Refraction - I

Department of Ophthalmology

Acknowledgement

- Photographs in this presentation are courtesy of Kanski's Clinical Ophthalmology.

Learning Objectives

At the end of the class, students shall be able to

- Understand what is refraction.
- Have basic knowledge of myopia and its management.

What is Refraction

- When rays of light traveling through air enter a denser transparent medium, the speed of the light is reduced and the light rays proceed at a different angle, i.e., they are refracted.
- Except when the rays are normal

Refraction in Ophthalmology

- Methods for evaluating the optical and refractive state of the eye

Emmetropia

- Parallