EXTRA EDGE QUESTIONS

- 57. An infant present with bilateral white pupillary reflex. On slit lamp examination a zone of opacity is observed around the fetal nucleus with spoke like radial opacities. The most likely diagnosis is:**
 A. Cataracto Centralis Pulverulenta
 B. Lamellar cataract
 C. Coronary cataract
 D. Posterior polar cataract
- 65. Complications of cataract surgery:**
 A. Endophthalmitis
 B. Optic neuropathy
 C. Retinal detachment
 D. Vitreous loss
 E. Lagophthalmos

50 : A 51 : B 52 : C 53 : B 54 : D 55 : A
 56 : C 57 : B

58 : A 59 : D 60 : C 61 : B 62 : A
 63 : A, C and E 64 : A, B and D 65 : A, C and D

66. Dislocation of lens is seen in all the following conditions except:

- A. Congenital rubella
- B. Marchesani's syndrome
- C. Marfan syndrome
- D. Homocystinuria

67. Ectopia lentis is seen in:

- A. Marfan's syndrome
- B. Congenital rubella
- C. Homocystinuria
- D. Sulfite oxidase deficiency
- E. Myotonic dystrophy

68. Which ocular structures is the most radio-sensitive:

- A. Lens

- B. Cornea
- C. Retina
- D. Optic nerve

69. Branching posterior spoke like cataracts (Pro-peller) are seen in:

- A. Down's syndrome
- B. Fabry's disease
- C. Neuro fibromatosis
- D. Atopic keratoconjunctivitis

70. Lens contain which antigen?

- A. Sequestered antigens
- B. Cross antigens
- C. Heterophile antigens
- D. Isoantigens

Quick Text Review

AQUEOUS HUMOUR

- Normal range of intraocular pressure is 10–21 mm Hg (mean 16 ± 2.5 mm Hg).
- Normal amount of aqueous humour present in the anterior chamber is 0.25 mL and in posterior chamber is 0.06 mL (total 0.31 mL).
- Normal aqueous production rate is about 2.3 $\mu\text{L}/\text{minute}$.
- Aqueous humour is secreted by non-pigmented epithelium of pars plicata region of the ciliary body.
- *Composition of aqueous* is similar to plasma except that it has high concentration of ascorbate, pyruvate, and lactate; and *low concentration of protein*, urea and glucose. Concentration of ascorbate and bicarbonate is high and that of chloride is low in posterior chamber aqueous as compared to that in anterior chamber.
- *Site of aqueous production is ciliary processes*. Aqueous humour is primarily derived from the plasma.
- *Mechanisms concerned with aqueous production* are diffusion (10%), ultrafiltration (20%), and active secretion (70%).
- *Trabecular (conventional) outflow* of aqueous humour accounts for 90 percent and *uveoscleral outflow* for 10 percent.

PRIMARY GLAUCOMAS

CONGENITAL/DEVELOPMENTAL GLAUCOMA

It may occur in three forms:

Primary congenital glaucoma occurs due to trabeculodysgenesis and is not associated with any other anomaly.

Congenital glaucoma with other associated ocular anomalies, such as posterior embryotoxon, Axenfeld–Rieger syndrome, aniridia, congenital microcornea, occurs due to iridocorneal dysgenesis.

Congenital glaucoma with associated systemic syndromes, e.g. Sturge–Weber syndrome, Von Recklinghausen’s neurofibromatosis, and Lowe’s syndrome.

Primary congenital glaucoma

- In about 40% cases, it presents since birth (New born glaucoma or *True congenital glaucoma*)
- In about 50% cases, it manifests prior to the age of 2 years (*Infantile glaucoma*)
- In 10% cases, it presents between 2 and 10 years of the age (*Juvenile glaucoma*).
- When it occurs before 3 years of age, eyeball usually enlarges, and so the term *buphthalmos* is used.

Prevalance and genetics

- Autosomal recessive inheritance with incomplete penetrance
- Affects 1 in 10,000 live births
- Male : female ratio: 3:2
- Bilateral in 75% cases.

Clinical features

- Lacrimation (first symptom), photophobia, blepharospasm and eye rubbing.
- Buphthalmos (occurs with onset before the age of 3 years), characterized by enlarged eyeball, corneal diameter more than 13 mm, corneal oedema (first sign), Haab’s striae (healed splits in Descemet’s membrane), deep anterior chamber, raised IOP, and variable optic disc cupping. Eye becomes myopic.
- *Gonioscopic examination* may reveal: Mesodermal membrane (Barkan’s membrane), thickening of trabecular sheets, hypoplastic iris stroma and insertion of iris above scleral spur.

Treatment

- *Goniotomy* is the surgery of choice (80% success rate).

- *Trabeculotomy* is required when corneal clouding prevents visualization of angle for goniotomy.
- *Combined trabeculotomy and trabeculectomy* (with antifibrotic treatment) is nowadays the preferred surgery with better results.

PRIMARY OPEN-ANGLE GLAUCOMA (POAG)

Predisposing and risk factors

1. Heredity: POAG has a polygenic inheritance. The approximate risk of getting disease in siblings is 10 percent and in offspring is about 4 percent.

2. Age: Affects 1 in 100 of population over 40 years of age. Risk increases in 50–70 years of age.

3. High myopes are more predisposed than the emmetropes.

4. Other risk factors include thyrotoxicosis, diabetes mellitus, and cigarette smoking.

Signs

1. IOP changes: Initially there is exaggeration of the normal diurnal variation. A difference of more than 6 mmHg is suspicious and over 8 is diagnostic (normal below 5). In later stages IOP is permanently raised and ranges between 30 and 45 mmHg.

2. Optic disc changes: Normal cup/disc ratio is 0.3. Asymmetry of more than 0.2 between two eyes and/or notching of the neural rim is suspicious. Marked cupping (0.7 to 0.9) may occur in advanced cases.

- Nasal shift of blood vessels at the disc with appearance of being broken at the margin (Bayoneting sign)
- NRR thinning/notching
- Lamellar dot sign
- Increased pallor (area of disc lacking small vessels)
- Haemorrhages on the disc or disc margin
- Glaucomatous optic atrophy (white and deeply excavated disc) is the end result.

3. Visual field defects: These run parallel to the optic disc changes and progress in the following sequence:

- Baring of blind spot (earliest field defect)
- Paracentral scotoma between 10 and 20 degrees of visual field (Bjerrum's area). It is the earliest clinical significant field defect.
- Seidel's sign (sickle-shaped extension of blind spot)
- Arcuate or Bjerrum's scotoma
- Ring or double arcuate scotoma
- Roenne's central nasal step
- Peripheral nasal step of Roenne's

- Tubular vision with a temporal island of vision
- Advanced field loss with a temporal island of vision only
- Complete loss of vision.

Ocular associations

High myopia, Fuchs' endothelial dystrophy, retinitis pigmentosa, central retinal vein occlusion and primary retinal detachment.

Diagnosis

1. Established POAG: IOP more than 23 mmHg associated with definite disc cupping and visual field defects.

2. Glaucoma suspect or ocular hypertension. IOP more than 23 mmHg with no disc changes or visual field defects. These cases should be treated as cases of POAG under following circumstances:

- Significant diurnal variation (more than 8 mmHg)
- Significantly positive water drinking provocative test (more than 8 mmHg)
- More than 0.2 asymmetry of cup-disc ratio in two eyes
- Splinter haemorrhages over or near the disc
- Family history of glaucoma
- IOP constantly more than 30 mmHg
- Diabetic and highly myopic patients.

3. Low tension glaucoma (LTG) or normal tension glaucoma: IOP less than 21 mmHg with typical disc and/or visual field defects.

Treatment

1. Medical therapy

a. Topical treatment is the treatment of choice for POAG in both eyes

- *Topical prostaglandin analogues* are the first drugs of choice (increase uveoscleral aqueous outflow) (latanoprost, bimatoprost, travoprost)
- *Topical beta blockers* decrease aqueous secretion from ciliary epithelium and are of second choice.
- *Alpha agonists*, non-selective, e.g. epinephrine and **dipivefrine**, increase uveoscleral aqueous outflow. Selective alpha 2 agonists, e.g. apraclonidine and brimonidine decrease aqueous outflow.
- *Carbonic anhydrase inhibitors*, e.g. dorzolamide, acetazolamide and brinzolamide decrease aqueous secretion due to lack of HCO_3^- .
- *Cholinomimetics*, e.g. pilocarpine, physostigmine, carbachol, echothiophate increase aqueous outflow by opening of trabecular meshwork due to ciliary muscle contraction.

b. Systemic therapy consists of carbonic anhydrase inhibitors (acetazolamide, dichlorophenamide, methazolamide), and hyperosmotic agents, e.g. mannitol and glycerol which reduce the vitreous volume.

II. Argon or diode laser trabeculoplasty

When treatment with antiglaucoma medications fails, laser trabeculoplasty is indicated.

III. Surgery (filtration surgery)

Most common surgery is trabeculectomy.

Note: POAG is a bilateral condition. Treatment of fellow eye is the same.

PRIMARY ANGLE-CLOSURE GLAUCOMA (PACG)

Prevalence

There is a great ethnic variability in the prevalence of PACG. The ratio of POAG versus PACG reported for different ethnic groups is as below:

Ethnic group	POAG : PACG
• European, African and Hispanics	5 : 1
• Urban Chinese	1 : 2
• Mongolians	1 : 3
• Indians	1 : 1

Clinical features

A. Symptoms

- Severe pain,
- Associated with nausea and vomiting and
- Colored halos seen.

B. Signs

- Pupil semidilated, vertically oval, fixed and non reactive to bright light and
- IOP increased.

Etiology

Predisposing factors

- Hypermetropic eyes with shallow anterior chamber
- Eyes in which iris-lens diaphragm is placed anteriorly
- Eyes with narrow angle of anterior chamber due to small eyeball, relative large crystalline lens or bigger size of the ciliary body
- Plateau iris configuration
- Sex; Male : Female is 1 : 3
- Nervous personality with unstable vasomotor system
- Positive family history
- Usually fifth or sixth decade of life.

Precipitating factors for acute PAC

- Dim illumination

- Emotional stress
- Use of mydriatics (atropine).

Clinical stages/Classifications

New classification (2006) of PAC disease is as below:

1. Primary angle closure suspect (PACS) is diagnosed when gonioscopy reveals iridotrabecular contact in $>270^\circ$ angle and no peripheral anterior synechia with normal IOP, optic disc and visual fields. Impression: the angle is at risk.

2. Primary angle closure (PAC) is characterized by:

- $>270^\circ$ iridotrabecular contact on gonioscopy
- IOP elevated and/or PAS present
- Optic disc and visual fields normal.

Impression: Angle is abnormal either in function (elevated IOP) and/or in structure (PAS +ve)

Acute primary angle closure: Sudden rise in IOP occurs due to total angle closure.

Surgical treatment is required after medical control of IOP

- Peripheral iridectomy/laser iridotomy—when peripheral anterior synechiae (PAS) are formed in less than 50 percent of the angle of anterior chamber
- Filtration surgery (e.g. Trabeculectomy)—when PAS are formed in more than 50 percent of the angle
- Peripheral iridectomy/laser iridotomy should also be considered for the fellow eye.

3. Primary angle closure glaucoma (PACG) is labeled when:

- Iridotrabecular contact is seen in $>270^\circ$ angle on gonioscopy
- PAS are formed
- IOP is elevated
- Optic disc and visual fields show typical glaucomatous damage.

PACG may develop as a sequelae to subacute or acute PAC or due to gradual and progressive (creeping) synechial angle closure.

Absolute glaucoma—In this end stage, the eye is painful, completely blind, and IOP is very high.

SECONDARY GLAUCOMAS

1. Lens-induced glaucomas

- Phacomorphic: IOP is raised due to secondary angle closure and/or pupil block by lens intumescence

or, anterior subluxation or dislocation of lens or spherophakia.

- **Phacolytic:** An acute secondary open-angle glaucoma due to clogging of trabecular meshwork by macrophages laden with lens proteins in a patient with hypermature cataract.
- **Lens particle glaucoma:** It occurs due to trabecular blockage by the lens particles.
- **Phacoanaphylactic:** It occurs due to sensitisation of eye or its fellow to lens proteins. IOP is raised due to clogging of trabeculae by inflammatory material.

2. Glaucomas due to uveitis

- **Non-specific hypertensive uveitis:** IOP is raised due to clogging by inflammatory material and associated trabeculitis.
- **Specific hypertensive uveitis syndromes:** These include: Fuchs' uveitis syndrome and glaucomatocyclitic crisis.
- **Post-inflammatory glaucoma:** It may result from annular synechiae, occlusiopupillae, angle closure following iris bombe formation or angle closure due to organisation of the inflammatory debris.

3. Pigmentary glaucoma

- About 35 percent of patients with pigment dispersion syndrome develop pigmentary glaucoma.
- Bilateral condition, typically affecting young myopic males.
- Glaucomatous features are similar to POAG with associated pigment deposition on corneal endothelium (Krukenberg's spindle), trabecular meshwork, iris, lens and zonules.

4. Neovascular glaucoma

- **Rubeosis iridis**
- It results due to formation of a neovascular membrane involving angle of the anterior chamber.
- Usually, stimulus to new vessel formation is retinal ischaemia as seen in diabetic retinopathy, CRVO, Eales' disease. Other rare causes are chronic uveitis, intraocular tumours, old retinal detachment, "CRAO" (known as 100 day glaucoma) and retinopathy of prematurity
- Neovascularisation begins at pupil and spreads centrifugally

Management includes: Panretinal photocoagulation to prevent stimulus to new vessel formation

- **Glaucoma implant** (e.g. Molteno tube) operation
- **Cyclocryotherapy.**

5. Glaucoma associated with intraocular tumours

Intraocular tumours such as retinoblastoma and malignant melanoma may raise IOP by one or more of the following mechanisms:

- Trabecular block by tumour cells
- Neovascularization of the angle
- Venous stasis following obstruction to vortex veins.

6. Pseudoexfoliative glaucoma (Glaucoma capsulare)

- Pseudoexfoliative syndrome (PES) refers to amyloid like deposits on pupillary border, anterior lens surface, posterior surface of iris, zonules and ciliary processes.
- 70 percent cases of PES are associated with raised IOP (secondary open-angle glaucoma).
- Other features and treatment are similar to POAG.

7. Glaucoma in aphakia

It implies association of glaucoma with aphakia.

Causes

- Raised IOP due to postoperative hyphaema, inflammation, vitreous filling the anterior chamber
- Angle closure due to flat anterior chamber
- Pupil block with or without angle closure
- Undiagnosed pre-existing POAG
- Steroid-induced glaucoma
- Epithelial ingrowth
- Aphakic malignant glaucoma.

8. Steroid-induced glaucoma

- Roughly, 5 percent of general population is high steroid responder (develop marked rise of IOP after about 6 weeks of steroid therapy), 35 percent are moderate and 60 percent are non-responders
- Pathogenesis: Probably mucopolysaccharides are deposited in the trabecular meshwork
- Features are similar to POAG.

Management

- Can be prevented by judicious use of steroids
- IOP may normalise in 98 percent of cases within 10 days to 4 weeks of discontinuation of steroids
- Medical therapy with 0.5% timolol maleate is effective during normalization period
- Filtration surgery is required in intractable cases.

9. Ciliary block glaucoma (Malignant glaucoma)

Also known as ciliovitreous block or aqueous misdirection syndrome.

- It can occur as a complication of any intraocular operation.

- Classically, it occurs following peripheral iridectomy or filtration operation for primary narrow-angle glaucoma.
- Pathogenesis involves ciliolenticular or ciliovitreal block.

Clinical Features

- Persistent flat anterior chamber with negative Seidel's test
- Markedly raised IOP
- May be phakic, aphakic or pseudophakic
- Vortex veins seen in malignant melanoma.

Management

1. Medical therapy (is useful in about 50 percent cases):

- a. Atropine eye drops
- b. Acetazolamide 250 mg TDS
- c. 0.5% Timolol maleate eye drops BD

2. Surgical therapy: Anterior vitrectomy and injection of air in the anterior chamber.

Note: YAG laser hyaloidotomy is also used as a treatment modalities.

10. Glaucoma associated with intraocular haemorrhage

- *Haemolytic glaucoma:* Acute open-angle glaucoma which occurs due to obstruction of the trabecular meshwork by macrophages laden with lysed RBC debris after hyphaema.
- *Ghost cell glaucoma:* It occurs in aphakic eyes with vitreous haemorrhage. RBCs converted into Khaki coloured ghost cells block the trabecular meshwork.
- *Red cell glaucoma:* Caused by blockage of trabecular meshwork by RBCs following massive hyphaema.
- *Haemosiderotic glaucoma:* It occurs due to sclerotic changes in trabecular meshwork induced by iron from the haemoglobin.

11. Glaucoma associated with iridocorneal-endothelial (ICE) syndromes

- ICE syndromes include progressive iris atrophy, corneal edema, Chandler's syndrome and Cogan-Reese syndrome.
- IOP is raised due to endothelial membrane lining the trabecular meshwork.

Histopathology: Collagen deposit on posterior surface of Descemet's membrane.

MISCELLANEOUS POINTS

- *Congenital anomaly most commonly associated with buphthalmos* is facial haemangiomas.
- *Sampaulesi's line* refers to heavy pigment deposition in a line above Schwalbe's line in the angle of anterior chamber (a feature of exfoliative glaucoma).
- *Vogt's triad* includes glaukomflecken (anterior subcapsular lenticular opacity), patches of iris atrophy and slightly dilated nonreacting pupil (due to sphincter atrophy); seen in the eye which has suffered an attack of acute congestive glaucoma.
- *Pilocarpine* and other *miotics* are *contraindicated* in inflammatory glaucoma, malignant glaucoma and glaucoma due to spherophakia.
- *Most preferred site for filtering operation* is superior nasal quadrant.
- *Pilocarpine in angle closure glaucoma* should be used after control of IOP by aqueous suppressant and hyperosmotic agents.
- *Argon laser trabeculoplasty* is only the adjuvant to medical therapy of primary open-angle glaucoma.
- *Miotics are not useful* in a buphthalmos, aphakic glaucoma, glaucomatocyclitic crisis, glaucoma inversus and in epidemic dropsy glaucoma.
- *Secondary glaucoma after perforation of the cornea* is due to blockage of the drainage angle by anterior synechiae.
- *In acute-congestive glaucoma*, the choice of surgery between peripheral iridectomy and filtering operation is decided by gonioscopic examination.
- *Single most important test in diagnosing POAG* and response to treatment is visual field testing.
- *Earliest and most constant symptom in infantile glaucoma* is lacrimation.
- *Latanoprost:* PGF₂α.
 - Uses: Uveoscleral pathway (only drug)
 - DOC of open angle glaucoma.
 - Most potent antiglaucoma.
 - DOC of low tension glaucoma.
- *Safest antiglaucoma/drug of choice in children* is dorzolamide.
- *Antiglaucoma drugs causing blepheroconjunctivitis*
 - Latanoprost (clinically significant and most common)
 - Timolol
 - Dipiverfrine
- *Increased IOP in glaucoma damages* retinal ganglion cells (RGC).
- *Nasal field* first to be damaged and temporal last.

- *Commonest hazard following surgery* of narrow angle glaucoma is *malignant glaucoma*.

- Diffused iris melanoma causes intractable secondary glaucoma.
 - In epidemic dropsy, wide angle glaucoma is associated with raised levels of histamine , prostaglandin and proteins (hypersecretary glaucoma)
 - Fincham's test is used to differentiate the halos of PACG and immature cataract, in this stenopaeic slit is passed across the pupil, glaucomatous halos remains intact while halos due to cataract are broken into segments.
 - Inverse glaucoma: Pilocarpine causes paradoxical rise in IOP.
 - Well-Marchesani syndrome is associated with spherophakia
- Mnemonic (5S)
- Short
Stubby finger
Stupid
Spherophakia
Subluxation.

Multiple Choice Questions (MCQs)

1. **Normal aqueous production rate is about:**
 - A. 2 l/min
 - B. 2.3 µl/min
 - C. 2.6 µl/min
 - D. 2.9 µl/min
2. **Trabecular (conventional) outflow of aqueous humour accounts for:**
 - A. 90 percent
 - B. 80 percent
 - C. 70 percent
 - D. 60 percent
3. **Incidence of congenital glaucoma is:**
 - A. 1 in 1000 births
 - B. 1 in 5000 births
 - C. 1 in 10,000 births
 - D. 1 in 34,000 births
4. **In normal diurnal variation, intraocular pressure is:**
 - A. Highest on awakening and lowest during evening
 - B. Lowest during morning and highest during evening
 - C. Highest in the morning and evening
 - D. Lowest in the morning and evening
5. **Normal diurnal variation of intraocular pressure is:**
 - A. 0-2 mm of Hg
 - B. 2-3 mm of Hg
 - C. 3-6 mm of Hg
 - D. 6-8 mm of Hg
6. **In indentation tonometry:**
 - A. Plunger indents a hard eye more than a soft eye
 - B. Lower scale readings are obtained in high intraocular pressure
 - C. Low scleral rigidity gives high reading of intraocular pressure
 - D. All of the above
7. **Retinal nerve fibres most sensitive to glaucomatous damage are:**
 - A. Superior and inferior arcuate fibres
 - B. Macular fibres
 - C. Superior radiating fibres
 - D. Inferior radiating fibres
8. **Incidence of primary open-angle glaucoma in population over 40 years of age is about:**
 - A. 1 in 100
 - B. 1 in 200
 - C. 1 in 500
 - D. 1 in 1000
9. **Sickle-shaped extension of blind spot is known as:**
 - A. Bjerrum's sign
 - B. Seidel's sign
 - C. Down's sign
 - D. Baring of blind spot
10. **Ocular associations of primary open-angle glaucoma include all except:**
 - A. Central retinal vein occlusion
 - B. Central retinal artery occlusion
 - C. Retinal detachment
 - D. Retinitis pigmentosa
11. **Vogt's triad is indicative of:**
 - A. Past attack of herpes zoster ophthalmicus
 - B. Past attack of acute-angle closure glaucoma
 - C. Vogt-Koyanagi-Harada syndrome
 - D. Past attack of acute iridocyclitis
12. **Glaukomflecken is a feature of:**
 - A. Acute narrow-angle glaucoma
 - B. Pseudoexfoliative glaucoma
 - C. Juvenile glaucoma
 - D. Phacolytic glaucoma

- 13. In the incidence of primary angle closure glaucoma, male to female ratio is:**
 A. 1:1
 B. 1:2
 C. 1:3
 D. 1:4
- 14. The earliest clinically significant field defect in primary open-angle glaucoma is:**
 A. Paracentral scotoma
 B. Baring of blind spot
 C. Seidel's scotoma
 D. Isopter contraction
- 15. All are the causes of neovascular glaucoma except:**
 A. Intraocular tumour
 B. Central retinal vein occlusion
 C. Diabetic retinopathy
 D. Central serous retinopathy
- 16. Krukenberg's spindle seen in patients with pigmentary glaucoma refers to deposition of pigment on:**
 A. Trabecular meshwork (gonioscopic sign)
 B. Back of cornea
 C. Anterior surface of the lens
 D. All of the above
- 17. In Fincham's test:**
 A. Glaucomatous halo remains intact
 B. Halo due to immature cataract does not break into segments
 C. Halo due to mucopurulent conjunctivitis is broken into segments
 D. All of the above
- 18. All are the features of an acute attack of primary narrow-angle glaucoma except:**
 A. Intraocular pressure is raised up to 940-70 mm of Hg
 B. Eye is red, painful and tender
 C. Disc shows glaucomatous cupping
 D. Fellow eye also shows shallow anterior chamber
- 19. In Indian population ratio of POAG : PACG is:**
 A. 4:1
 B. 2:1
 C. 1:1
 D. 1:2
- 20. All of the following can precipitate the attack of narrow angle except:**
 A. Prolonged prone position
 B. Mydriatics
 C. Prolonged work in bright light
 D. Emotional upsets
- 21. The most characteristic visual field change in primary open-angle glaucoma is:**
 A. Nerve fibre bundle defect
 B. Enlargement of blind spot
 C. Generalised constriction of field
 D. Sector-shaped defects
- 22. All of the following are true about pigmentary glaucoma except:**
 A. It occurs more often in young myopic men
 B. Iris transillumination defects are noted
 C. It is associated with Krukenberg's spindle
 D. The intensity of pigment deposit in the angle is related to iris colour
- 23. Epinephrine:**
 A. Reduces aqueous production
 B. Reduces outflow facility
 C. Reduces aqueous production and increases outflow facility
 D. Increases aqueous production and reduces outflow facility
- 24. Treatment of malignant glaucoma is:**
 A. Pilocarpine
 B. Cyclocryotherapy
 C. Vitreous aspiration
 D. Trabeculectomy
- 25. Neovascular glaucoma may be associated with all of the following except:**
 A. Diabetes
 B. Hypertension
 C. Central retinal vein occlusion
 D. Intraocular tumours
- 26. Primary open-angle glaucoma is associated with all of the following except:**
 A. Diabetes mellitus
 B. Myopia
 C. Hyperthyroidism
 D. Pars planitis
- 27. Cupping of the disc is not a feature of:**
 A. Buphthalmos
 B. Chronic simple glaucoma
 C. Acute congestive glaucoma
 D. Megalocornea
- 28. Inverse glaucoma occurs in:**
 A. Spherophakia
 B. Lenticonus
 C. Subluxated lens
 D. All of the above
- 29. Lowe's syndrome is characterized by all except:**
 A. Glaucoma
 B. Albuminuria
 C. Glycosuria
 D. Oligoammonuria
 E. Retinal detachment

- 30. All the following can be seen in Axenfeld's anomaly, except:**
 A. Posterior embryotoxon
 B. Iris synechiae to Schwalbe's line
 C. Ectopia of the lens
 D. Glaucoma
- 31. All the following are true concerning Rieger's syndrome except:**
 A. Autosomal recessive inheritance
 B. Glaucoma
 C. The possible presence of facial, dental and osseous defects
 D. The spectrum of Axenfeld's anomaly and marked abnormal development of the iris mesoderm.
- 32. In chronic simple glaucoma the most common field defect is:**
 A. Arcuate field defect
 B. Baring of blind spot
 C. Bjerrum scotoma
 D. Siedel's sign
- 33. Treatment of malignant glaucoma includes all except:**
 A. Topical atropine
 B. Topical pilocarpine
 C. IV mannitol
 D. Vitreous aspiration
- 34. The earliest change in glaucoma is:**
 A. Papilloedema
 B. Hazy cornea
 C. Baring of the blind spot
 D. Sickie scotoma
- 35. Neovascular glaucoma can occur in all except:**
 A. Diabetes mellitus
 B. Hypertension
 C. CRAO
 D. CRVO
- 36. Coloured haloes are found in all except:**
 A. Pigmentary glaucoma
 B. Acute-angle-closure glaucoma
 C. Cataract
 D. Uveitis
- 37. Secondary glaucoma following corneal perforation is due to:**
 A. Central anterior synechiae formation
 B. Peripheral anterior synechiae
 C. Intraocular haemorrhage
 D. Angle recession
- 38. In haemolytic glaucoma the mechanisms are all except:**
 A. Siderosis of trabeculae
 B. Deposition of haemosiderin
 C. RBC clogging the trabeculae
 D. Inflammation
- 39. The most reliable provocative test for angle-closure glaucoma is:**
 A. Homatropine mydriatic test
 B. Mydriatic-miotic test
 C. Water drinking test
 D. Dark room test
- 40. Which of the following types of senile cataract is the most notorious to produce glaucoma:**
 A. Incipient cataract
 B. Lamellar cataract
 C. Hypermature Morgagnian cataract
 D. Intumescent cataract
- 41. All of the following anatomical changes will predispose to primary-angle-closure glaucoma except:**
 A. Small cornea
 B. Flat cornea
 C. Anterior chamber shallow
 D. Short axial length of eyeball
- 42. Argon laser trabeculoplasty is used in:**
 A. Closed-angle glaucoma
 B. Primary open-angle glaucoma
 C. Neovascular glaucoma
 D. Aphakic glaucoma
- 43. In buphthalmos, lens is:**
 A. Anteroposterior flat
 B. Small
 C. Large
 D. None of the above
- 44. First sign seen in open-angle glaucoma is:**
 A. Arcuate scotoma
 B. Extension above blind spot
 C. Roene's nasal step
 D. Siedel's scotoma
- 45. Congenital glaucoma presents as:**
 A. Microphthalmos
 B. Photophobia
 C. Leucocoria (white reflex)
 D. Pain
- 46. In a hypertensive patient with glaucoma which of the following is not used:**
 A. Dipivefrine
 B. Alpha blocker
 C. Alpha agonist
 D. Laser trabeculoplasty
- 47. Schwalbe's ring corresponds to:**
 A. Corneal endothelium
 B. Descemet's membrane
 C. Schlemm's canal
 D. Ciliary body

48. A 75-year old patient present with deterioration of vision. On examination the pupillary reflex is observed to be sluggish and the intraocular pressure is normal. Optic disc evaluation shows a large and deep cup and primarily shows paracentral scotomas. The most likely diagnosis is:

- A. Primary narrow angle glaucoma
- B. Normal tension glaucoma
- C. Neovascular glaucoma
- D. Absolute glaucoma

49. Treatment of primary open angle glaucoma:

- A. Timolol maleate
- B. Atropine
- C. Acetazolamide
- D. Prostaglandin analogue

50. True about primary angle closure glaucoma:

- A. More common in females
- B. Shallow anterior chamber in a tank
- C. Deep anterior chamber is a risk factor
- D. Shorter diameter of cornea is a predisposing factor
- E. Common in myopes

51. Intractable secondary glaucoma is seen in:

- A. Diffuse iris melanoma
- B. Nodular iris melanoma
- C. Melanocytic deposits in anterior part of iris
- D. Melanocyte proliferation in posterior oveal tissue.

EXTRA EDGE QUESTIONS

52. Which of the following is primary glaucoma:

- A. Juvenile glaucoma
- B. Steroid induced glaucoma
- C. Pigmentary glaucoma
- D. Congenital glaucoma
- E. Infantile glaucoma

53. In POAG (primary open angle glaucoma) which is not seen:

- A. Horizontal cupping
- B. Bayonetting sign (crossing of vessels)
- C. Macular oedema
- D. Dot sign

54. A patient presents with H/o evening halos and occasional headache for some months. His examination shows normal IOP but shallow AC. He is in which stage of glaucoma:

- A. Acute
- B. Absolute

- C. Prodrome
- D. Constant instability

55. Acute angle closure glaucoma:

- A. Colored halos present
- B. Flashes of light seen
- C. Deep anterior chamber
- D. Vertically oval pupil
- E. Increased IOP

56. Drug used in acute congestive glaucoma are all except:

- A. Atropine
- B. Pilocarpine
- C. Acetazolamide
- D. Mannitol
- E. Timolol

57. Treatment of acute congestive glaucoma includes all except:

- A. Sclerectomy
- B. Trabeculectomy
- C. Trabeculoplasty
- D. Vitrectomy
- E. Iridotomy

58. Iridocorneal endothelial syndrome is associated with:

- A. Progressive atrophy of iris stroma
- B. Bilateral stromal edema of iris and cornea
- C. Deposition of collagen in Descemet's membrane
- D. Deposition of glycosaminoglycan in Descemet's membrane

59. Treatment option for glaucoma includes all except:

- A. Trabeculectomy
- B. Trabeculotomy
- C. Vitrectomy
- D. Viscoanulostomy
- E. Iridectomy

60. False statement about depth of anterior chamber:

- A. Less in women than men
- B. Correspondent to volume of anterior chamber
- C. Increase with age
- D. More in myopes
- E. Less in hypermetropes

61. Glaucomflecken is:

- A. Acute uvetis due to glaucoma
- B. Lens opacity due to glaucoma
- C. Retinal detachment due to glaucoma
- D. Corneal opacity due to glaucoma

CHAPTER

10

Diseases of Vitreous

Quick Text Review

DISORDERS OF VITREOUS

VITREOUS LIQUEFACTION (SYNCHYSIS)

- Most common degenerative change
- *Causes:* Senile, myopic degeneration, post-inflammatory, post-traumatic.

POSTERIOR VITREOUS DETACHMENT (PVD)

- PVD with vitreous liquefaction (synchysis) and collapse (syneresis) is of common occurrence in majority of the normal subjects above the age of 65 years.
- Flashes of light and floaters may be associated
- A ring like opacity (Weiss reflex) representing a ring of vitreous attachment at the optic disc margin is pathognomic.
- May be complicated by retinal break, retinal and/or vitreous haemorrhage and cystoid maculopathy.

VITREOUS HAEMORRHAGE

- *Causes* are diabetic retinopathy, hypertensive retinopathy, Coats disease, Eales' disease trauma, retinal breaks and/or posterior vitreous detachment, anaemia, leukaemia and sickle cell retinopathy, central retinal vein occlusion, and bleeding disorders—haemophilia, purpura.
- *Clinical features:* Sudden onset of floaters (black spots in front of the eye) when the hemorrhage is small; and sudden painless loss of vision if the haemorrhage is large.
- *Examination reveals* normal anterior segment, no red glow and non-visualization of fundus in a large haemorrhage.
- *B-scan USG* is particularly helpful in diagnosing vitreous haemorrhage
- *Complications* include retinitis proliferans, vitreous liquefaction and degeneration, and ghost cell glaucoma in aphakes.

- *Vitrectomy* is indicated if vitreous haemorrhage does not absorb in 3 months.

PERSISTENT HYPERPLASTIC PRIMARY VITREOUS

- Usually unilateral, bilateral cases are rare and may be associated with Trisomy 13 (Patau syndrome)
- Typically presents as a white reflex (congenital leukocoria) in pupil, it must be differentiated from other causes of leukocoria, particularly retinoblastoma. Differentiating features from retinoblastoma are:
 - Lack of calcification on CT (calcification is an important feature of retinoblastoma)
 - Development of cataract (cataract is rare in retinoblastoma)
 - Unilaterality (retinoblastoma is bilateral in about one-fourth of cases)
- Associations are: Long ciliary processes, microphthalmos, cataract, glaucoma, and vitreous detachment.
- *Visual prognosis* is poor despite early intervention.
- Seen in Patau syndrome.

MISCELLANEOUS POINTS

- *Synchysis (liquefaction) and syneresis (collapse)* are the two most common degenerative changes in the vitreous gel.
- Optimum time for vitrectomy in a patient of bacterial endophthalmitis not responding to conservative treatment is 24 hours after the intravitreal injection of antibiotics.
- Vitreous gel never regenerates
- Strongest attachment of the vitreous is to the ora serrata (vitreous base attachment)
- Most common cause of vitreous haemorrhage is trauma
- Most common cause of spontaneous vitreous haemorrhage is proliferative diabetic retinopathy.

VITRECTOMY

Indications of vitreous surgery

- Vitreous loss during cataract surgery
- Along with lensectomy
- Endophthalmitis
- Vitreous haemorrhage not getting absorbed in 3 months
- Proliferative retinopathies
- Dropped nucleus and intraocular lens
- Intraocular foreign bodies
- Vitreous amyloidosis.
- Aphakic keratoplasty

Types of vitrectomy

- *Anterior vitrectomy*, i.e. removal of anterior vitreous.
- *Core vitrectomy*, i.e. removal of central bulk of vitreous.
- *Subtotal and total vitrectomy*, i.e. removal of almost total vitreous.

Techniques of Vitrectomy

- I. ***Open-sky vitrectomy***. It is performed through the primary wound to manage disturbed vitreous in cataract surgery, aphakic keratoplasty, and globe rupture.

- II. ***Pars-plana vitrectomy (PPV)*** can be:

1. *One-port vitrectomy*, not a preferred technique now-a-days, can be performed with the help of a multifunction vitrectomy probe comprising vitreous infusion, suction, and cutter (VSC)
2. *Three-port-vitrectomy*, the preferred technique, comprises three different ports one each for illumination probe, infusion cannula, and cutter and suction probe. It includes:
 - 20 gauge PPV,
 - 23 gauge PPV, and
 - 25 gauge PPV.

Vitreous Substitute

Vitreous substitute are used in vitreo-retinal surgery to:

- Restore intraocular pressure, and
- Provide intraocular tamponade.

Commonly used vitreous substitutes include:

1. *Expanding gases* e.g:
 - Sulphur hexafluoride (SF₆),
 - Perfluoropropane (C₃F₈)
2. *Perfluoro carbon liquids* (PFCLS), e.g:
 - Perfluoro-n-octane
 - Perfluoro-tributylamine,
 - perfluoro-decalin, and
 - perfluoro-phenanthrene.
3. *Silicone oil*. It allows more controlled retinal manipulation during VR surgery.

Multiple Choice Questions (MCQs)

1. **Synchysis refers to:**
 - A. Liquefaction of the vitreous
 - B. Black spots in front of the eyes
 - C. Collapse of the vitreous
 - D. Detachment of the vitreous
2. **Syneresis refers to:**
 - A. Liquefaction of the vitreous
 - B. Black spots in front of the eye
 - C. Collapse of the vitreous
 - D. Detachment of the vitreous
3. **In vitreous base detachment, vitreous body is detached from its attachment with the:**
 - A. Optic disc
 - B. Ora-Serrata
 - C. Posterior surface of the lens
 - D. Fovea centralis
4. **All of the following are features of asteroid hyalosis except:**
 - A. Usually bilateral
 - B. Solid vitreous
 - C. Spherical calcium bodies
 - D. Usually asymptomatic
5. **All of the following are features of synchysis scintillans except:**
 - A. Fluid vitreous
 - B. Spherical calcium bodies
 - C. Shower of gold rain
 - D. Secondary to trauma or inflammations of the eye
6. **Vitrectomy should be considered if the vitreous haemorrhage is not absorbed within:**
 - A. 1 month
 - B. 3 months
 - C. 6 months
 - D. 2 months
7. **Presistent hyperplastic primary vitreous may be associated with:**
 - A. Long ciliary processes
 - B. Microphthalmos
 - C. Cataract
 - D. All of the above
8. **Commonest cause of vitreous haemorrhage is:**
 - A. Diabetes
 - B. Hypertension
 - C. Trauma
 - D. Lens extraction
9. **Vitreous haemorrhage is seen in all except:**
 - A. Coat's disease
 - B. Eales' disease
 - C. CRVO
 - D. CRAO
10. **Vitreous haemorrhage is not seen in:**
 - A. Hypertension
 - B. Eales' disease
 - C. Trauma
 - D. Diabetes mellitus
 - E. Vitreous degeneration
11. **A vitreous aspirate has been collected in an emergency at 9 pm. What advice would you like to give to the staff on duty regarding the overnight storage of the sample:**
 - A. The sample should be kept at 4°C
 - B. The sample should be incubated at 37°C
 - C. The sample should be refrigerated in deep freezer
 - D. The sample should be refrigerated for the initial 3 hours and then kept at 37°C
12. **Eales disease is:**
 - A. Recurrent optic neuritis
 - B. Recurrent papilloedema
 - C. Recurrent periphelbitis retinae
 - D. None
13. **Eale's disease is:**
 - A. Retinal hemorrhage
 - B. Vitreous hemorrhage
 - C. Conjunctival hemorrhage
 - D. Choroidal hemorrhage

- 14. A 25-year-old male presents with painless sudden loss of vision. Ocular and systemic examination is not contributory. What is probable diagnosis.**

- A. Retinal detachment
- B. Eale's disease
- C. Glaucoma
- D. Cataract

EXTRA EDGE QUESTIONS

- 15. Persistent primary hyperplastic vitreous (PHPV) is associated with:**

- A. Patau syndrome
- B. Edward syndrome
- C. Trisomy 14
- D. Downs syndrome

Diseases of Retina

Quick Text Review

CONGENITAL AND DEVELOPMENTAL DISORDERS

Coloboma of the optic disc

- Results from failure of the embryonic fissure closure.
- Minor defect manifests as inferior crescent, usually associated with hypermetropia or astigmatism.

Drusen of the optic disc

- Lies deep beneath the surface of the disc tissue in childhood (presents as pseudopapilloedema) and emerges out by the early teens presenting as waxy pea-like irregular refractile bodies.

Hypoplasia of the optic disc

- An important cause of blindness at birth in developed countries (rare in developing countries).
- Associated with maternal alcohol use, diabetes and use of certain drugs in pregnancy.
- Bilateral in 60 percent cases.
- Small disc with 'double ring sign' is pathognomonic.

Medullated nerve fibres/Opaque nerve fibres

- Represent myelination of nerve fibres of the retina (normally myelination stops at lamina cribrosa).
- Appear as whitish patch with feathery margins, usually present around the disc and may cause enlargement of the blind spot.
- Disappear in patients with optic atrophy.

Congenital remnants of the hyaloid arterial system

- *Bergmester's papilla*—a flake of glial tissue projecting from the disc (commonest anomaly of the hyaloid system)
- *Mittendorf dot*—remnant of anterior end of hyaloid artery attached to the posterior lens capsule, usually associated with a posterior polar cataract.

INFLAMMATIONS OF RETINA

Retinitis

- *Subacute retinitis of Roth* typically occurs in patients with subacute bacterial endocarditis (SABE)

and is characterised by Roth's spots (superficial haemorrhages with a white spot in the centre).

- *Cytomegalovirus (CMV) retinitis* and herpes zoster retinitis are more common in patients with AIDS. CMV retinitis is most common cause of chorioretinitis in AIDS, typical fundus changes are labeled as crumbled cheese and ketchup appearance (souse and cheese appearance), pizza pie appearance and brush fire appearance.

Periphlebitis retinae

- Primary periphlebitis retinae (*Eales' disease*) an idiopathic inflammatory venous occlusion, is considered a hypersensitive reaction to tubercular proteins.
- Secondary periphlebitis occurs in patients with uveitis.
- *Eales' disease* is a bilateral condition, affecting peripheral retina in young adult males. It is characterised by recurrent primary vitreous haemorrhages.
- *Complications of Eales' diseases* include—rubeosis iridis, neovascular glaucoma, proliferative retinopathy and fractional retinal detachment.

VASCULAR DISORDERS OF RETINA

RETINAL ARTERY OCCLUSIONS

Central retinal artery occlusion (CRAO)

- It occurs due to obstruction at the level of lamina cribrosa.
- *Emboli* are the most common causes of CRAO.
- *Other causes* are giant cell arteritis, SLE, Wegner's granulomatosis, scleroderma, and occasionally raised IOP.
- Causes *sudden painless loss of vision* (central vision not affected in patients with cilioretinal artery).
- Retina becomes white due to oedema and a '*Cherry-red-spot*' is seen at the fovea.

- Arterioles become narrow and blood column within the retinal vessels is segmented (*Cattle-track* appearance).
- Resuscitation time of the human retina following retinal ischaemia is 1½ hours.

Branch retinal artery occlusion (BRAO)

- Occurs following lodgement of embolus at a bifurcation.
- Retina distal to the occlusion becomes oedematous with narrowing of arterioles.
- Later on involved area is atrophied leading to permanent sectorial field defect.

Retinal vein occlusion

- *Predisposing factors* are hypertension, diabetes mellitus, open-angle glaucoma, polycythemia, and periphlebitis.
- *Non-ischaemic central retinal vein occlusion (CRVO)* is most common variety (75%), characterised by mild to moderate visual loss. About 15% cases of nonischaemic CRVO are converted to ischaemic CRVO in 4 months and about 30% in 3 years.
- *Ischaemic central retinal vein occlusion* is characterised by much more marked signs and symptoms than non-ischaemic CRVO.
- *Fundus changes* include tortuous and engorged veins, scattered retinal haemorrhages, cotton wool spots, and unilateral disc changes (Blood and thunder fundus appearance)
- *Complications*. Rubeosis iridis and neovascular glaucoma (NVG) occurs in more than 50 percent cases within 3 months, vitreous haemorrhage, and proliferative retinopathy.
- *Differential diagnosis* of CRVO, most important, is ocular ischemic syndrome. Veins are dilated in both, but veins are tortuous in CRVO.
- *Branch retinal vein occlusion*: the superotemporal branch is the most commonly affected (33%).

HYPERTENSIVE RETINOPATHY

Chronic hypertensive retinopathy

Generalized narrowing of arterioles which may be mild or moderate.

Focal arteriolar narrowing is seen as area of localized vasoconstriction on the disc or within.

Arteriovenous nicking (crossing changes, hallmark of chronic hypertensive retinopathy) include:

- *Salu's sign*, i.e. deflection of veins at crossing
- *Bonnet sign*, i.e. banking of veins distal to crossing
- *Gunn sign*, i.e. tapering of veins on either side of crossing.

Arterial reflex changes. Changes in normal reflex, which is sharp and thin due to blood column under the transparent wall, include:

- *Diffuse and loss bright reflex* is seen due to thickening of vessel wall.
- *Copper wiring*, i.e. reddish brown reflex occurs due to progressive sclerosis and hyalinization.
- *Silver wiring*, i.e. opaque white reflex, occurs ultimately due to continued sclerosis.

Superficial retinal haemorrhages, flame shaped, occur scattered, more around posterior pole.

Hard exudates, i.e. yellow waxy spots occur due to lipid deposits. They are more seen on posterior pole and may be arranged as macular fan or star.

Cotton wool spots, fluffy lesions, represent areas of infarct in nerve fiber layer.

Acute changes of hypertension

Acute hypertensive retinopathy changes includes

- *Marked arteriolar narrowing* due to spasm
- *Superficial retinal haemorrhages*, flame shaped, arranged in clusters.

Keith Wegner grading of hypertensive retinopathy

Grade I: Mild generalized narrowing of arterioles

Grade II: Marked generalized narrowing plus focal constriction of arterioles with deflection of the vein at arteriovenous crossing (Salu's sign)

Grade III: Grade II changes plus copper wiring of arterioles, Bonnet sign, Gunn sign, Salu's sign along with haemorrhages, cotton wool spots and hard exudates.

Grade IV: Grade III changes plus silver wiring and papilledema.

Retinopathy in toxemia of pregnancy

- Earliest changes consist of narrowing of nasal arterioles followed by generalised narrowing.
- Advent of hypoxic changes (cotton wool spots, haemorrhages and retinal oedema) should be considered an indication for termination of pregnancy.

DIABETIC RETINOPATHY

Risk factors

- *Duration of diabetes:* Incidence is about:
 - After 10 years of diabetes 20% of Type I and 25% of Type II.
 - After 20 years of diabetes 90% of Type I and 60% of Type II.

- After 30 years of diabetes 95% of both Type I and Type II.
- *Heredity*: Effect is more on proliferative DR, transmission is recessive
- *Sex*: Male: Female: 3: 4
- *Pregnancy*: Accentuates the changes of DR
- *Hypertension*: Accentuates the changes of DR.

Other ocular manifestations of DM

- Cataract (Snowflake/snow storm)
- Myopia (when there is sudden increase in blood sugar level)
- Rarely hypermetropia
- Cranial nerve palsy: 3rd (most common), 4th, 6th and 7th.

Classification of DR

1. Non-proliferative diabetic retinopathy (NPDR)

Signs

- Microaneurysms (an early sign)
- Dot and blot haemorrhages
- Hard exudates
- Retinal thickening due to diffuse oedema
- Venous abnormalities beading, looping and dilatation
- Cotton-wool spots
- Intraretinal microvascular abnormalities (IRMA)

Treatment is not required, management includes:

- Adequate control of diabetes
- Annual fundus examination.

2. Proliferative diabetic retinopathy

Signs of PDR: In chronological order, over and above the signs of NPDR are as follows:

- Neovascularization on the disc (NVD) or elsewhere (NVE)
- Incomplete posterior vitreous detachment
- Elevation of new vessels and vitreous haemorrhage
- Fibrovascular epiretinal membrane
- Tractional retinal detachment.

Treatment: Panretinal argon photocoagulation (PRP). Intravitreal injection of anti-VEGF before PRP protects the macula and reduces risk of vitreous haemorrhage. Intravitreal triamcinolone may be considered as an adjunct to PRP.

3. Diabetic maculopathy

Focal exudative maculopathy

- Characterized by changes of NPDR and hard exudates arranged in a circinate pattern in macular area.

- Fluorescein angiography reveals focal leakage with adequate macular perfusion.
- *Treatment* of focal DME not involving centre of fovea consists of focal argon laser to microaneurysms and centre of the hard exudates ring.

Diffuse exudative maculopathy

- Changes of NPDR with very few hard exudates in the macular area
- *Diffuse retinal oedema* and thickening throughout the posterior pole
- *Cystoid macular oedema* and lamellar hole in long standing cases
- *Fluorescein angiography* shows diffuse leakage but good macular perfusion.
- *Treatment* consists of intravitreal anti-VEGFs and argon laser photocoagulation should be reserved for recalcitrant cases not responding to anti-VEGFs and intravitreal triamcelone.

Ischaemic maculopathy

- Marked visual loss
- Microaneurysms, haemorrhages, mild or no oedema and only a few hard exudates if any
- Fluorescein angiography shows poor macular perfusion.

Mixed maculopathy

- Features of combined ischaemic and exudative maculopathy are present.

4. Advanced diabetic eye disease

- Persistent vitreous haemorrhage
- Tractional retinal detachment
- Neovascular glaucoma
- Treatment is pars plana vitrectomy with endophotocoagulation and management of RD.

SICKLE-CELL RETINOPATHY

Retinal changes are caused by hypoxia resulting from blockage of small blood vessels by the abnormal shaped rigid red blood cells.

Clinical features

- Stage I: Peripheral arteriolar occlusion
- Stage II: Peripheral arteriovenous anastomosis
- Stage III: Neovascularization
- Stage IV: Vitreous haemorrhage
- Stage V: Vitreoretinal traction bands and tractional retinal detachment.

Treatment

- *Pan retinal photocoagulation (PRP)* is effective in regressing the neovascularization.
- *Pars plana vitrectomy* for stage IV and V.

ANAEMIC RETINOPATHY

- Changes appear when haemoglobin falls below 5 g%
- Pale background and pale arterioles
- Dilated veins
- Superficial haemorrhages and subhyaloid haemorrhage
- A few Roth's spots and cotton wool spots

LEUCAEMIC RETINOPATHY

- Pale and orange fundus background
- Dilated and tortuous veins
- Superficial haemorrhages, Roth's spots and subhyaloid haemorrhage.
- Perivascular leucaemic infiltration

RETINOPATHY OF PREMATURITY (RETROLENTAL FIBROPLASIA)

Occurs in premature infants (weighing less than 1300 gm) exposed to high concentration of oxygen. It is an important cause of leukocoria in children.

Clinical features

- *Stage 1* : Formation of demarcation line.
- *Stage 2* : Formation of retinal ridge.
- *Stage 3* : Ridge with extraretinal fibrovascular proliferation.
- *Stage 4* : Subtotal tractional retinal detachment.
- *Stage 5* : Total retinal detachment.

Management

- *Oxygen concentration* in incubator should be kept less than 30 percent.
- *Regular screening* by indirect ophthalmoscopy between 2 and 4 months of life is most important
- *Ablation of peripheral avascular retina* with cryopexy or photocoagulation when neovascularization is detected
- *Pars plana vitrectomy* for tractional retinal detachment.

COAT'S DISEASE (EXUDATIVE RETINITIS OR EXUDATIVE RETINOPATHY OR RETINAL TELANGIECTASIS)

- It is an idiopathic condition with massive subretinal exudates and associated with telangiectatic retinal vessels and aneurysms.
- Males are more commonly affected in their first decade of life.
- No genetic predisposition.
- White pupillary reflex (leucocoria) may be present.
- Treatment includes early recognition followed by prophylactic laser.

DYSTROPHIES AND DEGENERATIONS OF THE RETINA**RETINITIS PIGMENTOSA (PIGMENTARY RETINAL DYSTROPHY)****Inheritance**

- Autosomal recessive—most common and most severe
- Autosomal dominant—common and relatively benign
- Sex linked—least common, relatively severe.

Incidence

- 1 person per 5000 of the world population
- Male: female ratio is 3: 2
- Bilateral equal involvement.

Clinical features

- *Night blindness*—may occur before the retinal changes, appear.

Fundus changes

- Retinal pigmentary changes occur in the form of perivascular deposition (jet black spots) of bony corpuscle pigments in the equatorial region; which later spread both anteriorly and posteriorly
- Retinal arterioles are attenuated
- Optic disc becomes pale waxy ending in consecutive optic atrophy.

Visual field changes

- Annular or ring scotoma
- Tubular vision in advanced cases.

Electrophysiological changes

- Appear even before the subjective symptoms and signs
- ERG is subnormal or abolished
- EOG is extinguished.

Ocular associations

- Myopia (common)
- Primary open-angle glaucoma in 30 percent
- Microphthalmos
- Keratoconus (rare)
- Subcapsular cataract.

Systemic associations**Laurence-Moon-Biedl syndrome (most common)**

- Retinitis pigmentosa
- Obesity
- Hypogenitalism
- Polydactyly
- Mental deficiency.

Cockayne's syndrome

- Retinitis pigmentosa
- Nystagmus
- Progressive infantile deafness
- Dwarfism
- Mental retardation
- Ataxia.

Refsum's syndrome

- Retinitis pigmentosa
- Peripheral neuropathy
- Cerebellar ataxia.

Usher's syndrome

- Retinitis pigmentosa
- Labyrinthine deafness.

Hallgren's syndrome

- Retinitis pigmentosa
- Vestibulocerebellar ataxia
- Congenital deafness
- Mental deficiency.

ATYPICAL FORMS OF RETINITIS PIGMENTOSA

- *Retinitis pigmentosa sine pigmento*: All features of retinitis pigmentosa, except no or minimal visible pigmentary changes.
- *Sectorial retinitis pigmentosa*: Only one quadrant (usually nasal) or one half (usually inferior) is involved.
- *Pericentric retinitis pigmentosa*: Pigmentary changes are confined to an area immediately around the macula.
- *Retinitis punctata albescens*: Autosomal dominant, innumerable discrete white dots are scattered over the fundus.

MACULAR DISORDERS**PHOTORETINITIS**

- Damage of the foveolar region caused by ultraviolet ray and infra-red rays of bright sun-light, commonly occurring during solar eclipse (Eclipse burn).
- Typical lesion appears as a bean or kidney shaped pigmented spot with yellowish white centre in the foveal region.

CENTRAL SEROUS RETINOPATHY (CSR)

- It refers to spontaneous detachment of neuro-sensory retina in the macular region
- Typically affects males between 20 and 40 years causing sudden painless mild loss of vision (6/9–6/12), micropsia, metamorphopsia and relative positive scotoma

- Fluorescein angiography may show 'ink-blot' or 'smoke-stack' sign (Mushroom or umbrella configuration)
- Self-limiting (90%) but recurrent (40%)
- Laser photocoagulation is indicated in:
 - Long standing cases (more than 4 months)
 - Patients showing multiple leaks
 - Impaired visual acuity in the fellow eye from GSR.

CYSTOID MACULAR OEDEMA

Collection of fluid in the outer plexiform (Henle's layer) and inner nuclear layer of the retina, centred around fovea due to break down of the inner blood-retinal barrier.

Causes

- Postoperative complication of cataract and keratoplasty operations.
- Inflammations such as pars planitis, and posterior uveitis
- Retinal vascular disorders, diabetic retinopathy, and retinal vein occlusion.
- Retinal dystrophy–Retinitis pigmentosa
- Side effect of topical 2% adrenaline in aphakic patients.
- Secondary to other maculopathies
- Complication of peripheral retinal photocoagulation.

Clinical features

- Minimal to moderate loss of vision which may be permanent in persistent cases
- Typical fundus picture in advanced cases is of 'Honey-comb appearance' of macula
- Fluorescein angiography in well established cases presents a 'flower-petal appearance'
- Long standing CME may end in macular hole.

AGE-RELATED (SENILE) MACULAR DEGENERATION (AMD)**Non-exudative AMD**

- Also called as *dry* or *geographical AMD*
- Comparatively common (90% cases) and causes gradually progressive mild to moderate loss of vision
- Fundus shows: Colloid bodies, pale areas of retinal pigment epithelium (RPE) atrophy, and irregular or clustered pigmentation.

Exudative AMD

- Also called as wet or neovascular AMD

- Comparatively rare (10% cases) but causes progressive and marked loss of vision.

Clinical course rapidly passes through following stages:

- Stages of drusen formation
- Stage of detachment of RPE.
- Stage of subretinal neovascular membrane (SRNVM)
- Stage of haemorrhagic detachment of RPE.
- Stage of haemorrhagic detachment of neurosensory retina
- Terminal stage of disciform macular scarring (degeneration).

Treatment includes

- *Intravitreal injections of anti-VEGF* (e.g. avastin) are recommended
- *Photodynamic therapy (PDT)* is the treatment of choice after anti-VEGF
- *Laser photocoagulation* (double frequency YAG 532) may be considered for an extrafoveal SRNVM situated 200 μ or more from the centre of fovea.

HEREDOMACULAR DEGENERATIONS

Best's disease

- Autosomal dominant.

Clinical picture. More commonly it occurs upto 6 years of age. In it loss of vision is not profound. Five stages are:

- *Pre-vitelliform stage:* Normal fundus but EOG is abnormal.
- *Vitelliform stage:* Egg yolk lesion at macula.
- *Pseudohypopyon stage:* Partially absorbed egg yolk lesion.
- *Vitelliruptive stage:* A scrambled egg appearance at macula
- *Stage of scarring:* Hypertrophic, atrophic or vascularized scar at macula.

Note: ERG is normal but EOG is abnormal.

Stargardt's disease

- Autosomal recessive disease
- No family history present
- Presents with central decreased vision in first or second decade of life (more commonly less than 21 years).
- Typical fundus picture is 'beaten-bronze' or 'snail-slime reflex' in the macular area.
- In this ERG and EOG both are normal
- On fluorescein angiography dark choroid stars are seen.

RETINAL DETACHMENT

Retinal detachment (RD) refers to separation of neurosensory retina from the retinal pigment epithelium (RPE).

I. RHEGMATOGENOUS RD

This is the commonest type of retinal detachment.

Predisposing factors

- Age—Most common 40–60 years (no bar)
- Sex—Male: Female: 3:2
- Myopia—40 percent cases
- Aphakia (previous cataract surgery)
- Retinal degenerations such as:
 - Lattice degeneration (most common)
 - Snail track degeneration
 - White-with-pressure and white-without pressure lesions
 - Diffuse chorioretinal degenerations
 - Acquired (senile) retinoschisis
- Trauma
- Senile posterior vitreous detachment (PVD).

Clinical features

Prevalence

Affects 1 in 1000 population each year

Prodromal symptoms

- Photopsia (flashes of light) due to vitreoretinal traction
- Dark spots (floaters) in front of the eyes (muscae volitantes)

Symptoms of detached retina

- Localized relative loss in the field of vision of detachment retina
- Loss of vision in detachments involving macular area.

Signs

- *Detached retina gives grey reflex*, is raised, thrown into folds which oscillate with the movements of the eye
- *Retinal breaks holes* (round, horse-shoe-shape or slit like) look reddish and are most frequently found in the periphery (commonest in the upper temporal quadrant)
- *Signs of old RD are:*
 - Thinning of the detached retina
 - Secondary intraretinal cysts
 - Subretinal demarcation lines (high water marks).

Management

Indications of prophylactic treatment

- Symptomatic retinal breaks associated with PVD
- Large asymptomatic retinal tears
- Asymptomatic retinal break and/or lattice degeneration in the presence of: aphakia, high myopia, only eye, RD in fellow eye, strong family history of RD, and Marfan's syndrome, Stickler's syndrome and Ehlers-Danlos syndrome.

Basic principles of treatment

1. *Sealing of retinal breaks:* It can be performed with cryopexy or photocoagulation.
2. *Bringing the sclera, choroid and detached retina with each other.* It is carried out by the procedure of external tamponade (scleral buckling or encirclage) or internal tamponade (PPV with intravitreal silicone oil).

Indications for drainage of subretinal fluid (SRF)

- Difficulty in localizing retinal breaks in bullous RD
- Long-standing (old) RD
- RD with inferior breaks
- RD with immobile retina
- RD with advanced glaucoma, thin sclera and recent cataract extraction.

II. EXUDATIVE OR SOLID RETINAL DETACHMENT

Retina is elevated due to accumulation of fluid beneath it, associated with RPE damage:

Causes

1. Systemic diseases

- Toxaemia of pregnancy
- Renal hypertension
- Blood dyscrasias
- Polyarteritis nodosa.

2. Ocular diseases

- Inflammations
 - Harada's disease
 - Sympathetic ophthalmitis
 - Posterior scleritis
 - Orbital cellulitis
- Vascular diseases
 - Exudative retinopathy of coats
 - Central serous retinopathy
- Neoplasms
 - Retinoblastoma (exophytic)
 - Malignant melanoma of choroid
- Sudden hypotony following:
 - Globe perforation
 - Intraocular operation

- *Other causes:* Choroidal neovascularisation, haemangioma and metastatic tumour of choroid.

Clinical features

Exudative RD can be differentiated from rhegmatogenous RD by following characteristics:

- Absence of photopsia
- Absence of retinal breaks, folds and undulations
- Configuration of the RD is convex
- Shifting fluid sign is pathognomonic of exudative RD
- On transillumination, rhegmatogenous RD is transparent while exudative RD is opaque.

III. TRACTIONAL RETINAL DETACHMENT

It occurs due to retina being mechanically pulled away from its bed by the progressive contraction of fibrous or fibrovascular membrane over large areas of vitreo-retinal adhesions (vitreoretinal traction bands).

Causes

- Post-traumatic retraction of scar tissue
- Proliferative diabetic retinopathy
- Sick cell retinopathy
- Retinopathy of prematurity
- Eales' disease
- Plastic cyclitis
- Post-vitreous haemorrhage retinitis proliferans.

Clinical features

- *Presence of vitreoretinal traction bands* with lesions of the causative disease
- *Configuration of the detached retina* is concave
- *Absent*—photopsia, floaters, retinal breaks, shifting fluid sign, mobility of detached retina.

RETINOSCHISIS

- Characterized by the abnormal splitting of the retina's neurosensory layer, usually in the outer plexiform layer, resulting in a loss of vision in the corresponding visual field in some rarer forms.
- Usually asymptomatic
- It is classified into degenerative (typical and reticular), hereditary (X-linked juvenile retinoschisis, familial foveal retinoschisis), and tractional and exudative (secondary to optic disc pit).

TUMOURS OF RETINA

RETINOBLASTOMA

Incidence

- Most common intraocular tumour of childhood
- Occurs in 1 in 15000–20000 live births.

- Age—Usually presents at 18 months (1–2 years)
- Rare in Negroes
- 25–30 percent cases are bilateral.

Heredity

- *Retinoblastoma (RB) gene* is a cancer-suppressor gene located on long arm of chromosome 13 (13q 14)
- Deletion or inactivation of RB gene by two mutations (Knudson's two-hit hypothesis) results in occurrence of retinoblastoma.
- Of all cases 10% are familial (inherited by autosomal dominant mode) and 90% are sporadic
- *Of sporadic cases*, about two-third (60% of all cases) occur by somatic mutation and one-third (30% of all cases) occur by germline mutation.
- *Heritable or germline cases* (10% familial + 30% sporadic = 40%) occur by first mutation in RB gene on germ cells (gametes) before fertilization and second mutation in RB gene on retinal cells. These cases have multifocal, usually bilateral (85%) tumours and can transmit to 50% of offspring.
- *Non-heritable or somatic cases* (60%) occur sporadically by both hits (mutations) in RB gene of retinal cells in embryo. These cases have unifocal, unilateral tumours which cannot be passed on to the off spring.

Pathology

- Arises from the immature retinal neural cells
- Histologically, cells may present as highly undifferentiated or well differentiated tumour
- Features of well-differentiated tumour include:
 - Flexner-Wintersteiner rosettes (highly specific for retinoblastoma)
 - Homer-Wright rosettes (also seen in neuroblastoma and medulloepithelioma)
 - Pseudorosettes
 - Fleurettes
- Other histological features of retinoblastoma are:
 - Areas of necrosis
 - Calcification.

Clinical features

Presenting Symptoms

- Leukocoria (61%)
- Squint (22%)
- Nystagmus in bilateral cases
- Secondary glaucoma and buphthalmos (rare)
- Pseudohypopyon (rare)
- Anterior chamber inflammation which may mimic anterior uveitis (rare)

- Hyphaema (rare)
- Proptosis which may mimic orbital cellulitis (rare).

Fundus examination in early stage (before leukocoria) may show:

Endophytic retinoblastoma which grows inwards and is white or pearly pink in colour. Fine blood vessels may be present on its surface. In the presence of calcification, it gives the typical 'cottage-cheese' appearance.

Exophytic retinoblastoma which grows outwards and causes exudative retinal detachment.

Investigations

- *Plain X-rays, orbit*— may show calcification in 75% cases.
- *Ultrasonography and CT scanning* are quite useful.
- *Lactic dehydrogenase (LDH)* levels are raised in aqueous humour.

Differential diagnosis

Differential diagnosis of leukocoria

- Congenital cataract
- Retinopathy of prematurity
- Persistent hyperplastic primary vitreous
- Toxocara endophthalmitis
- Coats' disease
- Coloboma of choroid
- Retinal dysplasia.

Differential diagnosis of endophytic retinoblastoma discovered on fundus examination:

- Patch of exudative choroiditis
- Astrocytoma

Differential diagnosis of exophytic retinoblastoma causing exudative retinal detachment:

- From other causes of exudative RD, e.g. Coat's disease.

International classification of retinoblastoma (ICRB)

Group A: (very low risk) includes all small tumours ≤ 3 mm in greatest dimension, confined to retina, located >3 mm from fovea and > 1.5 mm from the optic disc.

Group B: (low risk) includes large tumours >3 mm in dimension, and any size tumours located <3 mm from fovea, and <1.5 mm from the optic disc margin.

Group C: (moderate risk) includes *retinoblastoma with focal seeds* characterized by subretinal and/or vitreous seeds ≤ 3 mm from the retinoblastoma

Group D: (high risk) includes *retinoblastoma with diffuse seeds* characterized by subretinal and/or vitreous > 3 mm seeds from the retinoblastoma.

Group E: (very high risk) includes *extensive retinoblastoma* characterised by any of the following: tumour touching the lens, neovascular glaucoma, tumour anterior to anterior vitreous face involving ciliary body and anterior segment, diffuse infiltrating tumour, opaque media with hemorrhage, tumour necrosis with aseptic orbital cellulitis, invasion of postlaminar optic nerve, choroid, sclera, orbit, and anterior chamber, or phthisis bulbi.

Treatment

Enucleation

- It is treatment of choice for intraocular tumour of more than 10 mm in size or when optic nerve is involved.
- The eyeball should be enucleated with maximum length of the optic nerve and taking care not to perforate it.

Conservative (tumour destructive) therapy

It is indicated when tumour is less than 10 mm in size and optic nerve is not involved.

Tumour destructive therapy consists of chemoreductions with systemic carboplatin, vincristine and etoposide followed by focal therapy with any of following modalities:

- Cobalt plaques: For small peripheral tumour.
- Cryotherapy: For small peripheral tumour.
- Argon, diode or xenon arc photocoagulation: For small posterior tumours not invading either the macula or the optic nerve.

Surgical debulking of the orbit with radiotherapy (external beam therapy) and chemotherapy (etoposide, carboplatin, vincristine) are used as palliative measures. In patients with either orbital extension, or intracranial extension or distant metastasis.

Prognosis

Fair (survival rate 70–85%) if eyeball is enucleated, before the extraocular extension.

Poor prognostic factors are:

- Optic nerve involvement beyond the transection (65% mortality).
- Undifferentiated tumour cells (40% mortality)
- Massive choroidal invasion.

PHAKOMATOSES

1. Angiomatosis retinae (von Hippel-Lindau's disease)

- Angiomatosis involves retina, brain, spinal cord, kidneys and adrenals

- Retinal lesions comprise vascular dilatation, tortuosity and formation of aneurysms which vary from small miliary to balloon-like angiomas, followed by appearance of haemorrhages and exudates, resembling exudative retinopathy of Coats'. Massive exudation is frequently complicated by retinal detachment.

2. Tuberous sclerosis (Bourneville disease)

Classic diagnostic triad includes:

- Adenoma sebaceum
- Mental retardation
- Epilepsy associated with potato-like hamartomas of the brain, retina and viscera.

3. Neurofibromatosis (Von-Recklinghausen's disease)

- *Multiple tumours* of skin, nervous system and other organs
- *Cutaneous manifestations* vary from cafe-au-lait spots to neurofibromata
- *Ocular manifestations include:* Neurofibromas of lids and orbit, glioma of optic nerve and congenital glaucoma.

Characteristic features of neurofibromatosis (NF-1) and neurofibromatosis (NF-2) are as follows:

- *NF-1* has bare orbit/orphan Anne sign.
- *NF-2* is associated with bilateral acoustic neuroma, posterior subcapsular cataract and multiple schwannoma, meningioma and ependymoma.

4. Encephalofacial angiomatosis

(Sturge-Weber syndrome) Characterised by angiomatosis in the form of port wine stain (Naevus flammeus) involving one side of the face which may be associated with choroidal haemangiomas, leptomeningeal angioma and congenital glaucoma on the affected side.

To remember Mnemonic (STURGE) stands for:

- S : Port wine Stain, Seizures
T : **T**ram track appearance on X-ray skull
U : **U**nilateral cortical atrophy
R : **R**etardation (mental)
G : **G**laucoma (congenital)
E : **E**ncephalofacial angiomatosis

MISCELLANEOUS POINTS

- *Superficial retinal haemorrhages* are most commonly associated with hypertension.
- *Pseudoxanthoma elasticum* is the most common systemic disorder associated with angioid streaks; other causes are: macular degeneration, Paget's

disease, Gronblad-strandberg syndrome, senile elastosis.

- *Angioid streaks:*
 - May be mistaken for blood vessels
 - Are usually situated near the disc
 - Are situated at a deeper level than retinal vessels
 - Result due to defects in Bruch's membrane.
- *Rods are primarily affected in* retinitis pigmentosa.
- *Lattice degeneration* most commonly occurs in the superotemporal quadrant.
- *Salt and pepper fundus* is characteristic of congenital syphilitic retinal affection. It is also seen in Leber's amaurosis and congenital rubella.
- *Bull's eye macular lesions* are seen in chloroquine retinopathy and progressive cone dystrophy.
- *Reversal of diabetic retinopathy* can be seen in a woman with Sheehan's syndrome (due to lack of growth hormone).
- *Colour vision* is not significantly impaired in eyes with early macular disease, in contrast to eyes with early lesions of optic nerve.
- *Macular star* may occur in hypertensive retinopathy, papilledema and Eales' disease.
- *Flame-shaped superficial* haemorrhages occur in the nerve fibre layer of the retina.
- *Retinoblastoma is the most common* retinal malignancy.
- *Retinoblastoma is the most common primary malignant intraocular tumour of childhood and the second most common primary intraocular malignancy of all age groups* (Choroidal melanoma is more common).
- *Most common mode of metastasis* of retinoblastoma is by direct extension, by continuity to the optic nerve.
- *Most common site of metastasis* of retinoblastoma is brain.
- *Snow ball opacities in vitreous* are seen in pars planitis, candidiasis and sarcoidosis.
- *Causes of ring scotoma* include retinitis pigmentosa, high myopia, primary open angle glaucoma, aphakic spectacles correction and after pan retinal photocoagulation (PRP).
- *Causes of tubular vision* include retinitis pigmentosa, high myopia, primary open angle glaucoma, and CRAO with sparing cilioretinal artery.
- *Juxta foveal telangiectasia* is a variant of Coat's disease. It is macular telangiectasia which in structural abnormalities are seen in the vessels.

Multiple Choice Questions (MCQs)

1. **Congenital anomalies of the optic disc include all except:**
 - A. Coloboma
 - B. Drusen
 - C. Hypoplasia
 - D. Medullated nerve fibres
2. **Normally retinal fibres are:**
 - A. Medullated
 - B. Non-medullated
 - C. Medullated in childhood and become non-medullated in old age
 - D. Non-medullated in childhood but become medullated in old age
3. **All of the following are true for medullated nerve fibres of the retina except:**
 - A. Appear as a whitish patch usually present around the disc
 - B. Are commonly seen at birth in premature children
 - C. Disappear in patients with optic atrophy
 - D. May cause enlargement of blind spot
4. **All of the following are features of central retinal artery occlusion except:**
 - A. Marked narrowing of retinal arterioles
 - B. 'Cherry red spot' at macula
 - C. Retinal oedema
 - D. Multiple superficial haemorrhages
5. **The most common site of obstruction in central retinal artery is:**
 - A. In front of the lamina cribrosa
 - B. At the lamina cribrosa
 - C. Behind the lamina cribrosa
 - D. The point where the artery enters the optic nerve
6. **Dot and blot (round) retinal haemorrhages are situated at the level of:**
 - A. Ganglion cell layer
 - B. Nerve fibre layer
 - C. Inner nuclear layer
 - D. Outer plexiform layer
7. **Risk factors for development of diabetic retinopathy include:**
 - A. Duration of diabetes
 - B. Heredity
 - C. Pregnancy
 - D. All of the above
8. **Diabetic retinopathy is essentially an angiopathy affecting retinal:**
 - A. Precapillary arterioles
 - B. Capillaries
 - C. Venules
 - D. All of the above
9. **All of the following are true for anaemic retinopathy except:**
 - A. Occurs when haemoglobin level falls below 5 gm percent
 - B. Arterioles become pale
 - C. Veins are pale and narrow
 - D. Superficial retinal haemorrhages and subhyaloid haemorrhage are seen invariably
10. **Is not true about soft exudates (cotton wool patches on retina):**
 - A. Are a sign of retinal hypoxia
 - B. Formed due to swelling of nerve fibre layer
 - C. Frequently change their shape
 - D. In late stages are converted into hard exudates
11. **Hard exudates are seen in the following except:**
 - A. Hypertensive retinopathy
 - B. Diabetic retinopathy
 - C. Leukemic retinopathy
 - D. Exudative retinopathy of Coat's
12. **All of the following are true for retinopathy of prematurity except:**
 - A. Occurs in premature infants due to late crying
 - B. Due to hypoxia there occurs neovascularization followed by fibroproliferation
 - C. End result is bilateral blindness
 - D. Blindness can be prevented by early diagnosis and ablation of vascular premature retina with cryotherapy or photocoagulation

- 13. Most common mode of inheritance for retinitis pigmentosa is:**
 A. Autosomal recessive
 B. Autosomal dominant
 C. Sex linked
 D. None of the above
- 14. Following are the ocular association of retinitis pigmentosa except:**
 A. Myopia
 B. Primary angle closure glaucoma
 C. Microphthalmos
 D. Conical cornea
- 15. Retinitis pigmentosa forms a constituent of all the following syndromes except:**
 A. Lowe's syndrome
 B. Refsum's syndrome
 C. Usher's syndrome
 D. Hallgren's syndrome
- 16. All of the following are causes of night blindness except:**
 A. Retinitis punctate albescens
 B. Choroideremia
 C. Retinitis pigmentosa
 D. Retinitis of Roth
- 17. 'Bull's eye' lesion in macular region is seen in:**
 A. Progressive cone dystrophy
 B. Choroquine maculopathy
 C. Both of the above
 D. None of the above
- 18. Cherry red spot at macula is seen in all of the following except:**
 A. Tay-Sach's disease
 B. Letterer-Siwe disease
 C. Niemann-Pick disease
 D. Commotio retinae
- 19. Photoretinitis results from:**
 A. Infra-red rays of sunlight
 B. Ultraviolet rays of sunlight
 C. Both of the above
 D. None of the above
- 20. Spontaneous regression of proliferative retinopathy may occur in:**
 A. Diabetic retinopathy
 B. Proliferative sickle retinopathy
 C. Retinopathy of prematurity
 D. All of the above
 E. None of the above
- 21. In central serous retinopathy, in the macular region, there occurs:**
 A. Spontaneous detachment of neuro-sensory retina
 B. Macular oedema
 C. Detachment of pigment epithelium
 D. Detachment of choroid
- 22. Macular scar is formed in which of the following diseases:**
 A. Papillitis
 B. Hypertension
 C. Neuroretinitis
 D. Papilloedema
 E. All of the above
- 23. In cystoid macular edema fluid collects in the macular region at the level of:**
 A. Outer nuclear layer
 B. Outer plexiform layer
 C. Inner plexiform layer
 D. Between pigment epithelium and neurosensory retina
- 24. In cystoid macular edema, basic defect is:**
 A. Breakdown of inner blood retinal barrier
 B. Breakdown of outer blood retinal barrier
 C. Increased permeability of the choriocapillaris
 D. All of the above
- 25. Retinal degenerations predisposed to retinal detachment include all of the following except:**
 A. Lattice degeneration
 B. Snail track degeneration
 C. Focal pigment clumps
 D. Pavingstone degeneration
- 26. All of the following are the causes of exudative retinal detachment except:**
 A. Retinopathy of toxemia of pregnancy
 B. Retinopathy of prematurity
 C. Exudative retinopathy of Coats
 D. Sympathetic ophthalmia
- 27. Shifting fluid is pathognomonic of:**
 A. Solid retinal detachment
 B. Rhegmatogenous retinal detachment
 C. Tractional retinal detachment
 D. Choroidal detachment
- 28. All of the following are true about incidence of retinoblastoma except:**
 A. Is the most common intraocular tumour of childhood
 B. Occurs in 1 in 14000-34000 live births
 C. No sex predisposition
 D. More common in negroes than whites
- 29. Retinoblastoma arises from:**
 A. Layer of rods and cones
 B. Layer of bipolar cells
 C. Ganglion cells layers
 D. Any nucleated retinal layer

13 : A 14 : B 15 : A 16 : D 17 : C 18 : B
 19 : A 20 : D 21 : A

22 : E 23 : B 24 : A 25 : D 26 : B 27 : A
 28 : D 29 : D

- 30. In a child with phthisical eye of unknown etiology following possibility should be kept in mind:**
 A. Birth trauma
 B. Still's disease
 C. Retinoblastoma
 D. Untreated congenital glaucoma
- 31. All of the following are causes of leukocoria except:**
 A. Coloboma of choroid
 B. Coloboma of optic disc
 C. Retinopathy of prematurity
 D. Retinoblastoma
- 32. Poor prognostic factor in retinoblastoma is:**
 A. Optic nerve involvement
 B. Massive choroidal invasion
 C. Undifferentiated tumour cells
 D. All of the above
- 33. Which is not seen in retinitis pigmentosa:**
 A. Pale waxy optic disc
 B. Attenuated vessels
 C. Retinal haemorrhages
 D. Bone corpuscles
- 34. Best diagnostic test for Best's disease is:**
 A. Dark adaptation
 B. ERG
 C. EOG
 D. Gonioscopy
- 35. All are true about angioid streaks except:**
 A. They are mistaken for blood vessels
 B. Are situated near the disc
 C. Situated at a superficial level than the retinal vessels
 D. Result due to defects in Bruch's membrane
 E. Are associated with pseudoxanthoma elasticum
- 36. Eales' disease is best treated with:**
 A. Antitubercular drugs
 B. Steroids
 C. Antibiotic drops
 D. Antibiotics systemically
- 37. The commonest cause of rubeosis iridis is**
 A. Diabetes mellitus
 B. Central retinal vein occlusion
 C. Central retinal artery occlusion
 D. Carotid stenosis
- 38. The retinal capillaries are distinguished by having all, except:**
 A. Widening of the capillary calibre in the periphery
 B. Capillary free zone around the veins
 C. Superficial network
 D. Deep denser network
 E. Capillary-free-zone around the arteries
- 39. The true pulse in the retinal arteries is seen in:**
 A. Aortic aneurysm
 B. Aortic regurgitation
 C. Exophthalmic goitre
 D. All of the above
 E. None of the above
- 40. Commonest eye tumour is:**
 A. Melanoma
 B. Retinoblastoma
 C. Carcinoma of eyelid
 D. Carcinoma of lacrimal sac
- 41. Visual loss in diabetic retinopathy is due to all except:**
 A. Cataract formation
 B. Background diabetic retinopathy
 C. Ischaemic maculopathy
 D. Vitreous hemorrhage
- 42. The earliest change noticed in hypertensive retinopathy is:**
 A. Soft exudate
 B. Arteriolar spasm
 C. Venospasm
 D. Hard exudate
- 43. Primary retinal detachment is seen in:**
 A. Diabetes
 B. High myopia
 C. Malignant melanoma
 D. All of the above
- 44. Premature babies can have the following:**
 A. Buphthalmos
 B. Retinopathy of prematurity
 C. Increased incidence of myopia
 D. Persistent hyaloid artery
 E. All of the above
- 45. Earliest change in diabetic retinopathy is:**
 A. Hard exudate
 B. Soft exudate
 C. Dot haemorrhage
 D. Microaneurysm
- 46. Ring scotoma is seen in:**
 A. Glaucoma
 B. Retinitis pigmentosa
 C. Sympathetic ophthalmia
 D. Vitreous haemorrhage
- 47. Retinal detachment is preceded by:**
 A. Floaters and flashes
 B. Eales' disease
 C. Trauma
 D. All of the above

- 48. Resuscitation time of the human retina following ischaemia is:**
- 30 minutes
 - 45 minutes
 - 1 to 2 hours
 - 15 to 20 minutes
 - 8 minutes
- 49. Purtscher's retinopathy results from:**
- Head injuries
 - Chest injuries
 - Trichiasis
 - All of the above
- 50. In recently recognised IDDM patient examination of fundus is done at:**
- Immediately
 - At 1 year
 - At 5 year
 - None of the above
- 51. For prevention of retrolental fibroplasia O₂ should be:**
- 30–40%
 - 50–60%
 - 20–30%
 - 70–80%
- 52. Commonest cause of loss of vision in non-proliferative diabetic retinopathy is:**
- Vitreous haemorrhage
 - Macular edema
 - Detachment of retina
 - Subretinal haemorrhage
- 53. All of the following are differential diagnosis for cotton wool spots in fundus except:**
- AIDS
 - Diabetic retinopathy
 - Hypertension
 - Eales' disease
- 54. Sudden loss of vision in patient with diabetic retinopathy is due to:**
- Cataract
 - Glaucoma
 - Vitreous defects
 - Papilloedema
- 55. Enlarging dot sign in fundus fluorescein scanning is seen in:**
- Cystoid macular edema
 - Central serous retinopathy
 - Significant macular edema
 - Coat's disease
- 56. In a young patient presenting with recurrent vitreous haemorrhage diagnosis is:**
- Eales' disease
 - CRVO
 - Proliferative retinopathy
 - Coat's disease
 - Episcleritis
- 57. The superficial retinal haemorrhages are situated in:**
- Nerve fibre layer
 - Outer nuclear layer
 - Inner nuclear layer
 - Inner plexiform layer
- 58. Large haemangioma of lid and cheek along with glaucoma is seen in:**
- von Recklinghausen's disease
 - Sturge Weber's syndrome
 - von Hippel's disease
 - Lindau's disease
- 59. The following about retinoblastoma is true except:**
- Autosomal dominant
 - Treatment is enucleation
 - Radiotherapy is also given
 - Evisceration is the treatment
- 60. Retinoblastoma is bilateral in:**
- 1% of cases
 - 50% of cases
 - 100% of cases
 - 30% of cases
- 61. Familial retinoblastoma:**
- Has autosomal recessive inheritance
 - More commonly bilateral
 - Due to mutation
 - More common than sporadic retinoblastoma
- 62. Ideal treatment of B/L retinoblastoma:**
- Enucleation
 - Radiotherapy
 - Chemotherapy
 - Phototherapy
 - Cyclophotocoagulation
- 63. Most common second malignancy in patients with familial retinoblastoma is:**
- Teratoma
 - Medullary carcinoma
 - Osteosarcoma
 - Malignant melanoma
- 64. In photocoagulation of retina, which quadrant is first coagulated:**
- Temporal
 - Nasal
 - Superior
 - Inferior

65. Pseudo-rosettes are seen in:

- A. Retinoblastoma
- B. Ophthalmic nodosa
- C. Phakolytic glaucoma
- D. Trachoma

66. Knudson's hypothesis is applied for:

- A. Glaucoma
- B. Retinoblastoma
- C. Cataract
- D. Melanoma

67. True about fovea centralis:

- A. Cones present
- B. Visual acuity lowest
- C. Optic nerve passes
- D. Rods present
- E. Visual acuity highest

68. Broadest neuroretinal rim is seen in:

- A. Sup role
- B. Inf pole
- C. Nasal pole
- D. Temporal lobe

69. Cherry red spot is seen in:

- A. Eale's disease
- B. Retinitis pigmentosa
- C. Central retinal artery thrombosis
- D. Central retinal vein occlusion

70. All of the following take part in the pathogenesis of macular edema in diabetic retinopathy except:

- A. Retinal pigment epithelium dysfunction
- B. Oxidative stress
- C. VEGF
- D. Increased protein kinase-C

71. Vitreous haemorrhage in diabetic retinopathy

- A. Non-proliferative diabetic retinopathy
- B. Proliferative diabetic retinopathy
- C. Both
- D. None

72. Grid laser photocoagulation is indicated in:

- A. Ischaemic maculopathy
- B. Clinical significant macular oedema
- C. Macular hole
- D. Proliferative diabetes retinopathy

73. Panretinal photocoagulation is indicated in:

- A. Macular edema
- B. Retinal breaks
- C. Proliferative diabetic retinopathy
- D. Tractional retinal detachment

74. In retinal detachment:

- A. Effusion of fluid into the suprachoroidal space
- B. Retinoschisis
- C. Separation of sensory retina from pigment epithelium
- D. None of the above

EXTRA EDGE QUESTIONS**75. Soft exudates are found in:**

- A. DM
- B. HTN
- C. Toxemia
- D. Coat's disease
- E. All

76. Hard exudates not seen in:

- A. Hypertension
- B. DM
- C. Toxemia of pregnancy
- D. SLE
- E. Coat's disease

77. Hard exudates are seen in all except:

- A. Diabetic retinopathy
- B. Retinitis pigmentosa
- C. Eale's disease
- D. Retinal artery macroaneurysm
- E. Choroidal neovascularisation

78. Cherry red spot found in:

- A. Gangliosidosis
- B. Retinopathy of prematurity
- C. Tay-Sach's disease
- D. Gaucher's disease
- E. Retinal detachment

79. Features of non-proliferative DR is all except:

- A. Neovascularisation
- B. Soft exudate
- C. Hard exudate
- D. Vitreous detachment
- E. Cotton-wool spot

80. Diabetic retinopathy is characterized by:

- A. Hard exudates
- B. Neovascularisation
- C. Glaucoma
- D. Cataract
- E. Retinal detachment

81. Treatment of diabetic retinopathy

- A. Phocoemulsification
- B. Retina laser photocoagulation
- C. LASIK
- D. Pars plana vitrectomy

82. Treatment of diabetic retinopathy neovascularisation is/are:

- A. Retinal laser photocoagulation
- B. Pars plana vitrectomy
- C. Phacoemulsion
- D. Anti VEGF ab
- E. LASIK

65 : A 66 : B 67 : A and E 68 : B 69 : C
70 : A 71 : B 72 : B 73 : C 74 : C

75 : A, B and C 76 : C 77 : B 78 : A, C and D 79 : A and D
80 : A, B, C, D and E 81 : B and D 82 : A and D

- 83. Which of the following agents is not used in the treatment of Diabetic Macular Edema/Retinopathy:**
- Ruboxistaurim
 - Pyridazinones
 - Benfotiamine
 - Tamoxifen
- 84. All of the following may be used to differentiate central retinal venous occlusion (CRVO) from ocular ischemic syndrome due to carotid artery stenosis, except:**
- Dilated retinal vein
 - Tortuous retinal vein
 - Retinal artery pressure
 - Ophthalmodynamometry
- 85. Commonest type of retinal detachment:**
- Rhegmatogenous
 - Choroidal haemorrhage
 - Exudative
 - Tractional
- 86. Retinal detachment seen in:**
- Myopia
 - Hypermetropia
 - Eale's disease
 - Cataract extraction
 - Nd:YAG photocoagulation
- 87. Cause of exudative retinal detachment are:**
- Scleritis
 - Toxaemia of pregnancy
 - Dysthyroid eye disease
 - Central serous retinopathy
 - Sickle cell retinopathy
- 88. Causes of exudative retinal detachment:**
- Central retinal artery occlusion
 - Hypertensive retinopathy
 - Harada's syndrome
 - Coat's disease
- 89. RD is diagnosed by:**
- +90 D
 - Hruby lens
 - 3 mirror contact lens
 - Direct ophthalmoscopy
 - Indirect ophthalmoscopy
- 90. A patient presented with sudden onset of floater and perception of falling of a curtain (veil) in front of the eye which one of the following is the most appropriate diagnosis:**
- Retinal detachment
 - Eale's disease
 - Vitreous haemorrhage
 - Glaucoma
- 91. A young adult presents with night blindness and tubular vision. On examination, intraocular pressure was observed to be 18 mm and the anterior segment was unremarkable. Fundoscopy showed attenuation of arterioles and waxy pallor of the optic disc with bony corpuscles like spicules of pigmentation in mid peripheral retina. Ring scotomas were observed on perimetry. Which of the following is the most likely diagnosis:**
- Pigmentary retinal dystrophy
 - Primary open angle glaucoma
 - Lattice degeneration of retina
 - Diabetic retinopathy.
- 92. A 70-year-old man presents with deterioration of vision 3 weeks after cataract extraction and IOL implantation. Slit lamp examination shows honeycomb maculopathy and fluorescein angiography (FA) shows 'flower petal' hyperfluorescence. The most likely diagnosis is:**
- Age related macular degeneration (ARMD)
 - Central serous retinopathy (CSR)
 - Macular dystrophy
 - Cystoid macular edema
- 93. Bull's eye lesion seen with:**
- Chloroquine
 - Dapsone
 - Rifampicin
 - Ethambutol
 - Gold
- 94. A patient with clinically significant diabetic macular edema with non progressive diabetic retinopathy was treated with non-progressive diabetic retinopathy was treated with Macular grid photocoagulation. The patient still has vitreo macular traction. What is the preferred treatment?**
- Intravitreal bevacizumab
 - Pars plana vitrectomy
 - Repeat macular grid photocoagulation
 - Augmented macular photocoagulation
- 95. Mizuo-phenomenon is seen in:**
- Fundus albipathicus
 - Fundus flavimaculatus
 - Oguchi's disease
 - Choroideremia
- 96. Which retinal layer is most radioresistant:**
- RPE
 - Layer of rods and cones
 - Bipolar cell layer
 - Ganglion cell layer

97. 'Sea-Fan' retina is seen in:

- A. CRAO
- B. SLE
- C. Sick cell disease
- D. Gaucher's disease.

98. Central retinal artery occlusion is known to be associated with:

- A. Panophthalmitis
- B. Diabetic retinopathy
- C. CMV retinitis
- D. Orbital mucormycosis.

99. Lamina cribrosa is absent in:

- A. Morning glory syndrome
- B. Nanophthalmia
- C. Colobama of retina
- D. Optic nerve agenesis

100. A young patient presents to the ophthalmology clinic with loss of central vision. There is no obvious family history. ERG and EOG were observed to be normal which of the following is the most likely diagnosis:

- A. Stargardt's disease
- B. Best's vitelliform dystrophy
- C. Retinitis pigmentosa
- D. Cone-rod dystrophy

101. A young patient presents to the ophthalmology clinic with loss of central vision. ERG is normal but EOG is abnormal. Which of the following is the most likely diagnosis:

- A. Stargardt's disease
- B. Best's vitelliform dystrophy
- C. Retinitis pigmentosa
- D. Cone-rod dystrophy

102. A young patient present with significant loss of central vision and a normal ERG. There is no obvious family history of similar presentation. The most likely diagnosis:

- A. Best's disease
- B. Stargardt's disease
- C. Retinitis pigmentosa
- D. Cone-rod dystrophy

103. Von Recklinghausen disease is associated with:

- A. Glaucoma
- B. Optic nerve glioma
- C. Neurofibroma of the lids
- D. All of them

104. Von Recklinghausen disease is associated with:

- A. Glaucoma
- B. Choroidal hemangioma

- C. Sub-retinal neovascularization
- D. Anterior chamber angle malformation

105. Vortex Vein invasion is commonly seen in:

- A. Retinoblastoma
- B. Malignant melanoma
- C. Optic nerve glioma
- D. Medullo-epithelioma

106. All of them are true except:

- A. Retiniblastomas are hereditry 40%, non-hereditary 60%
- B. Retiniblastomas are B/L 30%, U/L 70%
- C. Retiniblastomas are familial 6%, non-familial 94%
- D. All are true.

107. Which is the only phacomatosis to be inherited on an autosomal recessive basis:

- A. Ataxia-telangiectasia
- B. Sturge-Weber syndrome
- C. von Hippel lindau syndrome
- D. Neurofibromatosis

108. Which of these features is a classic radiologic feature of optic nerve glioma:

- A. Tram-track appearance of optic nerve
- B. Kinging of optic nerve
- C. Multiple cystic spaces in optic nerve
- D. Adjacent bony erosion

109. Retinitis pigmentosa is a feature of all except:

- A. Refsum's disease
- B. Hallervorden Spatz Syndrome
- C. NARP
- D. Abetalipoproteinemia

110. Bergmeister papilla are present on the:

- A. Anterior corneal surface
- B. Near the optic disc
- C. Anterior lens surface
- D. Posterior lens surface

111. Which of the following is not an ophthalmic emergency:

- A. Macular hole
- B. Retinal Detachment
- C. CRAO
- D. Acute primary angle closure glaucoma

112. Marfan's syndrome associated with a/e:

- A. Retinal detachment
- B. Viterious hemorrhage
- C. Ectopic lentis
- D. Roth spots

97 : C > B 98 : D 99 : A 100 : A
101 : B 102 : B 103 : D 104 : A > D

105 : B 106 : D 107 : A 108 : B 109 : B 110 : B
111 : A 112 : D

Quick Text Review

LESIONS OF VISUAL PATHWAY

Lesions of visual pathway are summarized in Table 12.1.

ABNORMAL PUPILLARY REFLEXES

1. Amaurotic (pupil) light reflex (Total afferent conduction defect): It refers to absence of direct light reflex on the affected side and absence of consensual reflex on the normal side. It indicates blindness due to lesions of the optic nerve or retina. Near reflex is normal and pupils are equal in size in both eyes.

2. Marcus Gunt pupil (Relative afferent conduction defect): See Page 11

3. Efferent pathway defect: In this situation both direct and consensual light reflexes are absent on the affected side and present on the normal side. Causes of efferent pathway defect include: effect of parasympatholytic drugs like atropine and homatropine, internal ophthalmoplegia and third nerve paralysis.

4. Wernicke's hemianopic pupil: It is seen in lesions of one optic tract. In this condition ipsilateral direct and contralateral consensual light reflexes are absent when light is thrown on the temporal half

Table 12.1: Lesions of visual pathway

Site of lesion	Salient features	Common causes
• Optic nerve	<ul style="list-style-type: none"> – Ipsilateral blindness, – Absent ipsilateral direct light reflex, – Absent contra-lateral consensual light reflex 	<ul style="list-style-type: none"> – Optic atrophy, – Traumatic avulsion of optic nerve – Acute optic neuritis
• Saggital (central) lesions of the chiasma	– Bitemporal hemianopia	<ul style="list-style-type: none"> – Supra-sellar aneurysms, – Pituitary tumours, – Craniophary-ngioma, – Glioma of third ventricle
• Lateral chiasmal lesions	– Binasal hemianopia	<ul style="list-style-type: none"> – Distention of third ventricle, – Atheroma of posterior communicating arteries
• Optic tract	<ul style="list-style-type: none"> – Homonymous hemianopia – Wernick's hemianopic pupillary response 	<ul style="list-style-type: none"> – Syphilitic meningitis – Tuberculosis and tumours of optic thalamus – Aneurysms of superior cerebellar or posterior cerebral arteries
• Lateral geniculate body	– Homonymous hemianopia with sparing of pupillary reflexes	<ul style="list-style-type: none"> – Syphilitic meningitis – Tuberculosis and tumours of optic thalamus
• Optic radiations <ul style="list-style-type: none"> – Total fibres – Lower fibres only – Upper fibres only 	<ul style="list-style-type: none"> – Homonymous hemianopia (sometimes sparing the macula) – Homonymous upper quadrantanopia (pie-in the sky) – Homonymous lower quadrantanopia (Pie-in the floor) 	<ul style="list-style-type: none"> – Vascular occlusion – Primary and secondary tumours, and – Trauma – Temporal lobe lesions – Anterior parietal lobe lesion
Visual cortex	– Homonymous hemianopia (usually sparing the macula)	<ul style="list-style-type: none"> – Vascular occlusion – Primary and secondary tumour – Trauma

of the retina on the affected side and nasal half of the opposite side.

5. Argyll Robertson pupil (ARP)

- Near reflex and accommodation present (Mnemonic ARP: Accommodation Reflex Present)
- Light reflex absent
- Pupil: Bilateral symmetric, small and irregular (Iris damage).
- Poor dilation to mydriatics and in darkroom.
- Causes: Neurosyphilis, diabetes mellitus and multiple sclerosis.
- Pseudo Argyll Robertson pupil seen in aberrant degeneration of 3rd nerve.

6. Adies tonic pupil (Holmes-Adies pupil)

- Reaction to light absent
- Near reflex very slow and tonic
- Pupil usually unilateral, affected pupil is slightly larger (anisocoria) (NO MIOSIS)
- It constricts with weak pilocarpine (0.125%), while normal pupil does not, (denervated iris sphincter is suprasensitive to topical parasympathomimetics).
- It may be associated with absent knee jerk and occur more often in young women.
- Causes: Post-ganglionic parasympathetic pupillomotor damage.

DISEASES OF OPTIC NERVE

OPTIC NEURITIS

- Optic neuritis includes papillitis and retrobulbar neuritis
- The most common cause is multiple sclerosis, vitamin B12 deficiency, vitamin B2 deficiency and diabetes.

Clinical features

- The condition is usually unilateral, there is monocular sudden, progressive and profound vision loss.
- Occasionally patients may observe an altered perception of moving objects (Pulfrich phenomenon) or a worsening of symptoms with exercise or increase in body temperature (Uhthoff sign)
- There is pain behind the eyeball, particularly in retrobulbar neuritis in which there is pain on eye movement.
- Visual evoked response (VEP) shows reduced amplitude and delayed transmission time.

Signs

- Reduced visual acuity and the most common field defect in optic neuritis is a relative central or centrocaecal scotoma.

- Earliest sign of optic neuritis is relative afferent pupillary defect (RAPD).
- Ophthalmoscopic findings are seen in papillitis, while fundus is normal in retrobulbar neuritis as the part involved is behind the visible part of the optic disc.
- Leber's disease is a type of hereditary optic neuritis which primarily affects males around the age of 20 years and is transmitted by female carriers.

TOXIC AMBLYOPIAS

- Tobacco-alcohol-amblyopia occurring in heavy smokers and drinkers is characterized by foggy vision associated with bilateral centrocaecal scotomas.
- Methyl alcohol amblyopia results from degeneration of ganglion cells of the retina, due to effect of formic acid and formaldehyde which are metabolic products of methyl alcohol.
- Quinine amblyopia may occur even with small doses in susceptible individuals. Visual loss may be associated with deafness and tinnitus.
- Ethambutol amblyopia may recover completely in most of the cases after immediate cessation of the drug.

ANTERIOR ISCHAEMIC OPTIC NEUROPATHY (AION)

- Results from the occlusion of short posterior ciliary arteries
- Occurs in two forms arteritic and nonarteritic
- Arteritic AION caused by giant cell arteritis accounts for 10% cases
- Nonarteritic AION (90% cases)—exact etiology not known. Risk factors include: structural crowding of disc with small cup, cataract surgery, hypertension, diabetes mellitus, smoking, hyperlipidemia and drugs such as sildenafil (viagra).
- Characterized by inferior altitudinal hemianopic field defects.

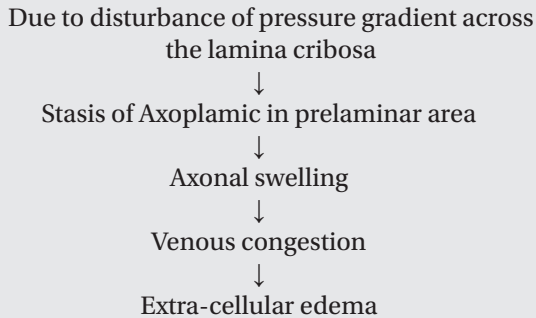
AUTOIMMUNE OPTIC NEUROPATHY

- Denotes optic nerve involvement in patients with systemic lupus erythematosus (SLE) and other systemic collagen vascular disorders.
- Pathogenesis and features are similar to AION.

PAPILLOEDEMA (CHOKED DISC)

- Papilloedema is non-inflammatory edema of optic disc
- Raised intracranial pressure is the commonest cause of bilateral papilloedema (optic nerve oedema).

- *Tumour of cerebellum, midbrain and parieto-occipital region* produce papilloedema more rapidly.
- *Tumour of medulla* rarely produce papilloedema.
- *Foster Kennedy syndrome* characterized by pressure optic atrophy on the side of lesion and papilloedema on the other side is a feature of olfactory groove meningioma and frontal lobe tumours.
- *Pathogenesis of papilloedema* involves



Clinical features

- Vision is normal initially
- Typically, there is recurring brief episodes (transient) of visual obscuration (Amaurosis fugax)
- Initially there is enlargement of blind spot and progressive contraction of the visual field.
- Thus, characteristically there is gradually progressive painless loss of vision.

Ophthalmoscopic findings

- *Blurring of optic disc margin* in papilloedema first of all involves nasal margins, followed by superior and inferior margin and lastly temporal margin.
- *Venous engorgement and venous congestion*
- *Loss of venous pulsations*
- There is filling of physiological cup with gradual obliteration of physiological cup
- *Paton's lines*: Radial retinal lines cascading from the optic disc.

OPTIC ATROPHY

1. Primary optic atrophy: It results from lesions proximal to the optic disc without antecedent papilloedema. Its common causes are multiple sclerosis, idiopathic retrobulbar neuritis, Leber's and other hereditary optic atrophy, pituitary tumours, toxic amblyopia, tabes dorsalis and trauma to the optic nerve.

Ophthalmoscopically, disc is chalky white in colour, margins are well defined, lamina cribrosa is visible, retinal vessels and surrounding retina are normal.

2. Consecutive optic atrophy: It occurs following destruction of the ganglion cells secondary to degenerative or inflammatory lesions of the choroid and retina. Its common causes are retinitis pigmentosa, diffuse chorioretinitis, pathological myopia and occlusion of central retinal artery. Its ophthalmoscopic features include: yellow waxy colour, not so sharply defined margins and attenuation of vessels.

3. Postneuritic optic atrophy: It develops as a sequel to long-standing papilloedema or papillitis.

The disc looks dirty white in colour, its edges are blurred, physiological cup is obliterated, lamina cribrosa is not visible, vessels are attenuated and perivascular sheathing is often present.

4. Glaucomatous optic atrophy: It results due to the effect of raised intraocular pressure. It is characterised by deep and wide cupping of the optic disc and nasal shift of the vessels.

5. Vascular (ischaemic) optic atrophy: It results from the conditions producing disc ischaemia (other than glaucoma) such as: central retinal artery occlusion, giant cell arteritis, severe haemorrhage, severe anaemia and quinine poisoning. Its ophthalmoscopic features are pallor associated with marked vascular attenuation.

Note:

- Pallor of the disc in optic atrophy is not due to atrophy of the nerve fibres but due to loss of vascularity.
- Pallor of the disc can not be correlated with the amount of visual loss.

SYMPTOMATIC DISTURBANCES OF THE VISION

Night blindness (Nyctalopia)

Its common causes are: vitamin A deficiency, tape-to-retinal degenerations (e.g. retinitis pigmentosa), congenital high myopia, and Oguchi's disease.

Day blindness (Hamarloopia)

Its causes are central corneal and central lenticular opacities and congenital deficiency of cones.

Colour blindness

a. Congenital colour blindness:

It is an inherited condition affecting males more (3-4%) than females (0.4%). It may be of following types:

i. Anomalous trichromatic colour vision: In this one of the primary colour i.e., red, green or blue is defective and the condition is called protanomalous, deuteranomalous or tritanomalous, respectively.

ii. Dichromatic colour vision: Here faculty to perceive one of the three primary colours viz. red, green or blue is completely absent and the condition is called protanopia, deuteranopia or tritanopia respectively.

iii. Blue cone Monochromatism (BCM): Here only hues of blue colour can be appreciated. It is very rare condition.

iv. Achromatopsia: It refers to total colour blindness. It is an extremely rare condition occurring due to congenital absence of the cones. Therefore, it is associated with day blindness and nystagmus.

b. Acquired colour blindness

It may follow damage to macula or optic nerve, where red, green discrimination is particularly affected. Acquired blue colour defect may occur in old age due to increased sclerosis of the crystalline lens.

Tests for colour vision

- Pseudoisochromatic charts
 - Ishihara plates mainly to screen congenital protan and deuterons (i.e., red and green defects)
 - Hardy- Rand- Rittler plates.
- Edridge-Green lantern test
- City university test.
- Fansworth Munsell 100 hue test (most sensitive)
- Fansworth D 15 hue discrimination test
- Nagel's anomaloscope
- Holmgren's wool test

Note: Currently, there is no treatment for colour blindness.

Amaurosis

A complete loss of sight in one or both eyes, in the absence of ophthalmoscopic or other marked objective signs.

Amaurosis fugax

A sudden, temporary (lasting 2-5 minutes) and painless monocular visual loss occurring due to a transient failure of retinal circulation.

Common causes

- Carotid transient ischaemic attacks (TIA)
- Embolization of retinal circulation

- Papilloedema
- Giant cell arteritis
- Raynaud's disease
- Migraine
- Prodromal symptom of central retinal artery or carotid artery occlusion
- Hypertensive retinopathy
- Venous stasis retinopathy.

MISCELLANEOUS POINTS

- *Supragenicular lesions* of visual pathway usually produce visual field defects with macular sparing.
- *Optic nerve lesions* produce negative scotomas whereas macular lesions cause positive scotoma.
- *Chromophobe adenoma* is the most common primary intracranial tumour producing neuro-ophthalmological features.
- *Gaze evoked amaurosis* is seen in optic nerve sheath meningioma.
- *Horner's syndrome* (lack of sympathetic innervation) is characterized by miosis, mild ptosis, mild enophthalmos, anhydrosis of the face on the affected side. Loss of cilio-spinal reflex and heterochromia (ipsilateral iris is of light colour). Tests to confirm diagnosis of Horner's syndrome are: dilation lag, and cocaine test (normal pupil dilates while Horner's pupil does not dilate with topical cocaine).
- The swelling of the optic disc in papillitis rarely exceeds 2-3D.
- *Scintillating scotoma* is a feature of migraine.
- Unilateral central scotoma is the earliest symptom of compression of optic nerve.
- *Hippus* (alternate rhythmic dilation and constriction of pupils) is a feature of multiple sclerosis.
- *Erythropsia* (red coloured vision) may be experienced by some patients after cataract extraction.
- *Pupil sparing, third nerve paralysis* suggests a medical cause (diabetes or hypertension). While in surgical causes (aneurysm, tumour) pupil is also involved.
- The two most common ocular signs of *myasthenia gravis* are ptosis and extraocular muscle weakness (paralytic squint).
- *Neuromyelitis optica* (Devic's disease) may be associated with sudden bilateral blindness.
- *Papillitis and retrobulbar neuritis* : Painful ocular movement is more common in retrobulbar neuritis than papillitis and fundus is normal in retrobulbar neuritis while papillitis has characteristic fundus abnormalities.

Multiple Choice Questions (MCQs)

1. Process of dark adaptation involves:

- A. Rods of retina
- B. Cones of retina
- C. Pigment epithelium of retina
- D. Both rods and cones

2. Visual acuity is a measure of:

- A. Light sense
- B. Form sense
- C. Contrast sense
- D. All of the above

3. Bitemporal hemianopia is associated with lesions of the:

- A. Optic tract
- B. Central chiasma
- C. Lateral parts of chiasma
- D. Optic radiations

4. Homonymous hemianopia with sparing of pupillary reflexes is a feature of lesions of:

- A. Optic radiations
- B. Visual cortex
- C. Geniculate body
- D. All of the above

5. Homonymous hemianopia with usually sparing of the macula is seen in lesions of:

- A. Geniculate body
- B. Optic radiations
- C. Visual cortex
- D. All of the above

6. Wernicke's heminopic pupillary reaction indicates lesions at the level of:

- A. Optic tract
- B. Distal part of optic nerve
- C. Optic chiasma
- D. Optic radiations

7. Marcus Gunn pupil is a feature of:

- A. Optic neuritis
- B. Papilledema
- C. Ciliary ganglion lesions
- D. Lesion of Edinger-Westphal nucleus

8. Argyll Robertson Pupil results from the lesion of:

- A. Accessory ganglion
- B. Ciliary ganglion
- C. Tectum region
- D. Lateral geniculate body

9. All of the following are true for the Adie's Tonic Pupil except:

- A. Light reflex is present
- B. Near reflex is very slow and tonic
- C. It is usually unilateral
- D. The affected pupil is larger

10. Pupil is small in all of the following except:

- A. During sleep
- B. Adie's pupil
- C. Argyll Robertson pupil
- D. Pontine haemorrhage

11. Pupil is spared in:

- A. Riley-Day syndrome
- B. Disseminated sclerosis
- C. Myasthenia gravis
- D. Horner's syndrome

12. The most common field defect in papillitis is:

- A. A relative central or centrocaecal scotoma
- B. Enlargement of the blind spot
- C. Tubular vision
- D. Multiple small peripheral scotomas

13. Bilateral centrocaecal scotoma more marked with red than white colour is a feature of:

- A. Tobacco amblyopia
- B. Leber's disease
- C. Papilledema
- D. Quinine amblyopia

14. Basic lesion in tobacco amblyopia is:

- A. Degeneration of ganglion cells especially of macular region
- B. Degeneration of foveal cones
- C. Ischaemia of optic nerve fibres
- D. All of the above

15. Typical field defect observed in anterior ischaemic optic neuropathy is:

- A. Altitudinal hemianopia
- B. Paracentral scotoma
- C. Homonymous hemianopia
- D. Baring of the blind spot

16. Tumours most common to cause early papilloedema arise from:

- A. Cerebellum
- B. Mid brain
- C. Parieto-occipital region
- D. All of the above

17. Occlusion of short posterior ciliary arteries may cause:

- A. Ischaemic optic neuropathy
- B. Posterior segment ischaemia
- C. Anterior segment ischaemia
- D. All of the above

18. Pseudo-Foster-Kennedy syndrome is characterised by all except:

- A. It is associated with raised intracranial pressure
- B. The culprit tumour causes optic atrophy on one side and papilloedema on the other side
- C. It may be associated with pseudotumour cerebri
- D. It needs to be differentiated from tumours arising from the orbital surface of frontal lobe

19. All of the following signs may be appreciated in a patient with early papilloedema except:

- A. Obscuration of superior, inferior and nasal disc margins
- B. Absence of spontaneous venous pulsation
- C. Mild hyperaemia of the disc
- D. Obliteration of physiological cup of the optic disc

20. The most important factor on which development of papilloedema depends in intracranial tumours is:

- A. Site of tumour
- B. Size of tumour
- C. Nature of tumour
- D. Rate of growth of tumour

21. Tumours arising from all of the following structures can induce papilloedema except:

- A. Medulla oblongata
- B. Cerebrum

- C. Olfactory groove
- D. Orbital surface of frontal lobe

22. In optic atrophy pallor of the disc is an index of:

- A. Degeneration of optic nerve fibres
- B. Loss of vascularity of the disc
- C. Demyelination of the optic nerve fibres
- D. All of the above

23. Congenital colour blindness is transmitted as:

- A. Recessive disorder
- B. Autosomal dominant
- C. Sex-linked disorder
- D. All of the above

24. Acquired blue blindness is a feature of:

- A. Increased sclerosis of the crystalline lens
- B. Disease of optic nerve
- C. Disease of macula
- D. All of the above

25. Amaurosis fugax may occur in all of the following conditions except:

- A. Papilloedema
- B. Papillitis
- C. Giant cell arteritis
- D. Raynaud's disease

26. Spiral field defect is a feature of:

- A. Amblyopia exanopsia
- B. Hysterical amblyopia
- C. Malingering
- D. Toxic amblyopia

27. In uraemic amaurosis the pupils are:

- A. Constricted
- B. Dilated and don't react to light
- C. Normal
- D. Dilated but react to light

28. In optic neuritis the best investigation to be done includes:

- A. Goldman perimetry
- B. Keratometry
- C. Ophthalmoscopy
- D. Ophthalmodynamometry

29. Normal visual acuity of 6/6 is achieved by the age of:

- A. 2 years
- B. 3 years
- C. 5 years
- D. 7 years

30. In fundus, first sign of raised intracranial pressure is:

- A. Filling of physiological cup
- B. Blurring of nasal disc
- C. Dilatation of vessels
- D. None of the above

31. Monocular diplopia with homonymous hemianopia originates in the:

- A. Geniculate body
- B. Calcarine cortex
- C. Parietal lobe
- D. Temporal lobe
- E. Tip of occipital lobe

32. Pupillary reflex is lost in:

- A. Optic neuritis
- B. Glaucoma
- C. Iridocyclitis
- D. Adie's pupil

33. Features of papilloedema include all except:

- A. May be due to intracranial haemorrhage
- B. Disc becomes elevated
- C. Cotton wool spots may be seen
- D. Vision is impaired

34. Which is incorrect of papilloedema:

- A. Disc edema
- B. Transient blurring of vision
- C. Sudden painless loss of vision
- D. Vascular engorgement

35. Functional assessment of optic nerve is by:

- A. Angiography
- B. Fundoscopy
- C. Perimetry
- D. CT Scan

36. Defect in amblyopia lies in:

- A. Lateral geniculate body
- B. Afferent pupillary reflex
- C. Rods and cones
- D. Retina

37. Pupil that responds to convergence but light reflex is absent:

- A. Adies pupil
- B. Argyl Robertson pupil
- C. Hutchinson pupil
- D. Wernicke's pupil

38. Macula is

- A. Optic nerve
- B. Optic tract
- C. Periodic blurring of vision
- D. Constant blinking

39. An optic nerve injury may result in all of the following except:

- A. Loss of vision in that eye
- B. Dilatation of pupil

- C. Ptosis
- D. Loss of light reflex

40. Bitemporal hemianopia can be due to:

- A. Third ventricle tumour
- B. Meningioma of sella diaphragmatica
- C. Calcarine cortex infarction
- D. Aneurysm of basilar artery

41. Homonymous hemianopia is seen in:

- A. Pituitary adenoma
- B. Optic nerve damage
- C. Post-chiasmic damage
- D. All of the above

42. Pituitary tumour causes:

- A. Binasal hemianopia
- B. Homonymous hemianopia
- C. Monocular blindness
- D. Bitemporal hemianopia

43. Psychogenic complaints are all except:

- A. Haloes around light
- B. Tired eyes
- C. Periodic blurring of vision
- D. Constant blinking

44. Most common type of colour blindness is:

- A. Protanopes
- B. Deutanopes
- C. Tritanopes
- D. None

45. In pupillary reflex nerve tested is:

- A. 2nd
- B. 3rd
- C. Both 2nd and 3rd
- D. 4th

46. In optic atrophy, the optic disc appears to pale is index of:

- A. Atrophy of the nerve fibre
- B. Loss of vasculature
- C. Gliosis
- D. All of the above

47. In case of anisocoria when 1% pilocarpine is instilled into the eye with abnormally dilated pupil, pupil remains dilated. Cause of anisocoria may be:

- A. Adies pupil
- B. Pharmacological blockage
- C. Uncal herniation
- D. Diabetic III cranial nerve palsy

EXTRA EDGE QUESTIONS

48. Headache with bitemporal hemianopia with 6/6 vision is seen in:

- A. Optic neuritis
- B. Trauma
- C. Chiasmal lesion
- D. Bilateral cavernous lesion

49. All statements are true about papilloedema except:

- A. Collection of extra-cellular fluid
- B. Disruption of neurofilament

- C. Stasis of axoplasmic transport
- D. Swelling of the axon

50. A young man with blurring of vision in right eye, followed by left eye after 3 months, showing disc hyperemia, edema, circumpapillary telangiectasia with normal pupillary response with centrocecal scotoma on perimetry, the cause is:

- A. Typical optic neuritis
- B. Acute papilledema
- C. Toxic optic neuropathy
- D. Leber's hereditary optic neuropathy

Disorders of Ocular Motility

Quick Text Review

ANATOMY AND PHYSIOLOGY OF OCULAR MOTILITY SYSTEM

PRINCIPLE MUSCLES OF ROTATION

- **Adduction:** Medial rectus; also superior and inferior recti.
- **Abduction:** Lateral rectus; also superior and inferior obliques.
- **Elevation:** Superior rectus and inferior oblique
- **Depression:** Inferior rectus and superior oblique
- **Intorsion:** Superior oblique and superior rectus.
- **Extorsion:** Inferior oblique and inferior rectus.

Actions of extraocular muscles

Muscle	Primary action	Subsidiary action
Superior rectus	Elevation	Adduction, Intorsion
Inferior rectus	Depression	Adduction, Extorsion
Medial rectus	Adduction	—
Lateral rectus	Abduction	—
Superior oblique	Intorsion	Depression, Abduction
Inferior oblique	Extorsion	Elevation, Abduction

Note: *Mnemonic to remember actions of muscles:*
RAD (**R**ecti are **A**dductors except lateral rectus)

Nerve supply of extraocular muscles

All EOMs are supplied by 3rd nerve, except the lateral rectus by 6th nerve and superior oblique by 4th nerve.

Synergists, antagonists and yoke muscles

I. Synergists: These muscles have the similar primary action in the same eye, e.g. superior rectus and inferior oblique of the same eye act as synergistic elevators.

2. Antagonists: These have opposite action in the same eye, e.g. medial and lateral recti-muscles.

3. Yoke muscles (contralateral synergists): It refers to a pair of muscles (one from each eye) which act simultaneously in conjugate movements of the two eyes. Six pairs of yoke muscles are as follows:

Movement	Yoke muscles
Dextroversion	Right lateral rectus and left medial rectus
Levoversion	Left lateral rectus and right medial rectus
Dextroelevation	Right superior rectus and left inferior oblique
Levoelevation	Left superior rectus and right inferior oblique
Dextrodepression	Right inferior rectus and left superior oblique
Levodepression	Left inferior rectus and right superior oblique

TYPE OF FIXATION MOVEMENT

I. Versions: Eye movements in which both eyes move in the same direction are called versions. These include:

- **Saccades** are rapid conjugate eye movements. These are of two types, voluntary saccades and reflex saccades (involuntary or reflective)
- **Smooth pursuit** (following eye movements): These are voluntary and slow conjugate eye movements.
- **Vestibuloocular reflex (VOR)**
- **Optokinetic movement**, these are slow reflexive (involuntary) conjugate movements.

II. Vergences: These are slow and disconjugate eye movements in which the eye moves in opposite directions. These includes:

- Convergence
- Divergence

Note: Mnemonic to remember:

For saccades is **FIF**

F—Fast eye movement

I—Involuntary

F—Frontal lobe (opposite)

For pursuit is **SVP**

S—Slow eye movements

V—Voluntary

P—Parieto-occipital lobe (same)

Laws governing ocular movements

1. Hering's law of equal innervation: According to it, an equal and simultaneous innervation flows from the brain to a pair of yoke muscles during conjugate movements. For example, during dextroversion right lateral rectus and left medial rectus receive equal innervation.

2. Sherrington's law of reciprocal innervation: According to it, during eye movements an increased flow of innervation to the contracting muscle is accompanied by a decreased flow of innervation to the antagonist muscle. For example, during dextroversion an increased flow to right LR and the left MR is accompanied by decreased flow to right MR and left LR.

BINOCULAR SINGLE VISION

It is a conditioned reflex which is not present since birth but is acquired during first 6 months and is completed during first few years.

Prerequisites for development of binocular single vision

1. *Straight eyes starting* from the neonatal period with precise co-ordination for all directions of gaze (motor mechanism).
2. *Reasonably clear vision* in both eyes so that similar images are presented to each retina (sensory mechanism).
3. *Ability of visual cortex* to promote binocular single vision (mental process).

Grades of binocular single vision

Grade I—Simultaneous perception: It is the power to see two dissimilar objects simultaneously. For example, when a picture of a bird is projected on to the right eye and that of a cage on to the left eye; an individual with presence of simultaneous perception will see the bird in the cage.

Grade II—Fusion: It consists of the power to superimpose two incomplete but similar images to form one complete image.

Grade III—Stereopsis: It consists of the ability to perceive the third dimension (depth perception).

SQUINT

Definition and classification

A misalignment of the visual axes of the two eyes is called *squint* or *strabismus*. Broadly it can be classified as below:

- I. Apparent squint or pseudostrabismus
- II. Latent squint (Heterophoria)
- III. Manifest squint (Heterotropia)
 1. Concomitant squint
 2. Incomitant squint

Estimation of angle of deviation

- *Hirschberg corneal reflex test.* Roughly, the angle of squint is 15° and 45° when the corneal light reflex falls on the border of pupil and limbus, respectively.
- *The prism and cover test* (Prism bar cover test, i.e. PBCT): This will measure the amount of deviation in prism dioptres. Both heterophoria as well as heterotropia can be measured by this test.
- *Krimsky corneal reflex test:* The power of prism required to centre the light reflex in the squinting eye equals the amount of squint in prism dioptres.
- *Maddox-rod test:* The Maddox rod converts the point light image into a line. Thus, the patient will see a point light with one eye and a red line with the other. Due to dissimilar images of the eyes, fusion is broken and heterophoria becomes manifest. The number on Maddox tangent scale where the red line falls will be the amount of heterophoria in degrees.
- *Maddox wing test:* By it the amount of phoria for near (at a distance of 33 cm) can be measured. It is also based on the basic principle of dissociation of fusion by dissimilar objects.
- *Measurement of deviation with synoptophore:* Both objective and subjective angle of squint can be measured accurately with synoptophore.

PSEUDOSTRABISMUS

1. *Pseudoesotropia* or apparent convergent squint may be associated with a prominent epicanthal fold and negative angle kappa.
2. *Pseudoexotropia* or apparent divergent squint may be associated with *hypertelorism*, (a condition of wide separation of the two eyes) and positive angle kappa.

ABNORMALITIES OF BINOCULAR VISION

Suppression. It is a temporary active cortical inhibition of the image of an object formed at the retina of the squinting eye. This phenomenon occurs only during binocular vision (with both eyes open).

Amblyopia. It is a uniocular impairment of vision in the absence of any organic disease of ocular media and visual pathway. Strabismic amblyopia results from prolonged uniocular suppression.

Abnormal retinal correspondence (ARC). If fovea of the normal eye and an extrafoveal point on the retina of the squinting eye acquire a common visual direction (become corresponding points).

HETEROPHORIA

It is also known as 'latent strabismus'. It is a condition in which the tendency of the eyes to deviate is kept latent by fusion. Therefore, when the influence of fusion is removed, the visual axis of one eye deviates away. *Factors predisposing to decompensation:* (i) inadequacy of fusional reserve, (ii) general debility and lowered vitality, (iii) psychosis, neurosis, and mental stress, (iv) precision of job; and (v) advancing age.

Types of heterophoria

Esophoria: It is the tendency of the eyes to rotate inwards towards nose.

Exophoria: It is a tendency of the eyes to rotate out towards temple.

Hyperphoria: It is a tendency to deviate upwards, while hypophoria is a tendency to deviate downwards. However, in practice it is customary to use the term right or left hyperphoria depending on the eye which remains up as compared to the other.

Cyclophoria: It is a tendency to rotate around the anteroposterior axis. When the 12 O'clock meridian of cornea rotates nasally, it is called *incyclophoria* and when it rotates temporally it is called *excyclophoria*.

Symptoms

Decompensated heterophoria is associated with multiple symptoms. Cyclophoria is the rarest type of heterophoria but gives greatest discomfort.

HETEROTROPIA

It refers to manifest deviation of the visual axis of the eye under binocular conditions. It is of two main types, namely, concomitant and incomitant. Sensory adaptations in patients with heterotropia.

Concomitant squint

It is a type of manifest squint, in which the amount of deviation remains constant (unaltered) in all the directions of gaze; and there is no associated limitation of ocular movements.

Concomitant esotropia

Infantile esotropia usually presents within the first 6 months of life. It is characterised by fairly large angle of squint ($>30^\circ$), alternate fixation in primary gaze and crossed fixation in lateral gaze. Binocular vision (both eye fixing simultaneously) does not develop. Inferior oblique over action may be present initially or develop later and dissociated vertical deviation develop in 80% by age of 3 years.

Treatment: Surgery is the treatment of choice. The usual recommended time is between 6 months-2 years of age (and preferably before 1 year of age)

Refractive accommodative esotropia (Normal AC/A ratio): It usually develops at the age of 2-3 years and is associated with high hypermetropia (+4 to +7D). Mostly it is fully correctable by use of spectacles.

Non-refractive accommodative esotropia: It is caused by abnormally high AC/A (accommodative convergence/accommodation) ratio. Esotropia is greater for near than the distance (minimal or no deviation for distance). It is fully corrected by adding +3D S for near vision.

Sensory deprivation (secondary) esotropia results from monocular lesions (in childhood) which either prevent the development of normal binocular vision or interfere with its maintenance. Examples of such lesions are cataract, severe congenital ptosis, aphakia, anisometropia, optic atrophy, retinoblastoma, central chorioretinitis and so on.

Consecutive esotropia results from surgical overcorrection of exotropia.

Concomitant exotropia

Congenital exotropia is rare and almost always present at birth. It is characterised by a fairly large angle of squint, usually alternating with homonymous fixation in lateral gaze, and no amblyopia.

Primary exotropia usually starts at the age of 2 years as *intermittent exotropia*. It is associated with normal fusion and no amblyopia. If not treated in time, it decompensates to become constant exotropia. It is usually alternating (ADS) with no binocular single vision.

- *Secondary (sensory deprivation) exotropia* is a constant unilateral deviation which results from long-standing monocular lesions (in adults), associated with low vision in the affected eye.
- *Consecutive exotropia* is a constant unilateral exotropia which results either due to surgical over-correction of esotropia, or spontaneous conversion of small degree esotropia with amblyopia into exotropia.

Incomitant squint

It is a type of heterotropia (manifest squint) in which the amount of deviation varies in different directions of gaze.

'A' and 'V' pattern heterotropias

The term 'A' or 'V' pattern squint is labelled when the amount of deviation in squinting eye varies by more than 10° in upward or downward gaze in comparison to that in primary position.

'A' and 'V' Esotropia: In 'A' esotropia the amount of deviation increases in upward gaze and decreases in downward gaze. The reverse occurs in 'V' esotropia.

'A' and 'V' Exotropia: In 'A' exotropia the amount of deviation decreases in upward gaze and increases in downward gaze. The reverse occurs in 'V' exotropia.

Special ocular motility defects

1. Duane's retraction syndrome. It is a congenital ocular motility defect occurring due to fibrous tightening of lateral or medial or both rectus muscles. Its features are: limitation of abduction or adduction or both, and retraction of the globe and narrowing of the palpebral fissure on attempted adduction. Eye in the primary position may be orthotropic, esotropic or exotropic.

2. Brown's superior oblique tendon sheath syndrome. It is a congenital ocular motility defect due to fibrous tightening of the superior oblique tendon. It is characterized by: limitation of elevation of the eye in adduction (normal elevation in abduction), usually straight eyes in primary position and positive forced duction test on attempts to elevate eye in adduction.

Paralytic squint

Paralytic squint is the most common type of squint in adults.

Symptoms

1. *Diplopia* occurs due to formation of image on dissimilar points of the two retinae.
2. *Confusion* occurs due to formation of image of two different objects on the corresponding points of two retinae.
3. *Nausea and vertigo* result from diplopia and confusion.
4. *Ocular deviation* is of sudden onset.

Signs

1. *Primary deviation:* It is deviation of the affected eye and is away from the action of paralysed muscle, e.g. if lateral rectus is paralysed the eye is converged.
2. *Secondary deviation:* It is deviation of the normal eye seen under cover; when the patient is made to fix with the squinting eye. It is greater than the primary deviation.
3. *Restriction of ocular movements:* It occurs in the direction of the action of paralysed muscles.
4. *Compensatory head posture:* It is adopted to avoid diplopia and confusion. Head is turned towards the direction of action of the paralysed muscle.
5. *False projection or orientation:* It can be demonstrated by asking the patient to close the sound eye and then to fix an object placed on the side of paralysed muscle. Patient will locate it to further away in the same direction.
6. There is no amblyopia and visual acuity is normal.

Pathological sequelae of an extraocular muscle palsy

1. Overaction of the contralateral synergistic muscle
2. Contracture of the direct antagonist muscle
3. Secondary inhibitional palsy of the contralateral antagonist muscle.

Clinical varieties of ocular palsies

1. Isolated muscle paralysis: Lateral rectus and superior oblique are the most common muscles to be paralysed singly, as they have separate nerve supply. Isolated paralysis of the remaining four muscles is less common, except in congenital lesions.

2. Paralysis of the third cranial nerve can be congenital or acquired,

Characteristic features are:

- *Ptosis* due to paralysis of LPS
- *Down and out deviation* of eyeball due to unopposed action of lateral rectus and superior oblique
- *Ocular movements* are restricted in all directions except outward
- *Fixed and dilated pupil* due to paralysis of sphincter pupillae

- *Accommodation lost*, due to paralysis of ciliary muscle.

3. Total ophthalmoplegia: In this condition all extraocular muscles including LPS and intraocular muscles are paralysed. It results from combined paralysis of third, fourth and sixth cranial nerves. It is a common feature of orbital apex syndrome and cavernous sinus thrombosis.

4. External ophthalmoplegia: In this condition all extraocular muscles are paralysed, sparing the intraocular muscles. It results from lesions at the level of motor nuclei sparing the Edinger-Westphal nucleus.

5. Internuclear ophthalmoplegia: In this condition there is lesion of the medial longitudinal bundle. Internuclear ophthalmoplegia (INO) is characterised by defective action of medial rectus on the side of lesion, horizontal nystagmus of the opposite eye and defective convergence. The most common cause of unilateral INO is vascular occlusion associated with diabetes mellitus and that of bilateral INO is multiple sclerosis.

6. Conjugate paresis which affects both eyes equally is produced by lesions of cerebral cortex and supranuclear pathway. In it though, position and movements of the eyes are abnormal, they maintain their relative coordination and thus produce no diplopia. Vestibulo-ocular reflexes are normal. Conjugate palsies are common in Niemann-Pick disease.

NYSTAGMUS

It is the repetitive, involuntary to and fro oscillation of the eyes.

Clinical classification

1. *Pendular nystagmus*: Velocity is equal in each direction.
2. *Jerk nystagmus*: Has slow drift and a fast phase.
3. *Mixed nystagmus*: Pendular in primary position and jerk in lateral gaze.

Etiological classification

I. Physiological nystagmus:

Optokinetic nystagmus (OKN). It constitutes of saccadic and pursuit movements. Defect in OKN indicates parietal lobe lesion.

Note: The center of Optokinetic nystagmus is parietal lobe.

II. Motor imbalance nystagmus:

1. Congenital nystagmus
2. Spasmus nutans: It is associated with head nodding
3. Latent Nystagmus: In infantile esotropia
4. Ataxic Nystagmus in internuclear ophthalmology
5. See-saw nystagmus is seen in patients with bitemporal hemianopia.

III. Ocular nystagmus: Due to sensory deprivation.

Note: Downbeat nystagmus found in lithium toxicity.

Multiple Choice Questions (MCQs)

1. **The muscle which makes an angle of about 51° with the optical axis is:**
 - A. Superior rectus
 - B. Superior oblique
 - C. Inferior rectus
 - D. Lateral rectus
2. **The muscle which makes an angle of about 23° with the optical axis is:**
 - A. Superior oblique
 - B. Superior rectus
 - C. Inferior oblique
 - D. Medial rectus
3. **Which of the following is not true for binocular single vision ?**
 - A. Provides stereoscopic vision
 - B. Is present since birth
 - C. Is the cause of diplopia in paralytic squint
 - D. Fusion is its second grade
4. **Pseudoesotropia is associated with:**
 - A. Hypertelorism
 - B. Positive angle kappa
 - C. Negative angle kappa
 - D. None of the above
5. **Pseudoexotropia is associated with:**
 - A. Prominent epicanthal fold
 - B. Positive angle kappa
 - C. Negative angle kappa
 - D. None of the above
6. **Asthenopic symptoms are most marked with:**
 - A. Cyclophoria
 - B. Hyperphoria
 - C. Esophoria
 - D. Exophoria
7. **All of the following are employed to evaluate a case of heterophoria except:**
 - A. Maddox-rod test
 - B. Alternate cover test
 - C. Measurement of fusional reserve
 - D. Measurement of near point of convergence
8. **In heterophoria prism is used:**
 - A. With apex towards the direction of phoria in glasses for treatment
 - B. With apex towards the direction of phoria for exercises only
 - C. For exercises mainly in hyperphoria
 - D. To detect grade III of binocular vision
9. **Conjugate fixation reflex is established by the age of:**
 - A. 3 weeks
 - B. 6 weeks
 - C. 3 months
 - D. 6 months
10. **An object located in the Panum's area stimulates:**
 - A. Fusion
 - B. Confusion
 - C. Diplopia
 - D. Stereopsis
11. **Strabismic amblyopia is more common in patients with:**
 - A. Intermittent squint
 - B. Alternate squint
 - C. Constant squint
 - D. Latent squint
12. **Which of the following tests helps to differentiate between concomitant squint and paralytic squint?**
 - A. Cover-uncover test
 - B. Direct cover test
 - C. Alternate cover test
 - D. None of the above
13. **All of the following lesions causing paralysis of extraocular muscles produce diplopia except:**
 - A. Nuclear lesions
 - B. Lesions of nerve trunks
 - C. Lesions of neuromuscular junction
 - D. Lesions of supranuclear pathways
 - E. None of the above

14. In paralytic convergent squint diplopia is:

- A. Homonymous
- B. Heteronymous
- C. Both of the above
- D. None of the above

15. The commonest cause of unilateral internuclear ophthalmoplegia is:

- A. Diabetes mellitus
- B. Hypertension
- C. Multiple sclerosis
- D. Lead toxicity

16. The common cause of bilateral internuclear ophthalmoplegia is:

- A. Multiple sclerosis
- B. Lead toxicity
- C. Diphtheria
- D. Diabetes mellitus

17. Onset of stereopsis occurs at the age of:

- A. 3 to 5 months
- B. 1 to 2 years
- C. 5 years
- D. 7 years

18. Uniocular diplopia occurs in all of the following except:

- A. Paralysis of inferior oblique
- B. Keratoconus
- C. Iridodialysis
- D. Incipient cataract

19. A point that falls on horopter excites:

- A. Corresponding retinal points
- B. Crossed diplopia
- C. Confusion
- D. Stereopsis

20. Convergence insufficiency is associated with all of the following except:

- A. Increase in accommodation
- B. General debility
- C. Refractive errors
- D. Wide interpupillary distance

21. All of the following may be present in Duane's retraction syndrome except:

- A. Limitation of abduction
- B. Narrowing of palpebral aperture in abduction
- C. Suppression
- D. Head turn

22. Brown's syndrome simulates paresis of:

- A. Inferior oblique
- B. Superior oblique
- C. Superior rectus
- D. Inferior rectus

23. In 'A'-Esotropia the amount of deviation:

- A. Increases in upward gaze and decreases in down gaze
- B. Decreases in upward gaze and increases in down gaze
- C. Increases in upward as well as downward gaze
- D. Decreases in upward as well as downward gaze

24. In 'V'-Exotropia amount of deviation:

- A. Increases in upward gaze and decreases in down gaze
- B. Decreases in upward gaze and increases in down gaze
- C. Increases in upward as well as downward gaze
- D. Decreases in upward as well as downward gaze

25. In caloric test left jerk nystagmus occurs when:

- A. Cold water is poured in right ear
- B. Hot water is poured in right ear
- C. Cold water is poured in left ear
- D. All of the above

26. Secondary deviation of the eye is based on the following law:

- A. Hering's
- B. Listing's
- C. Donder's
- D. Sherrington's

27. Uncrossed diplopia is seen with:

- A. Esotropia
- B. Exotropia
- C. Exophoria
- D. Esophoria

28. All are features of paralytic squint except:

- A. Unequal fixation
- B. Vertigo
- C. Amblyopia
- D. Abnormal head position

29. Amplitude of accommodative convergence is:

- A. Altered by weak cycloplegics
- B. Altered by lenses and prisms
- C. Decreased in older people
- D. Altered by orthoptics

30. Large angle Kappa gives rise to:

- A. Pseudo squint
- B. Manifest squint
- C. Latent squint
- D. Periodic squint

31. Most uncommon type of latent strabismus is:

- A. Esophoria
- B. Exophoria
- C. Hyperphoria
- D. Cyclophoria

- 32. In unilateral past pointing nystagmus the site of lesion is:**
 A. Cerebellar hemisphere
 B. Lateral semicircular canal
 C. Flocculo-nodular lobe
 D. Superior semicircular canal
- 33. Secondary deviation of the eye is an example of the following law:**
 A. Herring's
 B. Listing's
 C. Sherrington's
 D. Donder's
- 34. Action of right superior oblique muscle is:**
 A. Dextrodepression
 B. Dextroelevation
 C. Laevoelevation
 D. Laevodepression
- 35. The best treatment for correction of 15° non-accommodative esotropia in a 5-year-old child is:**
 A. Order refraction testing under atropine and full correction
 B. Synoptophore exercise
 C. Surgical alignment
 D. Occlusion patching
- 36. In right-sided sixth nerve palsy all of the following are seen except:**
 A. Convergent squint
 B. Right-sided abduction loss
 C. Diplopia on dextroversion
 D. Head turned to left
- 37. For a new-born baby with squint surgery should be done at:**
 A. 3-4 years
 B. Immediately
 C. 10-12 years
 D. 18-21 years
- 38. Hirschberg test is used to detect:**
 A. Squint
 B. Field defects
 C. Glaucoma
 D. Optic atrophy
- 39. Miners nystagmus is of which type:**
 A. Lateral
 B. Vertical
 C. Rotatory
 D. Can be of any type
- 40. Down beat nystagmus could be due to:**
 A. Cerebellar lesion
 B. Arnold-Chiari malformation
 C. All of the above
 D. None of the above
- 41. Downward and lateral gaze is action of:**
 A. Inferior oblique
 B. Medial rectus
 C. Superior oblique
 D. Lateral rectus
- 42. Elevators of eye:**
 A. SR and IO
 B. IO and SO
 C. IR and S
 D. SO SR
- 43. Yolk muscle pair is:**
 A. Rt MR and Rt LR
 B. Rt MR and Lt LR
 C. Rt SO and Lt IO
 D. Rt SR and Lt SR
- 44. Child with mild squint. Intrauterine, birth history, development history till date all normal. Corneal reflex normal. All other eye parameters normal except exaggerated epicanthal fold. Diagnosis:**
 A. Pseudostrabismus
 B. Accommodative squint
 C. Exophoria
 D. Esophoria
- 45. Which of the following best defines the "Saccade":**
 A. Voluntary slow eye movements
 B. Involuntary slow eye movement
 C. Abrupt, involuntary slow eye movements
 D. Abrupt, involuntary rapid eye movements
- 46. A patient has a right homonymous hemianopia with saccadic pursuit movements and defective optokinetic nystagmus. The lesion is most likely to be in the :**
 A. Frontal lobe
 B. Occipital lobe
 C. Parietal lobe
 D. Temporal lobe

EXTRA EDGE QUESTIONS

47. Weakness of both Adduction and Abduction to seen in:

- A. Duane's Retraction Syndrome Type 1
- B. Duane's Retraction Syndrome Type 2
- C. Duane's Retraction Syndrome Type 3
- D. All

48. Dilator pupillae is supplied by:

- A. Post-ganglionic parasympathetic fibers from Edinger Westphal nucleus
- B. Post-ganglionic sympathetic fibers from cervical sympathetic chain
- C. IIIrd nerve
- D. Sympathetic fibers from fronto-orbital branch of V nerve

49. A 30 year old man came at the outpatient department because he had suddenly developed double vision. On examination it was found that his right eye, when at rest was turned medially. The most likely anatomical structures involved are:

- A. Medial rectus and superior division of oculomotor nerve
- B. Inferior oblique and inferior division of oculomotor nerve
- C. Lateral rectus and abducent nerve
- D. Superior rectus and trochlear nerve

50. A patient presented with his head tilted towards left. On examination, he was having left hypertropia which increased on looking towards right or medially. The muscle which is most likely paralyzed is:

- A. Left superior oblique

- B. Left inferior oblique
- C. Right superior oblique
- D. Right inferior oblique

51. True about infantile esotropia:

- A. Presented from birth
- B. Large angle of deviation
- C. Inferior oblique muscle hyperactivity
- D. Variable angle of deviation
- E. A/W refractive error

52. A patient presents with diplopia with limitation of adduction in the left eye and abducting saccade in the right eye. Convergence is preserved. Most likely etiology is:

- A. Partial 3rd nerve palsy
- B. Internuclear ophthalmoplegia
- C. Duane's reactionary syndrome
- D. Absence of medial rectus muscle

53. A 26 years old male with restriction of eye movements in all directions and moderate ptosis but with no diplopia or squint. Diagnosis is:

- A. Thyroid ophthalmopathy
- B. Chronic progressive external ophthalmoplegia
- C. Myasthenia gravis
- D. Multiple cranial nerve palsies

54. Final centre for horizontal movement of eye is:

- A. Abducent nucleus
- B. Trochlear nucleus
- C. Oculomotor nucleus
- D. Vestibular nucleus

Diseases of Eyelids

Quick Text Review

INFLAMMATORY DISORDERS

BLEPHARITIS

Squamous blepharitis

- It is usually associated with seborrhoea of scalp (dandruff). In it, glands of Zeis secrete abnormal excessive neutral lipids which are splitted by corynebacterium acne into irritating free fatty acids.
- *Characterised by* accumulation of whitish soft scales along the lid margin.

Bacterial blepharitis (Ulcerative blepharitis)

- Chronic staphylococcal infection of the lid margin.
- Characterised by yellow crusts at the root of cilia. Small ulcers, which bleed easily are seen on removing the crusts. Anterior lid margin shows dilated blood vessels (rosettes).
- Complications and sequelae are:
 - Recurrent styes (very common)
 - Recurrent conjunctivitis (common)
 - Marginal keratitis (common)
 - Madarosis, poliosis, tylosis and eversion of punctum.

Posterior blepharitis (Meibomitis)

- A meibomian gland dysfunction, seen more commonly in patients with acne rosacea and seborrhoeic dermatitis.
- Foam in the tears (meibomian seborrhoea) is characteristic feature.

STYE (HORDEOLUM EXTERNUM)

- An acute suppurative staphylococcal infection of gland of Zeis or gland of moll and lash follicle.
- Recurrent styes are more common in patients with asthenopia, diabetes mellitus and chronic blepharitis.

CHALAZION (MEIBOMIAN CYST/TARSAL CYST)

- A chronic non-infective, non-suppurative lipo-granulomatous inflammation of the meibomian gland with blockage of duct and collection of sebaceous material.
- *Characterised by* painless tarsal swelling which often may be multiple (most common lid swelling).
- *Treatment:* Incision and curettage of chalazion (most common mode of therapy) is done from the conjunctival side by a vertical incision. Intralesional injection of steroid may be effective in soft, small and recurrent chalazion.
- *Recurrence* may occur in *seborrhoeic dermatitis, acne rosacea and malignant changes*.
- *Complications* include secondary malignancy (Meibomian gland adenocarcinoma or sebaceous cell carcinoma).

HORDEOLUM INTERNUM

- An acute primary staphylococcal infection of meibomian gland or secondary infection in a chalazion.
- Symptoms are similar to styne except that pain is more intense, due to the swelling being embedded deeply in the dense fibrous tissue.
- It can be differentiated from hordeolum externum by the facts that in it, the point of maximum tenderness and swelling is away from the lid margin and that pus usually points on the conjunctival side and not on the root of cilia.

MOLLUSCUM CONTAGIOSUM

- A viral infection (large pox virus) commonly affecting children with small, pale umbilicated lid nodules.
- *Complications:* Ipsilateral chronic follicular conjunctivitis and epithelial keratitis.

DISORDERS OF EYE LASHES AND LID MARGIN

TRICHIASIS

An inward misdirection of eye lashes with normal position of lid margin.

Causes

Trachoma (commonest), ulcerative blepharitis, healed membranous conjunctivitis, hordeolum externum, mechanical injuries, burns and operative scar on the lid margin.

Treatment

- *Epilation* is easy but temporary method, as recurrences occur within 3–6 weeks.
- *Electrolysis*: A current of 2 mA is passed for 10 seconds into the lash root. Recurrences are not rare.
- *Cryoepilation*: The cryoprobe with -20°C is applied for 20–25 seconds. It is the best method for segmental trichiasis. Its main disadvantage is depigmentation of the skin.
- *Argon laser destruction* is effective but may need to be repeated.

ENTROPION

An inward turning of lid margin.

1. Congenital entropion

A rare condition seen since birth. Lower lid retractors not well developed.

2. Cicatricial entropion

Common variety, more frequently involves the upper lid

- *Causes*—scarring of palpebral conjunctiva in trachoma (most common), membranous conjunctivitis, chemical burns, pemphigus and Stevens-Johnson syndrome.

3. Involutional (senile) entropion

Common variety, affects the lower lid in elderly.

Etiological factors

- Weakening or dehiscence of capsulopalpebral fascia (lower lid retractors).
- Degeneration of palpebral connective tissue allowing preseptal fibres to override the pretarsal fibres.
- Horizontal laxity of the lid.

Management

- *Tucking or plication of inferior lid retractors* (Jones, Reech and Wobing operation)
- Modified Wheeler's operation
- Weiss operation
- Bick's procedure

4. Spastic entropion

Occurs following spasm of orbicularis due to chronic ocular irritation or following tight bandaging. More common in elderly and frequently involves lower lid.

5. Mechanical entropion

Occurs due to lack of support provided by the globe to lids as in phthisis bulbi, enophthalmos, after enucleation or evisceration operation.

ECTROPION

- Out rolling or outward turning of the lid margin.
- Epiphora is the main symptom in ectropion.

1. Congenital ectropion is very rare, but may be seen in Down's syndrome and blepharophimosis syndrome.

2. Involutional (senile) ectropion

- Most common variety, involves the lower lid.
- Occurs due to following age-related changes:
 - Senile laxity of the lid tissues
 - Loss of the tone of orbicularis muscle
 - Weakness of medial and lateral canthal tendons.

3. Cicatricial ectropion. Occurs due to skin scarring as in thermal burns, chemical burns, lacerating injuries and skin ulcers.

4. Paralytic ectropion. Occurs in facial nerve palsy in lower lid.

SYMBLEPHARON

- Adhesions of the lids with the eyeball
- *Causes*: Chemical burns, thermal burns, membranous conjunctivitis, ocular pemphigus, Stevens-Johnson syndrome
- *Types*: Anterior, posterior and total.

ANKYLOBLEPHARON

- Refers to adhesions between upper and lower lid margins.
- Usually associated with symblepharon.

LAGOPHTHALMOS

- Inability to voluntarily close the eye-lids
- *Causes*: Orbicularis paralysis, severe ectropion, symblepharon, marked proptosis, overcorrection of ptosis and comatose patient.

BLEPHAROSPASM

- Essential (spontaneous) blepharospasm is a rare idiopathic condition occurring in elderly patients

- Reflex blepharospasm occurs in conditions of chronic ocular irritations
- **Treatment:** Eliminate the cause of reflex blepharospasm
 - Botulinum toxin injection into the orbicularis muscle.
 - Facial denervation in severe cases.

PTOSIS

Drooping of the upper lid more than the normal (2 mm).

Congenital myogenic ptosis

- Congenital weakness of levator palpebrae superioris (LPS) muscle.
- It is the most common congenital anomaly of the lid.
- It is characterized by dropping of one or both lids at birth, with diminished or absent lid crease and lid lag on downgaze due to tethering effect of abnormal muscle. It may occur in following forms:
 - *Simple congenital ptosis:* Not associated with other anomaly
 - *Congenital ptosis with superior rectus weakness.*
 - *Blepharohimosis syndrome:* Congenital ptosis, blepharophimosis, telecanthus and epicanthus inversus.
 - *Congenital synkinetic ptosis (Marcus Gunn-winking Ptosis):* Retraction of ptotic lid with jaw movement like chewing, i.e., with stimulation of ipsilateral pterygoid muscle.

Note: Marcus-Gunn Jaw-Winking syndrome occurs due to nuclear or infra-nuclear connection between IIIrd and Vth nerve.

Acquired ptosis

1. Neurogenic ptosis. Third nerve palsy, ophthalmoplegic migraine, multiple sclerosis. Horner's syndrome occurs in: cervical adenitis, thyroid operation, aortic aneurysm, syringomyelia, Pancoast's syndrome, trauma, cervical cord tumours and multiple sclerosis.

2. Myogenic ptosis. Myasthenia gravis, dystrophica myotonica, ocular myopathy, oculopharyngeal muscular dystrophy, trauma to LPS muscle, thyrotoxicosis, Lambert-Eaton myasthenia syndrome.

3. Aponeurotic ptosis. Involutional (senile) ptosis, post-cataract operation, blepharochalasis, traumatic dehiscence or disinsertion of the aponeurosis.

4. Mechanical ptosis. Lid tumours, multiple chalazia, lid oedema.

Causes of bilateral ptosis

- Myasthenia gravis
- Myotonic dystrophy
- Kearns-sayre syndrome.

Causes of pseudoptosis

- Microphthalmos
- Anophthalmos
- Enophthalmos
- Phthisis bulbi.

Evaluation of ptosis

I. Degree of ptosis

- Mild: 2 mm
- Moderate: 3 mm
- Severe: 4 mm or more.

II. Levator function by Burke's method

- Normal: 15 mm
- Good: 8 mm or more
- Fair: 5–7 mm
- Poor: 4 mm or less.

III. MRD 1

Marginal reflex distance-b/w upper lid margin and light reflex in primary gaze, normal is 4–4.5 mm.

IV. Vertical fissure height:

Male:- 7–10 mm

Female:- 8–12mm

V. Special tests

- Tensilon (edrophonium) test for suspected myasthenia
- Phenylephrine test for suspected Horner's syndrome.

Treatment

1. Fasanella—Servat operation (Excision of upper border of tarsus together with lower border of muller muscle and overlying conjunctiva)—for mild ptosis with good levator action. It is also indicated in Horner's syndrome.

2. Levator resection—for moderate and severe ptosis.

- Blaskovics' operation (conjunctival approach)
- Everbusch's operation (skin approach)

3. Frontalis sling operation (Brow suspension)

- For severe ptosis with poor levator function
- Materials used—autogenous fascia lata (best), supramid, prolene, silicone.

TUMOURS OF EYE LIDS

A. BENIGN TUMOURS

1. Simple papilloma

- Most common tumour
- Usually occurs at the lid margin.

2. Xanthelasma

- Creamy-yellow plaque like lesion
- Occurs on upper and lower lids near the inner canthus
- More common in middle aged women, diabetics and those with high cholesterol level.

3. Capillary haemangioma

- A childhood tumour, may occur pari-passi or as a part of Sturge-Weber syndrome
- In many cases self-resolution may occur by the age of 5 years

4. Neurofibroma

- Lids and orbits commonly affected
- Solitary neurofibroma or as a part of neurofibromatosis.

B. PRECANCEROUS CONDITIONS

- Solar keratosis
- Carcinoma-in-situ
- Xeroderma pigmentosa.

C. MALIGNANT TUMOURS

1. Basal cell carcinoma

- Commonest malignant tumour of the lids, seen in elderly people (western reports).
- Locally malignant.
- Sites: Lower lid–50% (most common)
 - Medial can thus: 25%
 - Upper lid: 10–15%
 - Outer canthus: 5%.
- Presentations
 - Noduloulcerative (most common)
 - Nonulcerative nodular
 - Sclerosing type
 - Pigmented basal cell carcinoma.
- Most common histological pattern is solid basal cell carcinoma with characteristic peripheral palisaded appearance
- Treatment: of choice is local excision
 - Radiotherapy only in inoperable cases.

2. Squamous cell carcinoma

- Second commonest malignant tumour of the eye lids

- Incidence is much less than the basal cell carcinoma
- Common site—lid margin
- *Presentations*
 - An ulcerated growth with elevated and indurated margins (common)
 - Fungating or polypoidal growth (rare)
- *Metastasis*: Preauricular and submandibular lymph nodes
- *Characteristic histological feature* is whorled arrangement forming horn pearls which may contain laminated keratin in the centre.

3. Sebaceous gland carcinoma

- It is a very rare tumour according to western reports, but Indian literature reports it as the most common lid malignancy.
- Arises from meibomian glands (most common), sebaceous glands of eyebrows and caruncle.
- May be mistaken for chalazion.

4. Malignant melanoma (melanocarcinoma)

- May arise from a pre-existing naevus, but usually arises de-novo from the melanocytes present in the skin.
- Metastasis: Locally, lymphatics and blood stream.
- Radioresistant, so surgery is treatment of choice.

MISCELLANEOUS POINTS

- *Blepharophimosis* may be associated with Down's syndrome, microphthalmos, Edward's syndrome and Waardenburg's syndrome.
- *Ptosis associated with* lower lid of the affected side being at a higher level than the lower lid of the normal side is seen in Horner's syndrome.
- *Epicanthus* may be associated with Down's syndrome.
- *Blepharitis acaria* is caused by Demodex follicularium.
- *Cutaneous horn of eye lids* is frequently associated with an underlying dysplastic (actinic keratosis) or neoplastic (squamous cell carcinoma) change.
- *Ptosis associated with lid lag* in down gaze is feature of congenital ptosis.
- *Peculiarities of the skin of the eyelids* are loose attachment, extreme thinness, and absence of hair.

Multiple Choice Questions (MCQs)

1. **Distichiasis is characterised by all of the following except:**
 - A. An extra row of cilia is present
 - B. Normal row of cilia is present anterior to the openings of the meibomian glands
 - C. Extra row of cilia occupies a position posterior to the openings of the meibomian glands
 - D. Cilia of the extra row may rub the cornea
2. **Rosettes found at the lid margin are a feature of:**
 - A. Squamous blepharitis
 - B. Ulcerative blepharitis
 - C. Both of the above
 - D. None of the above
3. **Stye is an acute suppurative inflammation of:**
 - A. Gland of Zeis
 - B. Gland of Moll
 - C. Meibomian gland
 - D. All of the above
4. **Hordeolum internum is a suppurative inflammation of the:**
 - A. Gland of Zeis
 - B. Gland of Moll
 - C. Meibomian gland
 - D. All of the above
5. **Of the following conditions most painful is:**
 - A. Stye
 - B. Hordeolum internum
 - C. Ulcerative blepharitis
 - D. Inflammation of gland of Moll
6. **In a chalazion with multiple recurrences at the same site the incision and curettage should be:**
 - A. Followed by cauterisation with carbolic acid
 - B. Preceded by cryotherapy
 - C. Preceded by intralesional injection of triamcinolone
 - D. Replaced by excision biopsy
7. **Pseudotrichiasis is seen in:**
 - A. Entropion
 - B. Ectropion
 - C. Distichiasis
 - D. Healed membranous conjunctivitis
8. **Simple and effective method of treatment for segmental trichiasis is:**
 - A. Epilation
 - B. Electrolysis
 - C. Cryolysis
 - D. Surgical correction
9. **All of the following operations are employed to correct senile entropion except:**
 - A. Modified Wheeler's operation
 - B. Modified Ketssey's operation
 - C. Weiss operation
 - D. Bick's procedure with Reeh's modification
10. **Which of the following types of entropion is not known:**
 - A. Spastic entropion
 - B. Paralytic entropion
 - C. Cicatricial entropion
 - D. Involutional entropion
11. **Senile ptosis is:**
 - A. Neurogenic
 - B. Myogenic
 - C. Aponeurotic
 - D. Mechanical
12. **Severe ptosis in a new born should be operated at the age of:**
 - A. 1 year
 - B. 3 years
 - C. 5 years
 - D. Earliest possible

13. All of the following are pre-cancerous conditions of the lids except:

- A. Naevi
- B. Solar keratosis
- C. Xeroderma pigmentosa
- D. Carcinoma-in-situ

14. The commonest malignant tumour of the lids is:

- A. Basal-cell carcinoma
- B. Squamous cell carcinoma
- C. Adenocarcinoma
- D. Melanocarcinoma

15. The most common site of basal cell carcinoma of the lids is:

- A. Upper lid
- B. Lower lid
- C. Medial canthus
- D. Lateral canthus

16. Sebaceous cell carcinoma of the lids arises from:

- A. Meibomian gland
- B. Sebaceous gland of eyebrows
- C. Caruncle
- D. All of the above

17. Epiphora in a patient with seventh nerve palsy is most likely due to:

- A. Eversion of lower punctum
- B. Lateral lower lid ectropion
- C. Failure of lacrimal pump system
- D. All of the above

18. Ptosis with lid lag is seen in:

- A. Traumatic ptosis
- B. Myogenic ptosis
- C. Synkinesis
- D. Congenital ptosis

19. Tylosis refers to:

- A. Hypertrophy and drooping of eyelid
- B. Inversion of eyelid
- C. Senile eversion of eyelid
- D. Distortion of cilia

20. The commonest fungal lesion of the eyelid is:

- A. Candida
- B. Aspergillosis
- C. Sporothrix
- D. None

21. Epilation is not indicated in:

- A. Ulcerative blepharitis
- B. Phthiriasis
- C. Trichiasis
- D. Madarosis

22. Sling surgery should be avoided in cases of ptosis with:

- A. Very poor levator action
- B. Poor Bell's phenomenon

- C. Weak Muller's muscle
- D. Multiple failed surgeries

23. All are complications of chronic staphylo-coccal blepharoconjunctivitis except:

- A. Chalazion
- B. Marginal conjunctivitis
- C. Follicular conjunctivitis
- D. Phlyctenular conjunctivitis

24. Fasanella Servat operation is specifically indicated in:

- A. Congenital ptosis
- B. Steroid induced ptosis
- C. Myasthenia gravis
- D. Horner's syndrome

25. The operation of plication of inferior lid retractors is indicated in:

- A. Senile ectropion
- B. Senile entropion
- C. Cicatricial entropion
- D. Paralytic entropion

EXTRA EDGE QUESTIONS

26. A recurrent chalazion should be subjected to histopathologic evaluation to exclude the possibility of:

- A. Squamous cell carcinoma
- B. Sebaceous cell carcinoma
- C. Malignant melanoma
- D. Basal cell carcinoma

27. Fusion of palpebral and bulbar conjunctiva is:

- A. Symblepharon
- B. Trichiasis
- C. Ectropion
- D. Tylosis

28. Eyelid drooping in/are seen in:

- A. Damage to edinger-westphal nucleus
- B. Damage to motor part of facial nerve
- C. Damage to sympathetic nerve supply
- D. Damage to motor root of oculomotor nerve
- E. Damage to lacrimal nerve

29. A patient with ptosis presents with retraction of ptotic eye lid on chewing. This represents:

- A. Marcus gunn jaw winking syndrome
- B. Third nerve misdirection syndrome
- C. Abducent palsy
- D. Oculomotor palsy

30. S shaped eyelid is seen in:

- A. Plexiform neurofibroma
- B. Hemangioma
- C. Arterio venous fistula
- D. Varix

13 : A	14 : A	15 : B	16 : D	17 : C	18 : D
19 : A	20 : A	21 : D	22 : B		

23 : A	24 : D	25 : B	26 : B	27 : A
28 : C and D	29 : A	30 : A		

Diseases of Lacrimal Apparatus

Quick Text Review

TEAR FILM AND ITS DISORDERS

TEAR FILM

Structure

Tear film consist of three layers:

1. Mucus layer

- Innermost and thinnest layer (0.02-0.05 mm)
- Consists of mucin secreted by goblet cells and glands of Manz
- Converts hydrophobic corneal surface into hydrophilic

2. Aqueous layer

- Thickest layer (6.5–7.5 mm) and consists of tears secreted by main and accessory lacrimal glands
- Alkaline and saltish in taste
- Contains antibacterial substances—lysozyme, betalysin, lactoferrin, immunoglobulin-A.

3. Lipid or oily layer

- Outermost layer, about 0.1 μm thick
- Consists of secretions of Meibomian, Zeis and Moll glands
- Prevents the overflow of tears, retards their evaporation and lubricates the eyelids as they slide over the surface of the globe.

Functions

- Keeps conjunctiva and cornea moist
- Provides oxygen to corneal epithelium
- Washes away debris and noxious irritants
- Antibacterial activity
- Facilitates movements of the lids over the globe.

DRY EYE

Etiology

1. **Aqueous tear deficiency**—Kerato-conjunctivitis sicca (KCS)

i. Sjogren's syndrome

- Pure KCS: In it only lacrimal gland is damaged by infiltration with mononuclear cells
- Primary Sjogren's syndrome (sicca complex) consists of KCS and a dry mouth (xerostomia)
- Secondary Sjogren's syndrome consists of sicca complex and a connective tissue disease (usually rheumatoid arthritis).

ii. Non-Sjogren's syndrome. It includes:

- Congenital alacrimia (rare)
- Riley-Day syndrome
- Idiopathic hyposecretion.

2. Evaporative dry eye. It is caused by the conditions which decrease tear film stability and thus increase evaporation. It includes:

i. Mucin deficiency dry eye

- Hypovitaminosis - A
- Severe conjunctival scarring (trachoma, Stevens-Johnson syndrome, chemical burns, radiations and ocular pemphigoid).

ii. Lipid deficiency and abnormalities

- Congenital absence of meibomian glands along with anhydrotic ectodermal dysplasia (rare)
- Chronic blepharitis and meibomitis (common).

iii. Impaired eyelid functions

- Bell's palsy
- Dellen
- Symblepharon
- Lagophthalmos
- Ectropion.

iv. Corneal epitheliopathies.

Tear film tests

1. Tear film break-up-time (BUT)

- It is the interval between a complete blink and appearance of first randomly distributed dry spot on the cornea
- Normal values: 15–35 seconds

- Value less than 10 seconds imply an unstable tear film
- Low values indicate mucin deficiency/disturbance.

2. Schirmer-I-test

- It measures total tear secretion (production)
- It is performed with 5 × 35 mm strip of Whatman 41 filter paper
- Normal value: 15 mm or above/5 minutes
- Values between 5 and 10 mm: Mild to moderate dry eye
- Value less than 5 mm: Severe dry eye
- Low values are suggestive of aqueous deficiency dry eye (kerato-conjunctivitis sicca).

3. Rose Bengal staining

- Stains devitalized cells
- Irritating—so use xylocaine
- Three staining patterns are described:
 - C-pattern: Fine punctate stain in interpalpebral area (suggests mild dry eye).
 - B-pattern: Extensive staining (moderate dry eye)
 - A pattern: Confluent staining of conjunctiva and cornea (severe dry eye).

THE WATERING EYE

1. Hyperlacrimation, i.e. more formation of tears is of two types:

- *Primary hyperlacrimation* occurs due to direct stimulation of the lacrimal gland as in early stages of lacrimal gland tumours and cysts and due to the effect of strong parasympathomimetic drugs.
- *Reflex hyperlacrimation* results from stimulation of sensory branches of fifth nerve due to irritation of cornea or conjunctiva.
 - a. *Physiological cause* of epiphora is lacrimal pump failure due to lower lid laxity or weakness of orbicularis muscle.
 - b. *Mechanical obstruction* in lacrimal passages.

2. Epiphora refers to watering due to decreased drainage of tears either due to blockage of lacrimal passage or due to lacrimal pump failure (atonia of sac).

- The commonest cause of epiphora in a newborn is membrane at the lower end of NLD
- The commonest site of obstruction in epiphora occurring in an adult is junction of the sac and the NLD
- For evaluation of functional (physiological) obstruction due to lacrimal pump failure dacryoscintigraphy or radionucleotide dacryocystography is used and it is the most sensitive method for evaluation.

Causes of false negative regurgitation test

- Internal fistula

- Wrong technique of performing regurgitation test
- Encysted mucocele.
- *Crocodile tears* are seen in abnormal VII nerve regeneration.

DISORDERS OF LACRIMAL SAC AND LACRIMAL GLAND

DACRYOCYSTITIS

Congenital dacryocystitis

As many as 30 percent of newborn infants are believed to have closure of nasolacrimal duct at birth; *mostly due to membranous occlusion at its lower end*, near the valve of Hasner. Watering develops after 7 days of birth followed by mucopurulent discharge. Regurgitation test becomes positive.

Treatment

- *Massage over the lacrimal sac area and topical antibiotics* constitute the treatment of congenital NLD block, up to 6 months of age. This conservative treatment cures obstruction in about 90 percent of the infants.
- *Probing of NLD with Bowman's probe* should be performed, in case the condition is not cured by the age of 6 months (some surgeon wait up to 9 months). In most instances a single probing will relieve the obstruction. In case of failure, it may be repeated after an interval of 3–4 weeks.
- Balloon catheter dilation may be carried out where repeated probing is a failure.
- Intubation with silicone tube may be tried when above treatment is a failure.
- *Dacryocystorhinostomy (DCR) operation*: Optimum age is 4 years.

Adult dacryocystitis (Acquired dacryocystitis)

Chronic dacryocystitis

- It is more common than the acute dacryocystitis.
- The disease is predominantly seen in females (80%).
- *Dacryocystorhinostomy (DCR) operation* is the treatment of choice.
- *Dacryocystectomy (DCT)* is indicated when DCR is contraindicated.

SWELLINGS OF THE LACRIMAL GLAND

Mickulicz's syndrome

It is characterised by bilaterally symmetrical enlargement of the lacrimal and salivary glands

associated with a variety of systemic diseases. These include: leukaemias, lymphosarcomas, benign lymphoid hyperplasia, Hodgkin's disease, sarcoidosis and tuberculosis.

- *Dacryops*. It is a cystic swelling, which occurs due to retention of lacrimal secretions following blockage of the lacrimal ducts.
- *Lymphoid tumours and inflammatory pseudotumors* constitute approximately 50% of cases.
- *Benign epithelial tumours* include benign mixed tumours which account for 25 percent cases.
- *Malignant epithelial tumours* constitute 25% of cases and include: Malignant mixed tumour, adenoid cystic carcinoma, mucoepidermoid carcinoma and adenocarcinoma.

Benign mixed tumour

It is also known as *pleomorphic adenoma* and occurs predominantly in young adult males. It is the *commonest tumour* of the lacrimal gland. *Clinically* it presents as a slowly progressive painless swelling in the upper-outer quadrant of the orbit. The eyeball may be proptosed with a down and in displacement. It is locally invasive and may infiltrate its own pseudocapsule to involve the adjacent periosteum. *Histologically*, it is characterised by presence of pleomorphic myxomatous tissue, just like benign mixed tumour of salivary gland. Its *treatment* consists of complete surgical removal with the capsule. Recurrences are very common following incomplete removal.

Multiple Choice Questions (MCQs)

1. Innermost stratum of tear film is:

- A. Mucus layer
- B. Aqueous layer
- C. Oily layer
- D. None of the above

2. Thickest layer of tear film is:

- A. Mucus layer
- B. Aqueous layer
- C. Oily layer
- D. None of the above

3. The antibacterial substance present in the tears is:

- A. Lysozyme
- B. Betalysin
- C. Lactoferrin
- D. All of the above

4. Keratoconjunctivitis sicca refers to:

- A. Aqueous tear deficiency dry eye
- B. Mucin deficiency dry eye
- C. Lipid deficiency dry eye
- D. All types of dry eye

5. Normal values of tear film break up time range from:

- A. 5 to 10 seconds
- B. 10 to 15 seconds
- C. 15 to 20 seconds
- D. 15 to 30 seconds

6. Schirmer-I test measures:

- A. Total tear secretions
- B. Basal tear secretions
- C. Reflex tear secretions
- D. All of the above

7. Normal values of Schirmer-I test are:

- A. 5 mm
- B. 10 mm
- C. 15 mm
- D. 15 mm or above

8. All of the following are features of Sjogren's syndrome except:

- A. It is an autoimmune chronic inflammatory disease
- B. Typically occurs in women after the menopause
- C. In primary Sjogren's syndrome, keratoconjunctivitis sicca is associated with rheumatoid arthritis
- D. In secondary Sjogren's syndrome, dry eye and/or xerostomia (dry mouth) is associated with rheumatoid arthritis

9. Tear film break-up-time is the time:

- A. Between the last blink and the appearance of first dry spot on the cornea
- B. Taken for appearance of dry spot between two blinks
- C. Taken by successive blinks to break the tear film
- D. Taken for disappearance of dry spots on the cornea

10. Tear lysozyme levels are decreased in:

- A. Keratoconjunctivitis sicca
- B. Stevens Johnson syndrome
- C. Ocular pemphigoid
- D. All of the above

11. Positive fluorescein dye disappearance test indicates that watering eye is due to:

- A. Atonia of the sac
- B. Mechanical obstruction in the lacrimal passages
- C. Both of the above
- D. None of the above

12. Most common site of congenital blockage in the nasolacrimal duct is:

- A. At the upper end
- B. In the middle
- C. At the lower end
- D. Whole of the duct

13. Optimum age for performing dacryocystorhinostomy operation in a child with congenital dacryocystitis is:

- A. 2 years
- B. 4 years
- C. 6 years
- D. 8 years

14. In dacryocystorhinostomy operation the communication of the sac is established with:

- A. Middle meatus
- B. Superior meatus
- C. Inferior meatus
- D. All of the above

15. Functional efficiency of lacrimal drainage system may be assessed by:

- A. Lacrimal syringing
- B. Subtraction macrodacryocystography
- C. Radionucleotide dacryocystography
- D. All of the above

16. Most common site of obstruction in chronic dacryocystitis in adults is:

- A. At upper end of nasolacrimal duct
- B. At lower end of nasolacrimal duct
- C. In the lacrimal sac
- D. In the common canaliculus

17. Normal pH of tears is:

- A. 5.7
- B. 6.7
- C. 7.5
- D. 7.9

18. Tears are produced in the new born after:

- A. 1 Week
- B. 2 Weeks
- C. 3 Weeks
- D. 4 Weeks

19. A 3 month old infant was brought with complaints of profuse lacrimation. On pressure pus exudes from the puncta. The best line of management is:

- A. Dacryocystorhinostomy
- B. Syringing
- C. Massaging of sac with antibiotics
- D. Syringing and probing

20. Crocodile tears are seen in:

- A. Frey's syndrome
- B. Conjunctivitis
- C. Lacrimal tumour
- D. Abnormal VIIth nerve regeneration

EXTRA EDGE QUESTIONS

21. Treatment of nasolacrimal duct obstruction:

- A. Syringing
- B. Probing
- C. DCR
- D. Dacryocystectomy
- E. Antibiotic

22. Initial treatment of congenital dacryocystitis:

- A. Massaging
- B. Probing
- C. DCR
- D. Ointment
- E. No treatment required

23. A 60 year old man presented with watering from his left eye since 1 year. Syringing revealed a patent drainage system. Rest of the ocular examination was normal. A provisional diagnosis of lacrimal pump failure was made. Confirmations of the diagnosis would be by:

- A. Dacryoscintigraphy
- B. Dacryocystography
- C. Pressure syringing
- D. Canaliculus irrigation test

24. Unilateral lacrimal gland destruction may be caused by:

- A. Inferior orbital fissure fracture
- B. Fracture of roof of orbit
- C. Fracture of lateral wall
- D. Fracture of sphenoid

25. Length of naso lacrimal duct is:

- A. 10 mm
- B. 11 mm
- C. 12 mm
- D. 9 mm

Quick Text Review

PROPTOSIS

DEFINITION

Proptosis refers to bulging of the eyeball (forward protrusion) beyond the orbital margins. Most sources define exophthalmos/proptosis as protrusion of globe greater than 18 mm.

Exophthalmos though synonymous with proptosis is the term often used when describing proptosis associated with Graves's disease.

CAUSES

Causes of unilateral proptosis

- **Congenital conditions.** Dermoid cysts, congenital cystic eyeball, and orbital teratomas.
- **Traumatic lesions:** Orbital haemorrhage, retained intraorbital foreign body, traumatic aneurysm and emphysema of the orbit.
- **Inflammatory lesions:** Acute inflammations are orbital cellulitis, abscess, thrombophlebitis, panophthalmitis and cavernous sinus thrombosis (proptosis is initially unilateral but ultimately becomes bilateral). Chronic inflammatory lesions include: pseudotumours, tuberculoma, gumma and sarcoidosis.
- **Circulatory disturbances and vascular lesions:** Angioneurotic oedema, orbital varix and aneurysms.
- **Cysts of orbit:** Haematic cysts, implantation cysts and parasitic cysts (hydatid cyst and cysticercus cellulosae).
- **Tumours of the orbit:** These can be primary, secondary or metastatic. (see page 81)

Causes of bilateral proptosis

- **Developmental anomalies of the skull:** Craniofacial dysostosis, e.g. oxycephaly (tower skull).
- **Osteopathies:** Osteitis deformans, rickets and acromegaly.

- **Inflammatory conditions:** Mikulicz's syndrome and late stage of cavernous sinus thrombosis.
- **Endocrinal exophthalmos:** It may be thyrotoxic or thyrotropic.
- **Tumours:** Symmetrical lymphoma or lymphosarcoma, secondaries from neuroblastoma, nephroblastoma, Ewing's sarcoma and leukaemic infiltration.
- **Systemic diseases:** Histiocytosis, systemic amyloidosis, xanthomatosis and Wegner's granulomatosis.

Causes of specific type of proptosis

Causes of acute proptosis are orbital emphysema following fracture of the medial orbital wall, orbital haemorrhage and rupture of ethmoidal mucocoele.

Causes of intermittent proptosis (proptosis developing intermittently and rapidly in one when venous stasis is induced by forward bending or lowering the head) are orbital varix (most common), periodic orbital oedema, recurrent orbital haemorrhage and highly vascular tumours.

Causes of pulsating proptosis are carotico cavernous fistula (most common), saccular aneurysm of ophthalmic artery, congenital meningocele or meningoencephlocele, neurofibromatosis and traumatic or operative hiatus in the roof of the orbit.

Causes of proptosis in infants. Craniostenosis, meningoencephalocoele, microphthalmia with teratoma, retinoblastoma, capillary haemangioma, juvenile xanthogranuloma and metastatic neuroblastoma.

Causes of proptosis beginning in childhood: Dermoid cyst, lymphangioma, cavernous haemangioma, orbital varices, neurofibroma, rhabdomyosarcoma, optic nerve glioma, intraorbital meningioma, orbital cellulitis leukaemic infiltration, granulocytic sarcoma, Burkitt's lymphoma, eosinophilic granuloma, Hand-Schuller Christian disease, sinus histiocytosis, hydatid cyst and fibrous dysplasia.

Causes of proptosis beginning in adulthood.

Graves' ophthalmopathy (commonest cause), lymphoproliferative disorders, fibrous histiocytoma, haemangiopericytoma, cavernous haemangioma, secondary orbital meningioma, osteoma, mucocele, orbital varices, lesions of lacrimal gland, secondary tumours of the orbit.

Causes of pseudoproptosis/pseudoexophthalmos

Causes of pseudoproptosis are buphthalmos, axial high myopia, retraction of upper lid and enophthalmos of the opposite eye.

EVALUATION OF PROPTOSIS**Different views of X-ray orbit****A. Caldwell-Luc view:**

- PA view
- Occipito-frontal view
- Structures seen: Superior orbital fissure, greater and lesser wing of sphenoid, ethmoid and frontal sinus and floor of sella.

B. Towne's view

- AP view
- Frontal occipital
- Structures seen: Inferior orbital fissure, dorsum sellae of sphenoid bone.

C. Water's view: Occipito-mental

- Structures seen-floor of orbit (blow out fracture)
- Occipitomenta, maxillary sinus and floor of orbital

D. Reese view: For optic foramen.***Proptosis: Findings in X-ray orbit***

Causes of symmetrical enlargement of orbital cavity in X-rays of the orbit

- Optic nerve glioma
- Haemangioma
- Neurofibroma
- Retinoblastoma.

Cause of asymmetrical enlargement of orbit

- Rhabdomyosarcoma
- Dermoid cyst
- Lacrimal gland tumour.

Causes of increased bone density (hyperostosis) in X-rays of orbit

- Sphenoidal ridge meningioma
- Chronic periostitis
- Fibrous dysplasia
- Paget's disease
- Osteoblastic metastasis.

Causes of intraorbital calcification

- Retinoblastoma
- Optic nerve sheath meningioma
- Phlebolith in orbital varix
- Phthisical eye.

Changes in optic canal (optic foramina) in X-rays

- Uniform regular concentric enlargement
 - optic nerve glioma
- Uniform irregular enlargement
 - retinoblastoma
 - optic nerve sheath meningioma
 - orbital neurofibroma
- Erosion of the upper margin
 - raised intracranial pressure
- Erosion of the inferolateral margin
 - infraclinoid aneurysm
 - infraclinoid meningioma.

ENOPHTHALMOS

- *Congenital*: Microphthalmos and maxillary hypoplasia
- *Traumatic*: Blow-out fractures of floor of the orbit
- *Post-inflammatory*: Cicatrization of extraocular muscles as in the pseudotumour syndromes
- *Paralytic enophthalmos*: It is seen in Horner's syndrome
- *Atrophy of orbital contents*: Senile atrophy of orbital fat, atrophy due to irradiation of malignant tumour, following cicatrizing metastatic carcinoma and due to scleroderma.

GRAVES' OPHTHALMOPATHY**PATHOLOGY**

The histopathologic reaction of various tissues is dominated by a mononuclear cell inflammatory reaction. Presence of mucopolysaccharides, predominantly hyaluronic acid, together with interstitial oedema and inflammatory cells accounts for the proptosis. Most data presently support the postulate that it is an autoimmune disease with the orbital fibroblast as the primary target of inflammatory attack, and extraocular muscle being secondarily involved.

CLINICAL FEATURES**Lid signs**

Dalrymple's sign—Retraction of the upper lids producing the characteristic staring and frightened appearance. It is the most common feature.

Lid lag (von Graefe's sign), i.e. when globe is moved downward, the upper lid lags behind.

Enroth's sign—Fullness of eyelids due to puffy oedematous swelling.

Gifford's sign—Difficulty in eversion of upper lid.

Stellwag's sign—Infrequent blinking

Ocular motility defects

- The most common ocular motility defect is a unilateral elevator palsy caused by fibrotic contraction of the inferior rectus muscle followed by failure of abduction due to contracture of medial rectus muscle. Sequence of involvement of muscle is: IR, MR, SR and LR.
- *Enlargement of extraocular muscles* without enlargement of tendons is the hallmark of thyroid ophthalmopathy (seen on CT scan or MRI orbit).

Note: Mnemonic '**I AM So Lucky**'

IR-MR-SR-LR

External ophthalmology

Thyroid ophthalmopathy can cause vertical diplopia due to paralysis of vertical acting muscles like inferior oblique.

Exophthalmos is the second most common sign, as a rule both eyes are symmetrically affected; but it is frequent to find one eye being more prominent than the other. Even unilateral proptosis is not uncommon.

Werner classification of ocular changes in Graves disease

Six classes depicted by Mnemonic "**NO SPECS**"

Class 0: No signs or symptoms

Class 1: Only signs

Class 2: Soft tissue involvement (sign and symptoms)

Class 3: Proptosis

Class 4: Extraocular muscle involvement

Class 5: Corneal involvement

Class 6: Sight loss (optic nerve compression)

ORBITAL CELLULITIS AND INTRAORBITAL ABSCESS

- Suppurative inflammation of the fat and cellular tissues of the orbit.
- It may result from penetrating injury especially when associated with retention of intraorbital foreign body, following operations like evisceration, enucleation, dacryocystectomy and orbitotomy.

- *Extension of infection from neighbouring structures* (most common-ethmoiditis especially in children) is the commonest mode of orbital infections.
- *Characteristic features* are marked swelling of lids conjunctival chemosis, proptosis and limitation of ocular movements. *Important blinding complications* are: central retinal artery occlusion, optic neuritis and corneal ulceration.
- *Orbital apex syndrome* is characterised by a triad of: (i) ophthalmoplegia due to paresis of third, fourth and sixth cranial nerves, (ii) anaesthesia in the region of supply of ophthalmic division of fifth nerve and (iii) amaurosis due to involvement of optic nerve.

CAVERNOUS SINUS THROMBOSIS

- Cavernous sinus thrombosis starts initially as a unilateral condition, which soon becomes bilateral in more than 50 percent of cases due to intercavernous communication.
- *Paralysis of opposite lateral rectus muscle* is often the first sign of involvement of contralateral cavernous sinus.

Clinical features

- *Generalized:* Abrupt onset of fever with chills and rigor.
- *Localized (ocular) features:* Chemosis of conjunctiva, ipsilateral ophthalmoplegia (3rd-Ptois, absent direct and consensual papillary light reflex in ipsilateral side, 4th and 6th nerve palsy), diplopia (lateral gaze is involved earliest) and corneal anesthesia occurs due to involvement of ophthalmic division of 5th cranial nerve- loss of corneal reflex.
- *Oedema in mastoid region* is a pathognomonic sign.
- Vision loss is not an early feature.
- Magnetic resonance venography (angiography) is the investigation of choice.
- *Rapidly developing, acute inflammatory type of proptosis* seen in cavernous sinus thrombosis needs to be differentiated from orbital cellulitis and panophthalmitis.

CAROTID-CAVERNOUS FISTULA

Carotid-cavernous fistula is an acquired abnormal communication between the carotid arterial system and the venous cavernous sinus. There are two type of carotid-cavernous fistula:

i. High-flow fistula

These are secondary to trauma or iatrogenic and present acutely with pain, proptosis (often pulsatile exophthalmos), chemosis, congestion, bruit, ophthalmoplegia (III-VI nerve palsies), headache, and objective pulsatile tinnitus. The classical triad of presentation is proptosis, chemosis, and bruit. It presents within days or weeks following trauma.

ii. Low-flow fistula

These develop spontaneously in elder women, during pregnancy or in those with hyperplastic tissue. These typically present slowly with less pronounced symptoms.

Investigations

- Selective carotid angiography using digital subtraction technique is the investigation of choice and essential if the treatment is contemplated.
- Magnetic resonance angiography (MRA) are also used commonly.

Treatment

A carotid-cavernous fistula requires a definitive treatment, which currently involves endovascular technique. The fistula can usually be occluded with a balloon or coil without sacrifice of the carotid.

ORBITAL TUMOURS

PRIMARY ORBITAL TUMOURS

- *Dermoids* are common developmental tumours in which the cystic component is lined with keratinizing epithelium and may contain one or more dermal adnexal structures such as hair follicles and sebaceous glands.
- *Lipodermoids* are solid tumours usually seen beneath the conjunctiva.
- *Teratomas* are composed of ectoderm, mesoderm and endoderm. These may be solid, cystic or a mixture of both.
- *Capillary haemangioma* is commonly seen at birth or during the first month.
- *Cavernous haemangioma* is the commonest benign orbital tumour among adults. The tumour is usually located in the retrobulbar muscle cone and produces unilateral axial proptosis.
- *Rhabdomyosarcoma* is the *most common primary orbital tumour among children*, usually occurring below the age of 15 years (90%).
- *Lacrimal gland tumours.* Pleomorphic adenoma (mixed cell tumour) is the most common benign tumour of lacrimal gland. It causes down and

medial displacement of the eyeball. Malignant tumours of lacrimal gland are: adenoid cystic carcinoma, pleomorphic adenocarcinoma, and mucoepidermoid carcinoma.

- *Optic nerve glioma* may present either as a solitary tumour or as a part of von Recklinghausen's neurofibromatosis (55%). It is characterised by early visual loss associated with a gradual, painless, unilateral axial proptosis occurring in a child usually between 4 and 8 years of age (female > male). CT scan typically shows fusiform enlargement of optic nerve along with enlargement of optic canal.
- *Primary intraorbital meningiomas* produce visual loss associated with limitation of ocular movements, optic disc oedema or atrophy, and a slowly progressive unilateral proptosis. The presence of opticociliary shunt is pathognomonic of an optic nerve sheath meningioma.
- *Lymphomas.* Orbits are involved more commonly by non-Hodgkin's lymphomas (Most common malignant orbital tumour in adults).
- *Hand-Schuller-Christian disease* is characterised by a triad of proptosis, diabetes insipidus and bony defects in the skull.

SECONDARY ORBITAL TUMORS

- *Tumors from eyeball:* Retinoblastoma and malignant melanoma.
- *Tumor from eyelids:* Squamous cell carcinoma and basal cell carcinoma
- *Tumors from nose and paranasal sinuses:* carcinoma, sarcoma and osteoma
- *Tumors from nasopharynx:* Nasopharyngeal carcinoma
- *Tumors from cranial cavity:* Glioma and meningioma

METASTATIC ORBITAL TUMORS

- *In children:* Neuroblastoma (most common), nephroblastoma, Ewing's sarcoma, Leukemic infiltration, testicular embryonal sarcoma and ovarian sarcoma.
- *In adults:* Carcinoma breast (most common in female), lungs (most common in males), prostate, thyroid and rectum. Malignant melanoma from skin.

BLOW-OUT FRACTURE OF THE ORBITAL FLOOR

- 'Blow-out fractures' mainly involve orbital floor (especially in the posteromedial floor) and medial wall.

- *Three factors responsible for producing enophthalmos in blow-out fracture* are: (a) Escape of orbital fats into the maxillary sinus; (b) Backward traction on the globe by entrapped inferior rectus muscle and (c) Enlargement of the orbital cavity from displacement of fragments.
- *Common roentgen findings* are: Fragmentation and irregularity of the orbital floor, depression of bony fragments, proptosis, diplopia (muscle restriction can be confirmed with forced duction test) and hanging drop opacity (tear drop sign) of the superior maxillary antrum from orbital contents herniating through the floor.

Treatment

Fracture involving half or more orbital floor with entrapment of orbital content and persistent diplopia in the primary position should be repaired within 2 weeks by using synthetic material such as silicon, Teflon or supramid.

SOME SALIENT POINTS

- *Most common and most virulent fungal disease involving the orbit* is caused by Mucor (Mucormycosis) and Rhizopus organism of the class Phycomycetes (phycomycosis). Orbital mucormycosis occur most often in patients with diabetic ketoacidosis.
- *Mucocele of paranasal sinuses affecting the orbit* most commonly occur in frontal sinus. The most common cause of intermittent proptosis is orbital varices.
- *Most common cause of pulsating proptosis* is caroticocavernous fistula.
- *Most common primary tumour of the orbital cavity* presenting as proptosis is cavernous haemangioma.
- *Rhabdomyosarcoma* of the orbit is the commonest primary malignant tumour of childhood.
- *Commonest histological type* of rhabdomyosarcoma of the orbit is embryonal type.
- *Paralysis of opposite lateral rectus muscle* is often the first sign of involvement of contralateral cavernous sinus.
- *Earliest clinical feature of orbital extension of the basal cell carcinoma* of the eyelid is diplopia.
- *Carotid angiography* is the investigation of choice in caroticocavernous fistula. The first sign of cavernous sinus thrombosis is restriction of ocular movements.
- *First sign of cavernous sinus thrombosis* is restriction of ocular movements.
- *Most common cause of unilateral proptosis in children* is orbital cellulitis
- *Most common cause of unilateral proptosis in adults* is thyroid ophthalmopathy.

Multiple Choice Questions (MCQs)

1. **Intermittent proptosis is a sign of:**
 - A. Pseudotumour
 - B. Carotico-cavernous fistula
 - C. Capillary haemangioma
 - D. Orbital varices
2. **Marcus Gunn pupil along with proptosis indicates:**
 - A. Involvement of ciliary ganglion
 - B. Compression of optic nerve
 - C. Compression of inferior division of 3rd nerve
 - D. Compression of sympathetic nerves of the eyeball
3. **Postural exophthalmometric changes are diagnostic of:**
 - A. Orbital varix
 - B. Carotico-cavernous aneurysm
 - C. Haemangioma
 - D. Thyroid ophthalmopathy
 - E. All of the above
4. **Intraorbital calcification in a patient with proptosis is observed in all except:**
 - A. Retinoblastoma
 - B. Orbital varix
 - C. Hydatid cyst
 - D. Pseudotumour
5. **Dehiscence of bone can be seen as X-rays findings in a patient with proptosis in all except:**
 - A. Mucocele
 - B. Neurofibroma
 - C. Lacrimal gland tumour
 - D. Rhabdomyosarcoma
6. **Orbital lesions of childhood include all of the following except:**
 - A. Lymphangioma
 - B. Secondary orbital meningioma
 - C. Cavernous haemangioma
 - D. Neurofibroma
7. **Pseudoproptosis is a feature of:**
 - A. Buphthalmos
 - B. High axial myopia
 - C. Upper lid retraction
 - D. All of the above
8. **Optociliary shunts observed on fundoscopy are a feature of:**
 - A. Meningioma
 - B. Cavernous haemangioma
 - C. Orbital varix
 - D. All of the above
9. **Horner's syndrome is characterised by all of the following except:**
 - A. Contralateral enophthalmos
 - B. Ipsilateral miosis
 - C. Ipsilateral ptosis
 - D. Anhydrosis of the affected side of face
10. **Ocular Graves disease is associated with:**
 - A. Hyperthyroidism
 - B. Hypothyroidism
 - C. Euthyroid state
 - D. All of the above
11. **Dalrymple's sign of ocular Graves' disease refers to:**
 - A. Retraction of the upper lid
 - B. Lid lag
 - C. Proptosis
 - D. All of the above combinedly
12. **The most common ocular motility defect noted in ocular Graves' disease is due to involvement of:**
 - A. Inferior rectus
 - B. Medial rectus
 - C. Superior oblique
 - D. Inferior oblique

- 13. The walls of the orbit which are removed in the two wall decompression for proptosis of thyroid ophthalmopathy include part of:**
- Orbital floor and medial wall
 - Orbital floor and lateral wall
 - Orbital roof and medial wall
 - Medial and lateral walls
- 14. All of the following are the features of orbital apex syndrome except:**
- Ophthalmoplegia
 - Enophthalmos
 - Ophthalmic nerve anaesthesia
 - Amaurosis
- 15. Most often the first sign of involvement of opposite side in cavernous sinus thrombosis is:**
- Paralysis of opposite lateral rectus muscle
 - Proptosis of the opposite side
 - Paralysis of opposite 3rd nerve
 - Paralysis of opposite 4th nerve
 - All of the above
- 16. Simultaneous thrombosis of both the cavernous sinuses usually occurs in:**
- Diseases of the sphenoid sinuses
 - Septic wounds of the face
 - Pyogenic meningitis
 - Patients with cerebral abscess
- 17. The most common mucocele of the paranasal sinuses involving the orbit arises from:**
- Frontal sinus
 - Ethmoidal sinus
 - Maxillary sinus
 - Sphenoidal sinus
- 18. The most commonly seen primary orbital tumour in children is:**
- Rhabdomyosarcoma
 - Glioma of optic nerve
 - Optic nerve sheath meningioma
 - Retinoblastoma
- 19. Ophthalmoscopic sign pathognomonic of optic nerve sheath meningioma is:**
- Papilloedema
 - Optic atrophy
 - Opticociliary shunt
 - All of the above
- 20. The diagnostic triad of exophthalmos, diabetes insipidus and bone lesions is characteristic of:**
- Hand-Schuller Christian disease
 - Letterer-Sieve disease
 - Fibrous dysplasia
 - Osteoporosis
- 21. Cause of lid retraction include:**
- Graves' ophthalmopathy
 - Hypokalemic periodic paralysis
 - Cirrhosis of the liver
 - Hydrocephalus
 - All of the above
- 22. Secondary tumour may spread to the orbit by all of the following except:**
- Direct spread from the lids
 - Via blood stream
 - Via lymphatic channels
 - Directly from the cranial cavity
- 23. The most common tumour that spreads into the orbit from the intracranial cavity is:**
- Astrocytoma
 - Pituitary adenoma
 - Sphenoid wing-meningioma
 - Neurofibroma
- 24. One of the early symptoms of orbital involvement by basal cell carcinoma of the lid is:**
- Diplopia
 - Defective vision
 - Proptosis
 - Severe pain
- 25. Intraorbital abscess formation occurs most commonly in which quadrant of the orbit?**
- Superotemporal
 - Superonasal
 - Inferonasal
 - Inferotemporal
- 26. The most common cause of pulsating exophthalmos is:**
- Orbital varices
 - Neurofibromatosis
 - Cavernous haemangioma
 - Caroticocavernous fistula
- 27. The most common cause of intermittent exophthalmos is:**
- Orbital varices
 - Cavernous haemangioma
 - Lymphangioma
 - Carotico-cavernous fistula
- 28. The most common benign tumour of the orbit is:**
- Optic nerve glioma
 - Meningioma
 - Benign-mixed tumour
 - Haemangioma
- 29. Optical media are clear in:**
- Cavernous sinus thrombosis
 - Orbital cellulitis
 - Both of the above
 - None of the above

13 : A 14 : B 15 : A 16 : A 17 : A 18 : A
19 : C 20 : A

21 : E 22 : C 23 : C 24 : A 25 : B 26 : D
27 : A 28 : D 29 : C

- 30. Superior orbital fissure syndrome is frequently caused by:**
 A. Carotid aneurysms
 B. Meningioma
 C. Arachnoiditis
 D. All of the above
- 31. All of the following structures are located in the lateral wall of the cavernous sinus except:**
 A. Abducent nerve
 B. Oculomotor nerve
 C. Trochlear nerve
 D. Ophthalmic nerve
- 32. Contracted socket occurs because of all the following except:**
 A. Chronic low grade infection
 B. Chronic mechanical irritation
 C. Irradiation
 D. Loss of fatty tissue during surgery of enucleation
- 33. A man presents 6 hrs after head injury complaining of mild proptosis and scleral hyperemia:**
 A. Pneumo-orbit
 B. Caroticocavernous fistula
 C. Retro-orbital hematoma
 D. Orbital cellulitis
- 34. Blow-out fracture of orbit is characterized by all except:**
 A. Diplopia
 B. 'Tear drop' sign
 C. Positive forced duction test
 D. Exophthalmos
- 35. "Blow-out" fracture of orbit involves:**
 A. Floor
 B. Medial wall
 C. All of the above
 D. None of the above
- 36. All of the following signs could result from infection within the right cavernous sinus, except:**
 A. Loss of pupillary light reflex
 B. Loss of corneal blink reflex
 C. Ptosis
 D. Right ophthalmoplegia
- 37. Commonest cause for bilateral proptosis in children is:**
 A. Cavernous hamangioma
 B. Chloroma
 C. Fibrous histiocytoma
 D. Rhabdomyosarcoma
- 38. Which of the following tumours present with proptosis:**
 A. Neuroblastoma
 B. Nephroblastoma
 C. Germ cell tumour
 D. Medulloblastoma
 E. Meningioma
- 39. A patient presented with unilateral proptosis, which was compressible and increases on ending forward. No thrill or bruit was present. MRI shows a retro-orbital mass with enhancement. The likely diagnosis is:**
 A. AV malformations
 B. Orbital encephalocele
 C. Orbital varix
 D. Neurofibromatosis
- 40. Thyroid ophthalmopathy a/w:**
 A. External ophthalmoplegia
 B. Internal ophthalmoplegia
 C. Proptosis
 D. Large extra-ocular muscle
 E. Lid lag
- 41. A 19 years old young girl with previous history of repeated pain over medial canthus and chronic use of nasal decongestants, presented with abrupt onset of fever with chills and rigor, diplopia on lateral gaze, moderate proptosis and chemosis. On examination optic disc is congested. Most likely diagnosis is:**
 A. Cavernous sinus thrombosis
 B. Orbital cellulitis
 C. Acute ethmoidal sinusitis
 D. Orbital apex syndrome
- 42. A young man following RTA presented with proptosis and pain in right eye after four days. On examination there is bruise on forehead and right eye. What is the diagnosis:**
 A. Cavernous sinus thrombosis
 B. Internal carotid artery aneurysm
 C. Carotico-cavernous fistula
 D. Fracture of sphenoid
- 43. A young adult presents with proptosis and pain in eye after 4 days of trauma to eye. Chemosis, conjunctival congestion and extraocular muscle palsy with inability to move eye are seen. Investigation of choice:**
 A. MRI
 B. Digital subtraction angiography
 C. CT
 D. MR angiography

EXTRA EDGE QUESTIONS

- 37. Commonest cause for bilateral proptosis in children is:**
 A. Cavernous hamangioma
 B. Chloroma
 C. Fibrous histiocytoma
 D. Rhabdomyosarcoma

30 : D 31 : A 32 : D 33 : C 34 : D 35 : C
 36 : B 37 : B

38 : A, B and E 39 : C 40 : A, C, D and E 41 : A
 42 : C 43 : B

44. Blow out fracture of the orbit, most commonly leads to fracture of:

- A. Posteromedial floor of orbit
- B. Medial wall of orbit
- C. Lateral wall of orbit
- D. Roof of orbit

45. Most common cause of fracture of roof of orbit:

- A. Blow on back of head
- B. Blow on parietal bone
- C. Blow on the forehead
- D. Blow on the upper jaw

46. Which of the following signs is classic for CT scanning in Graves ophthalmopathy:

- A. Nodular muscle enlargement
- B. Solitary muscle enlargement
- C. Fusiform muscle enlargement with sparing of tendons
- D. Kinking of extraocular muscles.

47. Vascular congestion over insertions of the rectus muscles (particularly lateral rectus) is seen in:

- A. Lymphoma
- B. Hemangioma
- C. Graves ophthalmopathy
- D. Trauma

Quick Text Review

MECHANICAL INJURIES

OCULAR TRAUMA TERMINOLOGIES

Birmingham eye trauma terminologies (BETT), as such adapted by 'American Ocular Trauma Society' (AOTS) terminology given below:

Eyewall: Cornea and Sclera

I. Closed—globe injury: No full thickness wound in eyewall but there is intraocular damage

1. *Contusion.* Closed globe injury with blunt trauma
2. *Lamellar laceration.* Closed globe injury with partial thickness wound of eyewall caused by a sharp object or blunt trauma.

II. Open globe injury. Full thickness wound of eyewall

1. *Rupture*, caused by blunt trauma
2. *Laceration*, caused by sharp object
 - Penetrating injury. One laceration (entry wound)
 - Perforating injury. Two laceration (one entry and one exit).

Intraocular foreign body. Technically penetrating injury with retained IOFB.

EXTRAOCULAR FOREIGN BODIES

Common sites: On the conjunctiva, it may be lodged in the sulcus subtarsalis, fornices or bulbar conjunctiva. In the cornea, it is usually embedded in the epithelium, or superficial stroma and rarely into the deep stroma.

CLOSED GLOBE TRAUMA

- *Partial corneal tears*
- *Blood staining of cornea* may occur occasionally from the associated hyphaema and raised intraocular pressure. Cornea becomes reddish-brown or greenish in colour, which clears very slowly from periphery toward centre. Blood staining of cornea simulates dislocation of clear lens in the anterior chamber.

- *Iridodialysis* (detachment of iris from its root at the ciliary body): It results in a D-shaped pupil.
- *Antiflexion of the iris* i.e., rotation of the detached portion of iris in which its posterior surface faces anteriorly.
- *Retroflexion of the iris*, i.e. whole of the iris is doubled back into the ciliary region and becomes invisible.
- *Vossius's ring* is a circular ring of brown pigment seen on the anterior capsule. It occurs due to striking of the contracted pupillary margin against the crystalline lens.
- *Early rosette traumatic cataract* is most typical form of concussion cataract. It appears as feathery lines of opacities along the star-shaped suture lines; usually in the posterior cortex.
- *Late rosette-shaped traumatic cataract:* It develops in the posterior cortex 1–2 years after the injury. Its sutural extensions are shorter and more compact than the early rosette cataract.
- *Ruptures of the choroid:* These are concentric to the optic disc and situated temporal to disc and look like a whitish crescent with fine pigmentation at its margins.
- *Comotio retinae (Berlin's oedema):* The traumatic macular oedema manifests as milky white cloudiness involving the posterior pole with a 'cherry-red-spot' in the foveal region.
- *Chorio-retinitis sclopetaria*, i.e. chorioretinal rupture with retinal haemorrhage.

OPEN GLOBE TRAUMA

Globe rupture

Full thickness wound of eyewall (sclera, cornea or both) caused by blunt trauma. It may occur in two ways: direct rupture, at the site of injury and indirect rupture (because of compression force) at its weakest part, 3 mm away and concentric to the limbus in the neighbourhood of canal of Schlemm.

Penetrating and perforating injuries

Modes of damage include:

- *Mechanical effects.* Uncomplicated/complicated eyewall wound
- *Intraocular infections.* Purulent uveitis/endophthalmitis and panophthalmitis.
- *Traumatic iridocyclitis*
- *Sympathetic ophthalmitis.*

Intraocular foreign bodies

Common foreign bodies

Chips of iron and steel (90%), particles of glass, stone, lead pellets, copper percussion caps, aluminium, plastic and wood.

Reactions of the foreign body

a. Inorganic foreign body

1. *No reaction:* Inert substances, glass, some plastics, porcelain, gold, silver, platinum, titanium and stone.
2. *Local irritative reaction* leading to encapsulation of the foreign body: Occurs with lead and aluminium particles.
3. *Suppurative reaction* is excited by pure copper, zinc, nickel and mercury particles.
4. *Specific reactions* are produced by iron and copper alloys (most toxic)

Siderosis bulbi

It refers to the degenerative changes produced by an iron foreign body. These usually occur after 6 months to 2 years of the injury.

Mechanism. The iron particle undergoes electrolytic dissociation by the current of rest and its ions are disseminated throughout the eye. These ions combine with the intracellular proteins and produce degenerative changes. In this process, the epithelial structures of the eye are most affected.

Clinical manifestations include:

1. The anterior epithelium and capsule of the lens are involved first of all. Here, the rusty deposits are arranged radially in a ring. Eventually, the lens becomes cataractous.
2. *Iris:* It is first stained greenish and later on turns reddish-brown.
3. *Retina develops pigmentary degeneration* which resembles retinitis pigmentosa.
4. *Secondary open-angle type of glaucoma* occurs due to degenerative changes in the trabecular mesh-work.

Chalcosis

It refers to the specific changes produced by the alloy of copper in the eye.

Mechanism: Copper ions from the alloy are dissociated electrolytically and deposited under the membranous structures of the eye. Unlike iron ions these do not enter into a chemical combination with the proteins of the cells and thus produce no degenerative changes.

Clinical manifestations include:

1. *Kayser-Fleischer ring:* It is a golden brown ring which occurs due to deposition of copper under peripheral parts of the Descemet's membrane of the cornea.
2. *Sun-flower cataract:* It is produced by deposition of copper under the posterior capsule of the lens. It is brilliant golden green in colour and arranged like the petals of a sun-flower.
3. *Retina:* It may show deposition of golden plaques at the posterior pole which reflect the light with a metallic sheen.

b. Organic foreign bodies

The organic foreign bodies such as wood and other vegetative materials produce a proliferative reaction characterised by the formation of giant cells. Caterpillar hair produces ophthalmia nodosum which is characterised by a severe granulomatous iridocyclitis with nodule formation.

SYMPATHETIC OPHTHALMITIS

It is a serious bilateral granulomatous panuveitis, which follows a penetrating ocular trauma. The injured eye is called *exciting eye* and the fellow normal eye which also develops uveitis is called *sympathizing eye*.

Predisposing factors

1. It, almost always, follows a perforating wound.
2. Wounds in the ciliary region (the so-called dangerous zone) are more prone to it.
3. Wounds with incarceration of the iris, ciliary body or lens capsule are more vulnerable.
4. It is more common in children than in adults.
5. It does not occur when actual suppuration develops in the injured eye.

Pathology

Dalen-Fuch's nodules are formed due to proliferation of the pigment epithelium (of the iris, ciliary body and choroid) associated with invasion by the lymphocytes and epithelioid cells. Retina shows perivascular cellular infiltration (sympathetic perivascularitis).

Clinical features

Sympathizing (sound) eye: It is usually involved after 4–8 weeks of injury in the other eye. Sympathetic ophthalmitis almost always manifests as acute plastic iritis. Rarely it may manifest as neuroretinitis or choroiditis.

- Sensitivity to light (photophobia) and transient indistinctness of near objects (due to weakening of accommodation) are the earliest symptoms.

Prophylaxis

Early excision of the injured eye is the best prophylaxis when there is no chance of saving useful vision. Meticulous repair and use of steroids, where eye can be salvaged.

NON-MECHANICAL INSURIES

CHEMICAL AND RADIATIONAL INJURIES

Alkali burns

- In general, alkali burns are much more dangerous than acid burns.
- Alkalies dissociate and saponify fatty acids of the cell membrane and, therefore, destroy the structure of cell membrane of the tissues.
- The strong acids cause instant coagulation of all the proteins which then act as barrier and prevent deeper penetration of the acids into the tissues.

Radiational injuries

1. *Ultraviolet radiations* may cause (i) photo-ophthalmia and (ii) may be responsible for senile cataract.
2. *Infra-red radiations* may cause solar macular burns
3. *Ionizing radiational injuries* are caused following radiotherapy to the tumours in the vicinity of the eyes. The common ocular lesions include (i) radiation keratoconjunctivitis; (ii) radiation dermatitis of lid and (iii) radiation cataract.

MISCELLANEOUS POINTS

- *Common sites of rupture of the globe* are the limbus, the equator and especially under the rectus muscles, where the sclera is thinnest.
- Indication of early surgical intervention in traumatic cataract is secondary glaucoma.
- *Prolapsed iris* in perforating trauma should preferably be abscised and not repositioned because it will carry intraocular infection.
- *Foreign bodies* are the most common cause of eye injury.
- A piece of glass in the anterior chamber is exceptionally difficult to see because its transparency and refractive index differ little from the surrounding media.
- Intraocular foreign body of iron causes maximum damage to the eye.

Multiple Choice Questions (MCQs)

1. In a worker engaged in stone breaking with a chisel and hammer, the most common foreign body which can be lodged in his eye is:
 - A. Stone particle
 - B. Particle from the chisel
 - C. Piece from the hammer
 - D. All of the above
2. In concussion trauma, damage to ocular structures is caused by:
 - A. Mechanical tearing of the tissues
 - B. Disruption of physiological activity by damage to tissue cells
 - C. Vascular damage leading to ischaemia
 - D. All of the above
3. After blood staining the cornea may look as:
 - A. Reddish brown in colour
 - B. Greenish in colour
 - C. Like a clear lens dislocated into the anterior chamber
 - D. Any of the above
4. All of the following are true about blood staining of the cornea except:
 - A. Its occurrence is hastened by the raised intraocular pressure
 - B. It clears from centre towards periphery
 - C. Its clearance may take 2 years or more
 - D. Visual prognosis is usually poor in such cases
5. Traumatic iridodialysis may cause:
 - A. Antiflexion of the iris
 - B. Retroflexion of the iris
 - C. Iridoplegia
 - D. All of the above
6. Rosette-shaped cataract most commonly involves:
 - A. Anterior cortex
 - B. Posterior cortex
 - C. Both of the above
 - D. None of the above
7. Traumatic cataract occurs as:
 - A. Rosette-shaped cataract
 - B. Zonular cataract
 - C. Total cataract
 - D. All of the above
8. Blunt trauma to the eye may produce all of the following changes in the vitreous except:
 - A. Syneresis
 - B. Asteroid hyalosis
 - C. Synchiasis scintillans
 - D. Liquefaction
9. Diameter of the Vossius's ring is:
 - A. Equal to normal pupil
 - B. Smaller than the normal pupil
 - C. Slightly larger than the normal pupil
 - D. Much larger than the normal pupil
10. Rupture of sclera in ocular contusion is seen most commonly in:
 - A. Superonasal quadrant
 - B. Superotemporal quadrant
 - C. Inferonasal quadrant
 - D. Inferotemporal quadrant
11. Commonest type of concussion cataract is:
 - A. Punctate cataract
 - B. Early rosette-shaped cataract
 - C. Late rosette-shaped cataract
 - D. Zonular cataract
12. Prolapsed iris in perforating trauma should preferably be absced and not repositated to prevent chances of:
 - A. Infection
 - B. Post-traumatic iridocyclitis
 - C. Sympathetic ophthalmitis
 - D. All of the above

- 13. Perforating injuries with retained intraocular foreign body are more serious than those without because of:**
- More chances of infection
 - Deleterious effects of foreign bodies
 - More chances of sympathetic ophthalmitis
 - All of the above
- 14. All of the following intraocular foreign bodies produce suppurative reaction except:**
- Pure zinc
 - Mercury
 - Copper alloys
 - Nickel
- 15. The earliest clinical manifestation of siderosis bulbi is:**
- Rusty deposits in the anterior subcapsular cells of the lens
 - Discolouration of iris
 - Deposits in Descemet's membrane of cornea
 - Pigmentary changes in retina
- 16. In siderosis bulbi the electrolytically dissociated iron ions:**
- Are deposited under the membranous structures of the eye
 - Combine with intraocular proteins and produce degenerative changes
 - Produce local irritative reaction at the site where deposited
 - All of the above
- 17. In chalcosis bulbi the electrolytically dissociated ions of copper are:**
- Deposited under the membraneous structures of the eye
 - Combine with intracellular proteins and produce degenerative changes
 - Produce irritative reaction at the local site
 - All of the above
- 18. Clinical manifestations of chalcosis include all of the following except:**
- Kayser-Fleischer ring
 - Sunflower cataract
 - Greenish discolouration of iris
 - Deposition of golden plaque at the posterior pole of the retina
- 19. The most toxic intraocular foreign body is a particle of:**
- Copper
 - Iron
 - Tantalum
 - Aluminium
- 20. All of the following are true about sympathetic ophthalmitis except:**
- It is a bilateral disease
 - Pathological features are of non-granulomatous panuveitis
 - Clinically manifests as non-granulomatous iridocyclitis
 - The non-injured eye developing uveitis is called sympathizing eye
- 21. Regarding occurrence of sympathetic ophthalmitis, all of the following are true except:**
- It almost always follows a perforating wound
 - Wounds in the ciliary region are more prone to it
 - More common in adults than in children
 - Less common when actual suppuration develops in the injured eye
- 22. Clinically in the non-injured eye, sympathetic ophthalmitis may manifest as:**
- Acute plastic iridocyclitis
 - Neuroretinitis
 - Choroiditis
 - All of the above
- 23. In sympathetic ophthalmitis, Dalen-Fuch's nodules are formed on the:**
- Iris
 - Ciliary body
 - Choroid
 - All of the above
- 24. The most serious alkali burns of the eye are produced by:**
- Strong liquid ammonia
 - Caustic soda
 - Lime
 - None of the above
- 25. All of the following are true of chemical burns of the eye except:**
- Acid burns are more serious than the alkali burns
 - Alkalies combine with lipids of cells to form soluble compounds, which produce a condition of softening and gelatinisation
 - Acids cause instant coagulation of all the proteins
 - Symblepharon is a distressing sequelae
- 26. In rosette-shaped cataract the suture act as backbone in:**
- Early-rosette cataract
 - Late-rosette cataract
 - Both of the above
 - None of the above
- 27. Orange-skin cornea results due to:**
- Chalcosis
 - Siderosis
 - Ammonia burn
 - Mustard gas

- 28. Most common site for the lodgement of intraocular foreign body is:**
 A. Vitreous
 B. Posterior chamber
 C. Lens
 D. Anterior chamber
- 29. Best method of detection of retained glass intraocular foreign body is:**
 A. CT scan
 B. Radiography
 C. Ultrasonography
 D. Tonography
- 30. Commotio retinae is seen in:**
 A. Concussion injury
 B. Retinopathy of AIDS
 C. Central vein thrombosis
 D. Central artery thrombosis
- 31. Ruptured globe is suspected if there is:**
 A. Proptosis
 B. Subluxation of lens
 C. Blow-out fracture
 D. Chemosis, haemorrhage, decreased IOP
- 32. The incidence of retained intraocular foreign bodies is maximum with injuries due to:**
 A. Bow and arrow
 B. Chisel and hammer
 C. Air-gun pellet
 D. Glass
- 33. All are seen in blunt injury of the eye except:**
 A. Hyphema
 B. Iridocyclitis
 C. Double perforation
 D. Retinal detachment
- 34. Traumatic dislocation of lens is best diagnosed by:**
 A. Direct ophthalmoscopy
 B. Indirect ophthalmoscopy
 C. Distant direct ophthalmoscopy
 D. Slit-lamp examination
- 35. A 20-year-old man complains of difficulty in reading the newspaper with his right eye, three weeks after sustaining a gun shot injury to his left eye. The most likely diagnosis is:**
 A. Macular edema
 B. Sympathetic ophthalmia
 C. Optic nerve avulsion
 D. Delayed vitreous haemorrhage
- 36. Vossius ring is seen in:**
 A. Cornea
 B. Lens
 C. Vitreous
 D. Retina
- 37. Dangerous area of eye:**
 A. Ciliary body
 B. Optic nerve
 C. Sclera
 D. Choroid

EXTRA EDGE QUESTIONS

- 38. Traumatic eye lesion can causes:**
 A. Vitreous haemorrhage
 B. Corneal opacity
 C. Exudative retinal detachment
 D. Glaucoma
 E. Cataract
- 39. A boy gets hit by a tennis ball in the eye following which he has complaints of decreased vision. Which of the following tells that blunt injury is due to the ball?**
 A. Optic neuritis
 B. Pars planitis
 C. Vitreous base detachment
 D. Equatorial edema
- 40. Common feature between sympathetic ophthalmitis and Vogt-Kanayagi-Harada syndrome:**
 A. Autoimmune etiology
 B. Injury
 C. Uveitis
 D. Vitiligo

Ocular Therapeutics, Lasers and Cryotherapy in Ophthalmology

Quick Text Review

INTRAOCULAR PENETRATION OF DRUGS

Intraocular penetration of topically instilled drugs

It is mainly determined by the corneal epithelium which is lipophilic and is crossed readily by non-polar drugs. Stroma being hydrophilic allows rapid passage of the drug through endothelium into the anterior chamber. Following features will allow better penetration of the drug through the cornea:

- Solubility both in water and fat
- Pro-drug forms are lipophilic and after absorption through epithelium are converted into proper drugs which can easily pass through the stroma.
- Wetting agents increase the drug absorption.

The intraocular penetration of systemically administered drugs

It mainly depends upon the blood aqueous barrier. The two characteristics of the drugs which affect their passage through the blood aqueous barrier are:

- Low molecular weight
- Lipid solubility (e.g. sulphonamides being lipid soluble are 16 times more permeable than sucrose having almost same molecular weight).

COMMON OCULAR THERAPEUTICS

ANTIVIRAL DRUGS

Idoxuridine (IDU, 5 Iodo-2 deoxyuridine)

- Inhibits the synthesis of DNA by substituting for thymidine and thus prevents replication of virus
- Used as 0.1% eye drops one hourly during day and 0.5% eye ointment at night for 10–21 days
- *Side effects:* Follicular conjunctivitis, punctal stenosis.

Adenine arabinoside

- Blocks synthesis of nucleic acids
- 3% ointment is applied 5 times a day for 14–21 days.

Cytosine-Arabinoside

- Not available commercially.

Trifluorothymidine

- DNA inhibitor like IDU
- Advantages over IDU are: higher solubility, greater potency, lack of toxicity and allergic reactions
- Dose: 1% drops 4 hourly for 14 days.

Acyclovir

- Effective in most forms of herpes simplex and herpes zoster
- Penetrates deep and so is very effective in stromal keratitis
- Dose: (i) Topically 3% ointment is used 5 times a day in patients with herpes zoster ophthalmicus and recalcitrant cases of herpes simplex.

Ganciclovir

- Used for CMV retinitis
- Dose: 5 mg/kg body weight every 12 hours for 2–3 weeks followed by maintenance dose of 5 mg/kg once daily.

Foscarnet

- As effective as ganciclovir in treating CMV retinitis with AIDS.

Zidovudine (Azidothymidine, AZT)

- Combined with immunoglobulins in treating HIV infection (AIDS).

ANTIFUNGAL DRUGS

I. Polyene antifungals

- Are isolated from streptomycetes
- Act by binding to the sterol group in fungal cell membranes, rendering them permeable

1. Nystatin

- Fungistatic

- Effective against candida and aspergillus
- Poor intraocular penetration
- 3.5% eye ointment is used 5 times a day.

2. Amphotericin B (Fungizone)

- Effective against candida, histoplasma and cryptococcus
- Topically, effective as 0.75% to 0.3% drops in superficial corneal ulcers
- Intravitreal injection for fungal endophthalmitis
- Intravenously, it is used as 0.1 mg/ml in 5 percent dextrose for systemic infections.

3. Natamycin (Pimaricin)

- Broad spectrum antifungal (effective against candida, aspergillus, fusarium and cephalosporium)
- Drugs of choice for fusarium keratitis
- Used as 5% suspension.

II. Imidazole antifungal drugs

1. *Miconazole*: Broad spectrum fungicidal topically used as 1% solution.
2. *Clotrimazole*: Fungistatic, 1% suspension is effective against candida and aspergillus keratitis.
3. *Econazole*: Used as 1% econazole nitrate ointment.
4. *Ketoconazole*: Used in single oral dose of 200-400 mg daily in fungal keratitis and endophthalmitis.
5. *Fluconazole*.

III. Pyrimidine group

- *Flucytosine* used as 1.5% aqueous eye drops one hourly is very effective against candida and yeast infections.

IV. Silver compounds

- *Silver sulfadiazine* eye drops are effective against aspergillus and fusarium keratitis.

ANTI GLAUCOMA DRUGS

I. Miotics

Mechanisms of action

- In *primary open-angle glaucoma*, miotics lower the IOP by enhancing aqueous outflow facility by widening inter-trabecular pores due to a pull exerted on the scleral spur by contraction of the longitudinal fibres of ciliary muscle.
- In *primary angle-closure glaucoma* the miotics open the angle by pulling the iris away from the trabecular meshwork.
- *Pilocarpine*, once the most commonly used antiglaucoma drugs, is sparingly used presently because of availability of better drugs.

Contraindications

Miotics are not useful in:

- Buphthalmos
- Epidemic dropsy glaucoma
- Glaucoma inversus
- Glaucomatocyclitic crisis
- Aphakic glaucoma
- Inflammatory glaucoma.

II. Sympathomimetic drugs

Mechanisms of action

- Decreased aqueous secretion due to stimulation of alpha receptors in the ciliary body
- Increased aqueous outflow due to stimulation of alpha and beta receptors.

Indications

- POAG—Preferred in the presence of systemic contraindication to beta-blocker
- Secondary glaucomas—Useful in most.

III. Beta adrenergic blockers

Mechanism of action

- Timolol and levobunolol reduce aqueous secretion by blockade of beta-2 receptors in the ciliary processes
- Mechanism of action of betaxolol (cardioselective beta-blocker) is unknown.

Indications

- In POAG and secondary glaucomas, it is the drug of first choice unless contraindicated due to systemic diseases
- In PACG, it is useful as a temporary adjunct.

Commonly used preparations

Timolol

- Non-selective beta-1 and beta-2 blocker
- Available as 0.25 and 0.5 percent eye drops
- Efficacy is very good; however, the phenomenon of 'short-term escape' (marked initial fall, followed by a transient rise with continued moderate fall in IOP) and 'long term-drift' (slow rise in IOP after well controlled with months of therapy) are seen.

Betaxolol

- Relative cardioselective beta-1 blocker (10 times more affinity for beta-1 than beta-2 receptors), so can be used in patients with bronchial asthma.
- Available as 0.25% and 0.5% eye drops.

IV. Prostaglandin derivatives

- *Latanoprost* (0.005%), an ester analogue of prostaglandin F₂-α, which increases uveoscleral outflow.

- *Bimatoprost* (0.03%), a prostamide, which decreases ocular outflow resistance.
- *Travoprost* (0.004%), a synthetic prostaglandin F2 analogue that increases uveoscleral outflow.

V. Carbonic anhydrase inhibitors (CAI)

Mechanism of action

Reduce aqueous secretion by inhibiting the enzyme carbonic anhydrase.

Indications

Systemic use (mainly acetazolamide)

- Used as additive therapy for short term in all types of acute glaucomas
- Long-term use is reserved for patients with high risk of visual loss, not responding to other modes of therapy.

Topical use. CAIs are used as second line of drug and also as adjunct therapy. Preparations include:

- Dorzolamide (2%), TDS.
- Brinzolamide (1%), BD.

VI. Hyperosmotic agents

Mechanism of action

Increase the osmotic pressure gradient between the blood and vitreous and thus draw sufficient water out of the eye ball, thereby lowering IOP.

Indications

- For rapidly lowering of the acutely raised IOP as in primary acute congestive glaucomas or secondary acute glaucomas.
- As a prophylactic measure prior to intraocular surgery.

Side effects

- Cardiovascular overload
- Headache and backache
- Urinary retention
- Nausea
- Mental confusion.

Preparations

Glycerol

- An oral hyperosmotic agent with sweet and sickening taste
- Dose: 1–1.5 g/kg body weight, used as 50% solution, therefore, dose is 50–80 ml mixed with equal amount of lemon juice
- Action peaks in 1 hour and lasts for 4–6 hours
- Metabolised to glucose and so repeated use in diabetes is not recommended.

Mannitol

- Dose: 1–2 g/kg body weight or 5–10 ml/kg body weight of 20% solution in water
- Should be administered intravenously very rapidly over 20–30 minutes
- Action peaks in 30 minutes and lasts for 6 hours.

Antiglaucoma drugs: Mechanism of lowering IOP at a glance

Drugs which increase trabecular outflow

- Miotics (e.g. pilocarpine)
- Epinephrine, dipivefrine
- Bimatoprost.

Drugs which increase uveoscleral outflow

- Prostaglandins (latanoprost)
- Epinephrine, dipivefrine
- Brimonidine
- Apraclonidine.

Drugs which decrease aqueous production

- *Carbonic anhydrase inhibitors* (e.g. acetazolamide, dorzolamide)
- *Alpha receptor stimulators* in ciliary process (e.g. epinephrine, dipivefrine, clonidine, brimonidine, apraclonidine)
- *Beta-blockers* (e.g. timolol, betaxolol, levobunolol)
- *Hyperosmotic agents* (e.g. glycerol, mannitol, urea).

LASERS AND CRYOTHERAPY IN OPHTHALMOLOGY

LASERS IN OPHTHALMOLOGY

Types of lasers are summarised in Table 18.1

Table 18.1: Lasers used in ophthalmology

Type of laser	Wave length (nanometer)	Atomic environment used	Effects produced	Clinical uses
Argon	514	Argon gas	Photocoagulation	Diabetic retinopathy
Krypton	714	Krypton gas	Photocoagulation	Peripheral retinal vascular abnormalities such as Eales' disease, proliferative sickle cell disease, Coat's disease and retinopathy of prematurity
Diode	800	Diode crystal	Photocoagulation	Intraocular tumours such as retinoblastoma, malignant haemangioma
nd-YAG	1064	A liquid dye, or a solid compound of yttrium-aluminium garnet and neodymium	Photodisruption	Capsulotomy iridotomy
Excimer	193	Helium and fluorine gas	Photoablation	Refractive corneal surgery (LASIK)
				Phototherapeutic Keratectomy (PTK)
Femtosecond	1053	Neodymium-glass	Photodisruption	Femto-LASIK Femto- cataract surgery

CRYOSURGERY IN OPHTHALMOLOGY

Principle

Working of cryoprobes is based on the Joule-Thompson principle of cooling.

Cryounit and probe

The cryounit uses freon, nitrous oxide or carbondioxide gas as cooling agent. Temperature produced depends upon the size of the cryoprobe tip, duration of freezing process and the gas used.

- Temperature produced at the tip of cryoprobe
 - For intracapsular cataract extraction is about -40°C
 - For cyclocryopexy is about -80°C
 - For cryoretinopexy in retinal detachment surgery is about -70°C .

Uses

1. **Lids:** (i) Cryolysis for trichiasis, (ii) Cryotherapy for warts and molluscum contagiosum, (iii) Cryotherapy for basal cell carcinoma and haemangioma.
2. **Conjunctiva:** Cryotherapy is used for hypertrophied papillae of vernal catarrh.

3. **Lens:** Cryoextraction of the lens is the best-intracapsular technique.

4. **Ciliary body:** Cyclocryopexy for absolute glaucoma and neovascular glaucoma.

5. **Retina:** (i) Cryopexy is widely used for sealing retinal holes in retinal detachment, (ii) Prophylactic cryopexy to prevent retinal detachment in certain prone cases, (iii) Retinal cryopexy for neovascularization, (iv) Cryo-treatment of retinoblastoma and angioma.

MISCELLANEOUS POINTS

- Tropicamide is the *fastest acting cycloplegic* drug.
- Sulfonamides are most commonly known to cause Stevens-Johnson syndrome.
- Topical steroids are contraindicated in superficial viral keratitis, bacterial corneal ulcer, fungal corneal ulcer.
- Intraocular permeability of the topically instilled drugs is mainly determined by the epithelium of cornea.
- Phenylephrine (10%) drops should not be used in neonates, cardiac patients and patients receiving antidepressants.

Multiple Choice Questions (MCQs)

1. **Intraocular penetration of topically-instilled drugs is mainly determined by the corneal:**
 - A. Epithelium
 - B. Endothelium
 - C. Stroma
 - D. Bowman's and Descemet's membrane
2. **The antiviral drug used for treatment of cytomeglo-virus retinitis is:**
 - A. Acyclovir
 - B. Ganciclovir
 - C. Trifluorothymidine
 - D. All of the above
3. **In primary open-angle glaucoma pilocarpine eye drops lowers the intraocular pressure by its direct action on the:**
 - A. Trabecular meshwork
 - B. Ciliary epithelium
 - C. Longitudinal fibres of the ciliary muscle
 - D. All of the above
4. **In primary angle-closure glaucoma pilocarpine lowers the intraocular pressure by its direct action on the:**
 - A. Sphincter pupillae muscle
 - B. Ciliary epithelium
 - C. Trabecular meshwork
 - D. All of the above
5. **Steroid-induced ocular complication is:**
 - A. Glaucoma
 - B. Papilledema
 - C. Central retinal vein occlusion
 - D. All of the above
6. **The technique of blocking the facial nerve at the neck of mandible is:**
 - A. Van Lint's block
 - B. O'Brien's block
 - C. Nadbath block
 - D. Atkinson's block
7. **Retrobulbar injection of xylocaine blocks all of the following except:**
 - A. 3rd cranial nerve
 - B. 4th cranial nerve
 - C. 6th cranial nerve
 - D. Ciliary nerves and ciliary ganglion
8. **Absolute indication of enucleation is:**
 - A. Intraocular retinoblastoma
 - B. Endophthalmitis
 - C. Mutilating ocular injury
 - D. All of the above
9. **In the laser machines used in ophthalmology, the atomic environment used consists of:**
 - A. Crystal rod
 - B. Fluid-filled cavity
 - C. Gas-filled cavity
 - D. Any of the above
10. **Photo disruption is the basic mechanism of action of:**
 - A. Argon laser
 - B. Nd: YAG laser
 - C. Excimer laser
 - D. All of the above
11. **Photoablation is the basic mechanism of action of:**
 - A. Argon laser
 - B. Nd:YAG laser
 - C. Excimer laser
 - D. All of the above
12. **All of the following are indications of pan retinal photocoagulation except:**
 - A. Pre-proliferative diabetic retinopathy
 - B. Proliferative diabetic retinopathy
 - C. Ischaemic central retinal vein occlusion
 - D. Central retinal artery occlusion

- 13. Laser photocoagulation is useful in all of the following macular disorders except:**
- Exudative age-related macular degeneration
 - Central serous retinopathy
 - Focal type of diabetic maculopathy
 - Aphakic cystoid macular oedema
- 14. Excimer laser is used in the correction of:**
- Myopia
 - Hypermetropia
 - Astigmatism
 - All of the above
- 15. Pilocarpine is not used in young adults as it causes:**
- Myopia
 - Cystic blebs of iris
 - Fatigue reaction
 - Allergy with circumcorneal congestion
- 16. Drugs used in treatment of herpes simplex keratitis include all except:**
- Idoxuridine 0.1%
 - 5-Fluorouracil
 - Adenosine arabinoside
 - Cytosine arabinoside
 - Pimarcin
- 17. In atropine instillation, all are seen except:**
- Dilated pupil
 - Paralysis of accommodation
 - Increased water content to tear
 - Decreased water content to tear
- 18. Near vision is not affected with:**
- Atropine
 - Adrenaline
 - Homatropine
 - Pilocarpine
- 19. In a patient predisposed to glaucoma, the drug contraindicated is:**
- Pilocarpine
 - Ecothiopate
 - Timolol
 - None of the above
- 20. Main disadvantage of cocaine as local anaesthetic was:**
- Causes dry eyes
 - Follicular conjunctivitis
 - Intraocular penetration
 - Epithelial erosions
- 21. Combination of pilocarpine and epinephrine use in glaucoma treatment may inhibit:**
- Pigmented pupillary cyst
 - Retinal detachment
 - Vitreous haemorrhage
 - Iridocyclitis
- 22. Type of laser used for capsulotomy is:**
- CO₂
 - Ruby
 - Nd:YAG
 - Argon
- 23. YAG laser is used in the treatment of:**
- Retinal detachment
 - Diabetic retinopathy
 - Open-angle glaucoma
 - After cataract
- 24. Argon laser is used in all except:**
- Retinal detachment
 - Retinitis pigmentosa
 - Retinal vein occlusion
 - Eales' disease
- 25. Excimer laser is used in:**
- Glaucoma
 - Cataract
 - Uveitis
 - Diabetic retinopathy
 - None of the above
- 26. Wavelength of ND: Yag laser:**
- 1040 nm
 - 1040 mm
 - 1040 cm
 - 1040 m

EXTRA EDGE QUESTIONS

Systemic Ophthalmology

Quick Text Review

OCULAR MANIFESTATIONS OF SYSTEMIC DISEASES

OCULAR MANIFESTATIONS OF NUTRITIONAL DEFICIENCIES

Vitamin-A deficiency

Xerophthalmia is the term now reserved to cover all the ocular manifestations of vitamin A deficiency which has been classified by WHO (1982).

Night blindness is the earliest symptom of xerophthalmia in children.

A revised schedule of vitamin 'A' supplements for prophylaxis being followed in India since August 1992 under the programme, named as 'child survival and safe motherhood (CSSM), is as follows:

- First dose (1 lac. I.U.)— at 9 months of age along with measles.
- Second dose (2 lac. I.U.)—at 1½ years of age along with booster dose of DPT/OPV.
- Third dose (2 lac. I.U.)—at the age of 2 years.

Deficiency of vitamin B1 (thiamine)

It can cause corneal anaesthesia, conjunctival and corneal dystrophy, acute retrobulbar neuritis and external ophthalmoplegia.

Deficiency of vitamin B2 (Riboflavin)

It can produce photophobia and burning sensation in the eyes due to conjunctival irritation and vascularisation of the cornea.

Deficiency of vitamin C

It may be associated with haemorrhages in the conjunctiva, lids, anterior chamber, retina and orbit. It also delays wound healing.

Deficiency of vitamin D

It may be associated with zonular cataract, papilledema and increased lacrimation.

OCULAR MANIFESTATIONS OF IMMUNOLOGICAL DISORDER

1. *Rheumatoid arthritis*

- 'Dry eye' episcleritis
- Scleritis
- Iridocyclitis
- Corneal melting
- Cataract .

2. *Systemic lupus erythematosus*

- Episcleritis
- Iritis
- Retinopathy.

3. *Giant cell arteritis*

- Extraocular muscle palsies
- Anterior ischaemic optic neuropathy.

4. *Sarcoidosis*

- Enlargement of lacrimal gland
- Iridocyclitis
- Retinal periphlebitis.

5. *Reiter syndrome*

- Conjunctivitis
- Uveitis
- Retinal vasculitis

6. *Periarteritis nodosa*

- Episcleritis
- Extraocular muscle palsy
- Uveitis
- Retinal haemorrhage
- Papilledema.

7. *Vogt-Koyanagi-Harada syndrome*

- Poliosis
- Uveitis
- Choroiditis
- Exudative retinal detachment .

8. *Multiple endocrine neoplasia (MENIIb)*

- Mucosal neuromas of the lid and conjunctiva
- Medullated nerve fibres in the cornea.

OCULAR MANIFESTATIONS OF HEMATOLOGICAL DISEASE

1. *Lymphocytic leukaemia*
 - Proptosis
 - Iris nodules
 - Retinal edema
 - Haemorrhages
 - Leukaemic infiltrates
 - Roth spots.
2. *Myeloid leukaemia*
 - Orbital chloroma
 - Haemorrhages
 - Peripheral retinal neovascularisation.
3. *Lymphomas*
 - Lid/orbital deposits
 - Uveitis.
4. *Sickle cell anemia*
 - Dilated conjunctival vessels
 - Retinal capillary occlusion
 - Neovascularisation
 - Chorioretinal scars.

OCULAR MANIFESTATIONS OF INFECTIOUS DISEASES

I. Viral

1. *Herpes simplex*
 - Vesicles on the lids
 - Dendritic keratitis
 - Uveitis
 - Acute retinal necrosis.
2. *Measles:*
 - Catarrhal conjunctivitis
 - Koplik's spots on conjunctiva
 - Corneal ulceration
 - Optic neuritis
 - Retinitis.
3. *Mumps:*
 - Conjunctivitis
 - Acute dacryoadenitis
 - Keratitis
 - Uveitis.
4. *Rubella:*
 - Congenital microphthalmos
 - Congenital cataract
 - Congenital glaucoma
 - Chorioretinitis
 - Optic atrophy.
5. *Whooping cough:*
 - Subconjunctival haemorrhage
 - Rarely orbital haemorrhage leading to proptosis.

6. Acquired immune deficiency syndrome
 - *Retinal microvasculopathy:* It is characterised by multiple cotton wool patches, superficial and deep haemorrhages. Micro-aneurysms and telangiectasia occur rarely.
 - *Usual ocular infections* which occur with greater frequency and produce more severe infections in patients with AIDS include: herpes zoster ophthalmicus, herpes simplex infections, toxoplasmosis, syphilis and fungal corneal ulcers.
 - *Opportunistic infections of the eye:* Cytomegalovirus (CMV) retinitis, candida endophthalmitis, cryptococcal infections and pneumocystis carinii choroiditis.
 - *Unusual neoplasms* are Kaposi's sarcoma of the lids or conjunctiva and Burkitt's lymphoma of the orbit.
 - *Neurophthalmic lesions* include isolated or multiple cranial nerve palsies.

II. Fungal

1. *Candida and cryptococcus*
 - Conjunctivitis
 - Keratitis
 - Retinitis
 - Endophthalmitis
 - Papilledema
 - Optic atrophy.

III. Bacterial

1. *Tuberculosis*
 - Phlyctenular conjunctivitis
 - Granulomatous uveitis
 - Juxtapapillary choroiditis.
2. *Leprosy*
 - Facial palsy
 - Madarosis
 - Iritis
 - Secondary glaucoma
 - Cataract.

OCULAR ABNORMALITIES IN TRISOMIES

Trisomy 13 (D Trisomy or Patau Syndrome)

- Microphthalmos
- Colobomas (almost 100%)
- Retinal dysplasia
- Cataract
- Corneal opacities
- Optic nerve hypoplasia
- Cyclopia
- Intraocular cartilage.

Trisomy 18 (E trisomy or Edwards syndrome)

- Blepharophimosis
- Ptosis

- Epicanthal fold
- Hypertelorism
- Microphthalmos
- Uveal coloboma
- Congenital glaucoma
- Corneal opacities.

Trisomy 21 (G Trisomy or Down's syndrome)

- Upward slanting palpebral fissure (Mongoloid slant)
- Almond-shaped palpebral fissure
- Epicanthus
- Telecanthus
- Narrowed interpupillary distance
- Esotropia (35% cases)
- High refractive errors
- Cataract
- Iris hypoplasia
- Keratoconus.

Ocular abnormalities in chromosomal deletion syndromes

Cri-du-Chat syndrome (5 p.)

- Hypertelorism
- Epicanthus
- Antimongoloid slant
- Strabismus.

Cri-du-Chat syndrome (11 p.)

- Aniridia
- Glaucoma
- Foveal hypoplasia
- Nystagmus
- Ptosis.

Cri-du-Chat syndrome (13 q.)

- Retinoblastoma
- Hypertelorism
- Microphthalmos
- Epicanthus
- Ptosis
- Coloboma
- Cataract.

De Grouchy syndrome (18 q.)

- Hypertelorism
- Epicanthus
- Ptosis
- Strabismus
- Myopia
- Glaucoma
- Microphthalmos (with or without cyst)
- Coloboma
- Optic atrophy
- Corneal opacity.

Turner syndrome (XO)

- Antimongoloid slant
- Epicanthus
- Ptosis
- Strabismus
- Blue sclera
- Eccentric pupils
- Cataract
- Colour blindness
- Pigmentary disturbances of fundus.

ADVERSE OCULAR EFFECTS OF COMMON SYSTEMIC DRUGS

CVS drugs

- *Digitalis*: Disturbance of colour vision, scotomas
- *Quinidine*: Optic neuritis (rare)
- *Thiazides*: Xanthopsia (yellow vision), Myopia
- *Carbonic anhydrase inhibitors*: Ocular hypotony, Transient myopia
- *Amiodarone*: Corneal deposits
- *Oxprenolol*: Photophobia, Ocular irritation.

GIT drugs

- *Anticholinergic agents*: Risk of angle-closure glaucoma due to mydriasis, blurring of vision due to cycloplegia (Occasional).

CNS drugs

- *Barbiturates*: Extraocular muscle palsies with diplopia, ptosis, cortical blindness
- *Chloral hydrate*: Diplopia, Ptosis, Miosis
- *Phenothiazines*: Deposits of pigment in conjunctiva, cornea, lens and retina, oculogyric crisis
- *Amphetamines*: Widening of palpebral fissure, dilatation of pupil, paralysis of ciliary muscle with loss of accommodation
- *Monoamine oxidase inhibitors*: Nystagmus, extraocular muscle palsies, optic atrophy
- *Tricyclic agents*: Pupillary dilatation (glaucoma risk), cycloplegia
- *Phenytoin*: Nystagmus, diplopia, ptosis, slight-blurring of vision (rare)
- *Neostigmine*: Nystagmus, miosis
- *Morphine*: Miosis
- *Haloperidol*: Capsular cataract
- *Lithium carbonate*: exophthalmos, oculogyric crisis
- *Diazepam*: Nystagmus.

Hormones

Female sex hormones

- Retinal artery thrombosis
- Retinal vein thrombosis

- Papilloedema
- Ocular palsies with diplopia
- Nystagmus
- Optic neuritis and atrophy
- Retinal vasculitis
- Scotomas
- Migraine
- Mydriasis
- Cyloplegia
- Macular oedema.

Corticosteroids

- Cataract (posterior subcapsular)
- Local immune suppression causing susceptibility to viral (herpes simplex), bacterial and fungal infection
- Steroid-induced glaucoma.

Antibiotics

- *Chloramphenicol*: Optic neuritis and optic atrophy
- *Streptomycin*: Optic neuritis
- *Tetracycline*: Pseudotumor cerebri, transient myopia.

Antimalarial

Chloroquine

- Macular changes (Bull's eye maculopathy)
- Central scotomas
- Pigmentary degeneration of the retina
- Chloroquine keratopathy
- Ocular palsies
- Ptosis
- Electroretinographic depression.

Amoebicides

- *Diiodohydroxy quinoline*: Subacute myelo-optic neuropathy (SMON), optic atrophy.

Chemotherapeutic agents

- *Sulfonamides*: Stevens-Johnson syndrome
- *Ethambutol*: Optic neuritis and atrophy
- *Isoniazid*: Optic neuritis and optic atrophy.

Heavy metals

- *Gold salts*: Deposits in the cornea and conjunctiva
- *Lead*: Optic atrophy, papilledema, ocular palsies.

Chelating agents

- *Penicillamine*: Ocular pemphigoid, ocular neuritis, ocular myasthenia.

Oral hypoglycemic agents

- *Chloropropamide*: Transient change in refractive error, diplopia, Stevens-Johnson syndrome.

Vitamins

Vitamin A

- Papilloedema
- Retinal haemorrhages
- Loss of eyebrows and eyelashes
- Nystagmus
- Diplopia and blurring of vision.

Vitamin D

- Band-shaped keratopathy.

Antirheumatic agents

- *Salicylates*: Nystagmus, retinal haemorrhages, cortical blindness (rare)
- *Indomethacin*: Corneal deposits
- *Phenylbutazone*: Retinal haemorrhages.

MISCELLANEOUS POINTS

- Most common ocular involvement in sarcoidosis is iritis.
- The most common ocular finding in AIDS patients is iritis and the most common fundus finding is cotton wool spots.
- The commonest ocular finding in anaemia is pallor of conjunctiva.
- Diabetes is the most common cause of cotton wool spots.
- Toxoplasmosis is the most common cause of posterior uveitis.
- The major cause of blindness in leprosy is iritis
- The most common ocular manifestation of multiple sclerosis is retrobulbar neuritis.
- Ocular signs in SLE are marginal corneal degeneration, episcleritis, scleritis, retinal haemorrhages and cotton-wool retinal exudates.
- Pupillary abnormalities in tabes dorsalis include spinal miosis, anisocoria and argyll-robertson pupil.
- Most commonly involved cranial nerve in fracture base of the skull is facial nerve.
- The commonest ocular sign of hypothyroidism is cataract.
- Dalrymple's sign is the commonest lid sign of Graves' ophthalmopathy.
- The commonest feature of Waardenburg's syndrome is lateral displacement of both medial canthi and lacrimal puncta.
- The commonest ocular infection associated with AIDS is CMV retinitis.
- Ocular complications associated with pregnancy are worsening of diabetic retinopathy, ptosis, central serous retinopathy, ophthalmoplegia.

Multiple Choice Questions (MCQs)

1. **Ocular manifestations of vitamin D deficiency include:**
 - A. Zonular cataract
 - B. Papilloedema
 - C. Increased lacrimation
 - D. All of the above
2. **As per WHO classification 'X2' stage of xerophthalmia refers to:**
 - A. Conjunctival xerosis
 - B. Bitot's spots
 - C. Corneal xerosis
 - D. Corneal ulceration
3. **Earliest feature of xerophthalmia is:**
 - A. Night blindness
 - B. Conjunctival xerosis
 - C. Bitot's spots
 - D. Dry eye
4. **Ocular lesions of rubella include all of the following except:**
 - A. Congenital megalocornea
 - B. Congenital cataract
 - C. Congenital glaucoma
 - D. Optic atrophy
5. **All of the following ocular lesions may occur in patients suffering from AIDS except:**
 - A. Central toxoplasma chorioretinitis
 - B. Central serous retinopathy
 - C. CMV retinitis
 - D. Candida endophthalmitis
6. **Ocular lesions of gout include all of the following except:**
 - A. Episcleritis
 - B. Scleritis
 - C. Keratitis
 - D. Uveitis
7. **Atopic dermatitis may be associated with:**
 - A. Conjunctivitis
 - B. Keratoconus
 - C. Cataract
 - D. All of the above
8. **Isolated painful third nerve palsy is a feature of aneurysms of:**
 - A. Posterior communicating artery
 - B. Anterior communicating artery
 - C. Vertebrobasillary artery
 - D. Ophthalmic artery
9. **Which of the following is ocular false localising sign of raised intracranial pressure:**
 - A. Diplopia due to pressure palsy of 6th nerve
 - B. Sluggish pupillary reactions and unilateral mydriasis
 - C. Homonymous hemianopia
 - D. All of the above
10. **Temporal lobe tumours may produce:**
 - A. Crossed upper quadrantanopia
 - B. Crossed lower quadrantanopia
 - C. Uncrossed upper quadrantanopia
 - D. Uncrossed lower quadrantanopia
11. **Parietal lobe tumours may be associated with:**
 - A. Crossed lower homonymous quadrantanopia
 - B. Crossed upper homonymous quadrantanopia
 - C. Both of the above
 - D. None of the above
12. **Occipital lobe tumours may produce:**
 - A. Crossed homonymous quadrantanopia
 - B. Crossed homonymous hemianopia
 - C. Both of the above
 - D. None of the above
13. **The commonest cranial nerve palsy in tabes dorsalis is:**
 - A. III nerve
 - B. IV nerve
 - C. VI nerve
 - D. Total ophthalmoplegia

- 14. Bilateral retrobulbar neuritis occurs in:**
 A. Multiple sclerosis
 B. Neuromyelitis optica
 C. Both of the above
 D. None of the above
- 15. Hutchinson's pupil is characterised by:**
 A. Initial ipsilateral miosis, later followed by dilatation
 B. Initial ipsilateral miosis and contralateral dilatation
 C. Ipsilateral mydriasis and contralateral miosis
 D. None of the above
- 16. The commonest ocular infection associated with AIDS is:**
 A. Herpes zoster
 B. Cytomegalovirus
 C. Toxoplasmosis
 D. Tuberculosis
- 17. Ocular lesions of leprosy include all of the following except:**
 A. Avascular keratitis
 B. Interstitial keratitis
 C. Fascicular keratitis
 D. Neuroparalytic keratitis
- 18. Ocular manifestations of Wegener's granulomatosis include all of the following except:**
 A. Proptosis
 B. Nasolacrimal duct obstruction
 C. Necrotizing scleritis
 D. Internal ophthalmoplegia
- 19. The most common lid sign associated with Grave's ophthalmopathy is:**
 A. Von Graefe's sign
 B. Dalrymple's sign
 C. Stellwag's sign
 D. Rosenbach's sign
- 20. Hutchinson's triad of congenital syphilis includes all of the following except:**
 A. Eighth nerve deafness
 B. Interstitial keratitis
 C. Hutchinson's teeth
 D. Saddle nose
- 21. Most common ophthalmic affection of diphtheria is:**
 A. Ptosis
 B. Isolated ocular palsies
 C. Total ophthalmoplegia
 D. Ophthalmoplegia externa
- 22. Most common adverse effect of oral contraceptive is:**
 A. Colour blindness
 B. Optic neuritis
 C. Ring scotoma
 D. Nystagmus
- 23. All are seen in albinism except:**
 A. Glaucoma
 B. Photophobia
 C. Refractive error
 D. Nystagmus
- 24. Night blindness may be caused by all except:**
 A. Vitamin A deficiency
 B. Retinitis pigmentosa
 C. Syphilis
 D. Lattice degeneration
- 25. Fundus picture in collagen disease is dominated by:**
 A. Multiple cotton wool spots
 B. Multiple superficial haemorrhages
 C. Macular edema
 D. None of the above
- 26. The most characteristic eye lesion in diabetes is:**
 A. Flame haemorrhages
 B. Papilledema
 C. Capillary aneurysm
 D. Cataracts
- 27. Occurrence of diplopia, dysphagia, dysarthria, blurring of vision and muscle weakness could be due to:**
 A. Diphtheria
 B. Botulism
 C. Infantile beriberi
 D. Myasthenia gravis
- 28. Internal ophthalmoplegia is seen in:**
 A. Migraine
 B. Diabetes
 C. Ethambutol toxicity
 D. All of the above
- 29. Which of the following is most likely to be the cause of painful third nerve palsy of sudden onset in a man of 40?**
 A. Rupture of an infraclinoid aneurysm
 B. Sphenoidal ridge meningioma
 C. Diabetes mellitus neuropathy
 D. Rupture of a supraclinoid aneurysm
- 30. Sudden increase in blood sugar in a diabetic causes:**
 A. Myopia
 B. Hypermetropia
 C. Presbyopia
 D. Anisometropia

31. Basilar insufficiency shows:

- A. Ptosis
- B. Blurred vision
- C. Diplopia
- D. VI nerve weakness

32. In uraemic amaurosis the pupils are:

- A. Constricted
- B. Dilated and do not react to light
- C. Dilated but react to light
- D. Normal

33. Diabetes mellitus can cause the following in the eye except:

- A. Cataract
- B. Retinopathy
- C. Anterior ischemic neuropathy
- D. Neuroparalytic keratitis

34. The presence of Kayser-Fleischer ring is pathognomonic of:

- A. Keratoconus
- B. Lowe's syndrome
- C. Wilson's disease
- D. Albinism

35. Roth's spots in the fundus are seen in:

- A. Diabetes
- B. Chorioretinitis
- C. Bacterial endocarditis
- D. Retinoblastoma

36. In Weber's syndrome there is:

- A. 3rd nerve palsy
- B. 4th nerve palsy
- C. 5th nerve
- D. 7th nerve

37. Muscle mostly affected in thyroid ophthalmopathy is:

- A. Lateral rectus
- B. Inferior rectus
- C. Superior rectus
- D. Medial rectus

38. Dalen Fuch lesion is seen in:

- A. Purulent keratitis
- B. Epidemic keratoconjunctivitis
- C. Retinoblastoma
- D. Sympathetic ophthalmitis

39. "Rubeosis Iridis" is most commonly seen in:

- A. Diabetes mellitus
- B. Central retinal vein occlusion
- C. Trauma
- D. Central retinal artery occlusion

40. All are seen in albinism except:

- A. Nystagmus
- B. Glaucoma
- C. Photophobia
- D. Refractive error

41. Bowen's disease is characterized by all except:

- A. Predilection for the limbus
- B. Poikilocytosis
- C. Presence of monster cell
- D. Being incapable of metastasizing

42. Essential atrophy of choroid is due to inborn error of metabolism of amino acid:

- A. Cystine
- B. Cysteine
- C. Arginine
- D. Ornithine E Lysine

43. Which of the following is the most common ocular complication with renal transplantation:

- A. Cataract
- B. Glaucoma
- C. Cytomegalo virus retinitis
- D. Candida keratomycosis
- E. Candida endophthalmitis

44. Pepper salt fundus is seen in:

- A. CMV retinitis
- B. Toxoplasmosis
- C. Rubella
- D. Measles

45. In mumps the most common eye lesion is:

- A. Dacryoadenitis
- B. Uveitis
- C. Membranous conjunctivitis
- D. Chorioretinitis

46. Ptosis with orbicularis oculi palsy is seen in:

- A. Eaton Lambert syndrome
- B. Myasthenia gravis
- C. Polymyositis
- D. Motor neuron disease

47. Most common cranial nerve involved in ophthalmoplegic migraine is:

- A. II nerve
- B. III nerve
- C. V nerve
- D. VI nerve

48. In a patient with AIDS chorioretinitis is typically caused by:

- A. Cytomegalo virus
- B. Toxoplasma gondi
- C. Cryptococcus neoformans
- D. All of the above

49. The most common condition of inherited blindness due to mitochondrial chromosomal anomaly is:

- A. Retinopathy of prematurity
- B. Leber's hereditary optic neuropathy
- C. Retinitis pigmentosa
- D. Retinal detachment

50. Toxic amblyopia is produced by:

- A. INH
- B. Rifampicin
- C. Ethambutol
- D. Pyrazinamide

51. Contraindications of topical steroids are:

- A. Dendritic ulcer
- B. Disciform keratitis
- C. Anterior uveitis
- D. Acute angle-closure glaucoma

52. Which drug causes bull's eye macula:

- A. Phenytoin
- B. Chloroquine
- C. Steroids
- D. Ethambutol

53. Most common adverse effect on eye in oral contraceptive usage is:

- A. Colour blindness
- B. Ring scotoma
- C. Optic neuritis
- D. Nystagmus

54. Drug not deposited in cornea:

- A. Gold
- B. Chloroquine
- C. Amiodarone
- D. Antimony

55. In Waardenburg's syndrome, following are seen except:

- A. Widening of the eyebrow
- B. Short palpebral fissure
- C. Interstitial keratitis
- D. Heterochromia iridis

EXTRA EDGE QUESTIONS

56. Xerophthalmia is caused by:

- A. Vit C deficiency
- B. Small bowel resection
- C. Cystic fibrosis
- D. Chronic alcoholism
- E. Glomerulonephritis

57. Vit A deficiency produces:

- A. Bitots spots
- B. Trantas spots
- C. Keratomalacia
- D. Xerophthalmia
- E. Color blindness

58. Ocular manifestation of HIV are all except:

- A. Predispose to viral, bacterial and fungal infection
- B. Kaposi sarcoma
- C. CMV retinitis
- D. Cotton wool spot
- E. Intraocular lymphoma

59. Ocular manifestations in AIDS:

- A. Kaposi sarcoma
- B. Retinitis
- C. Lymphoma
- D. Tuberculosis
- E. Herpes

60. Eye involvement is seen in:

- A. Seropositive polyarticular JRA late onset
- B. Seronegative pauciarticular JRA late onset
- C. Seronegative polyarticular JRA early onset
- D. Seronegative pauciarticular JRA early onset

CHAPTER 20

Community Ophthalmology

Quick Text Review

BLINDNESS

DEFINITION OF BLINDNESS

WHO has defined blindness as “*Visual acuity of less than 3/60 (Snellen) or inability to count fingers in daylight at a distance of 3 meters*”.

In the Ninth Revision (1977) of the International classification of diseases (ICD), the visual impairment (maximum vision less than 6/18 Snellen) has been divided into 5 categories. Patients with the visual fields less than 10° are also labelled as blinds (Table 20.1).

Table 20.1: Categories of visual impairment (WHO, (1977)

Category of visual	Level of visual acuity (Snellen) impairment	
Normal vision	1	Less than 6/18 to 6/60
Low vision	2	Less than 6/60 to 3/60
	3	Less than 3/60 (FC at 3 m) to 1/60 (FC at 1m) or visual field between 5° and 10°
Blindness	4	Less than 1/60 (FC at 1 m) to light perception or visual field less than 5°
	5	No light perception

Avoidable blindness includes both preventable blindness (e.g. xerophthalmia blindness) and curable blindness (e.g. cataract blindness).

MAGNITUDE OF BLINDNESS

- The prevalence of blindness in developing countries ranges from 0.5 to 2 percent or higher, while the representative figures in developed countries are 0.05 to 0.3 per cent.
- The prevalence of blindness reported from India is 1.49 percent (WHO-NPCB 1986-89) and 1.1% (NPCB, 2001-2002).

CAUSES OF BLINDNESS

Developed countries versus developing countries.
In developed countries, causes include: Accidents,

glaucoma, diabetes, vascular diseases, cataract, macular degeneration and hereditary conditions. While in developing countries the frequent causes are cataract, infectious diseases, xerophthalmia, injuries and glaucoma.

Causes of blindness in India: The major causes of blindness in elderly (70 and above) are senile cataract and age-related macular degeneration. See Table 20.2.

Table 20.2: Major causes of blindness in India

RAAB Survey (2006-07)	
Disease condition	Percent blindness
Cataract	72.2
Refractive errors (0.7%) + aphakia (5.6%)	6.3
Glaucoma	4.4
Complications of cataract surgery	3.0
Corneal opacity including trachoma	6.5
Posterior segment disorders (DR, 0.1% + ARMD 0.7% + others 2.2%)	3.0
NPCB Survey (2001-02)	
Cataract	62.6
Refractive errors	19.7
Glaucoma	5.8
Posterior segment disorders	4.7
Surgical complications	1.2
Corneal blindness	0.9
Others	5.0
WHO-NPCB Survey (1986-89)	
Cataract	80.1
Refractive errors	7.35
Glaucoma	1.7
Trachoma	0.39
Aphakic blindness	4.67
Corneal opacity	1.52
Others	4.25

ICMR Survey (1971-74)	
Cataract	55
Malnutrition	2
Glaucoma	0.5
Trachoma and associated infections	20
Injuries	1.2
Small pox sequele	3
Others	18

CHILDHOOD BLINDNESS

- Approximately 1.5 million children are blind in the world (WHO, 1992).
- Every year, approximately half a million children become blind, i.e. about one every minute (WHO, 1992)
- Of the children going blind, about 60% die within one year (WHO, 1992)
- In about 70% of new cases (of childhood blindness), blindness is due to vitamin A deficiency (WHO, 1992).

GLOBAL INITIATIVES FOR PREVENTION OF BLINDNESS

VISION 2020: THE RIGHT TO SIGHT

Objective: It is a global initiative to eliminate avoidable blindness by the year 2020.

Partners of vision 2020 initiative are WHO and task force of international NGOs.

Implementation is being done through four phases each of five year plan, commencing in 2000, 2005, 2010 and 2015, respectively.

Basic strategies include:

- Disease prevention and control
- Training of eye health personnel
- Strengthening of existing eye care infrastructures
- Use of appropriate and affordable technology, and
- Mobilization of resources

Global target diseases include: Cataract, childhood, blindness, trachoma, refractive errors, and low vision and onchocerciasis.

VISION FOR THE FUTURE (VFTF)

The International ophthalmology strategic plan to restore and preserve vision, directed and co-ordinated by the International Council of Ophthalmology has been launched as multi year, flexible and interactive programme.

NATIONAL PROGRAMME FOR CONTROL OF BLINDNESS IN INDIA

NPCB in India was launched in the year 1976 with the objective to reduce prevalence of blindness.

Programme organization: NPCB operates through activities at central level, state level and district level.

District blindness control society (DBCS) with Deputy Commissioner as its chairman who co-ordinates the activities at district level and ensures participation of the community and private sector.

‘Vision 2020: The Right to Sight, in India has been adopted under NPCB since August 2002 with following strategies:

- Strengthening advocacy,
- Reduction of disease burden,
- Human resource development, and
- Eye care infrastructure development.

Target diseases identified for intervention in India include: Cataract, childhood blindness, refractive errors and low vision, corneal blindness, diabetic retinopathy, glaucoma and trachoma (focal).

NPCB DURING 12TH FIVE YEAR PLAN (2012-2017)

- **NPCB to continue under NCO flexipool** as part of National Health Mission; to be implemented by District Health Societies.
- **Financial contribution:** Government of India, 75% and state/UT govt, 25%
- **Cataract surgery target:** 33 corer operations with above 95% being IOL implantation.
- **Spectacle distribution** target for school age group children: 44 lakhs.

Multiple Choice Questions (MCQs)

1. WHO definition of blindness is a visual acuity in the better eye equal to or less than:
 - A. 3/60
 - B. 4/60
 - C. 5/60
 - D. 6/60
2. In the ninth revision of the international classification of diseases, 'Visual impairment' is a visual acuity in the better eye of:
 - A. 6/18
 - B. 6/36
 - C. 6/60
 - D. 3/60
3. WHO definition of blindness in addition to visual acuity of less than 3/60 (Snellen's) also includes a visual field in the better eye equal to or less than:
 - A. 5°
 - B. 10°
 - C. 15°
 - D. 3°
4. As per WHO-NPCB (1986-89) survey, all of the following are true about causes of blindness in India except:
 - A. Cataract 55%
 - B. Refractive errors 7.35%
 - C. Glaucoma 1.7%
 - D. Trachoma 0.39%
5. All of the following are true about prevention of vitamin A deficiency by supplements except:
 - A. Dose in children over 1 year is 2 lac IU orally
 - B. Dose in infants less than 6 month (not being breast fed) is 50 thousand IU orally
 - C. Dose in first trimester of pregnancy is 1 lac IU
 - D. Under CSSM Programme first dose (1 lac IU) is given at 9 months of age along with measles
6. The school health surveys are quite useful in early detection of mainly:
 - A. Refractive errors
 - B. Amblyopia
 - C. Colour vision defects
 - D. All of the above
7. Most common cause of blindness (as per WHO-NPCB Survey, 1989) in India out of the following is:
 - A. Aphakic blindness
 - B. Glaucoma
 - C. Trachoma
 - D. Vitamin A deficiency
8. Commonest cause of blindness in India:
 - A. Vitamin A deficiency
 - B. Cataract
 - C. Trauma
 - D. Trachoma
9. Lowest incidence of trachoma is seen in:
 - A. Punjab
 - B. Rajasthan
 - C. Uttar Pradesh
 - D. Orissa
10. Cataract blindness is:
 - A. Preventable
 - B. Curable
 - C. Avoidable
 - D. Curable and avoidable
11. Blindness in a child is most commonly due to:
 - A. Keratomalacia
 - B. Congenital cataract
 - C. Glaucoma
 - D. Injuries

12. The commonest cause of low vision in India is:

- A. Uncorrected refractive error
- B. Cataract
- C. Glaucoma
- D. Squint

13. All of the following are given global prominence in the VISION 2020 goal, except:

- A. Refractive errors
- B. Cataract
- C. Trachoma
- D. Glaucoma

EXTRA EDGE QUESTIONS**14. Most common cause of blindness in children in India except:**

- A. Malnutrition
- B. Ophthalmia neonatorum
- C. Glaucoma
- D. Congenital dacryocystitis

15. All of the following conditions are immediate priorities in the WHO's "vision -2020: The right to sight" except:

- A. Trachoma

- B. Epidemic conjunctivitis

- C. Cataract

- D. Ibcgicercuasus

16. Under the WHO "Vision 2020" program, the "SAFE" strategy is adopted for which of the following diseases:

- A. Trachoma

- B. Glaucoma

- C. Diabetic retinopathy

- D. Onchocerciasis.

17. On SAFE strategy false is:

- A. Screening

- B. Antibiotics

- C. Facial hygiene

- D. Environmental modification

18. All of the following are causes of night blindness except:

- A. Oguchi's disease

- B. Gyrate atrophy

- C. Choroideremia

- D. Devics disease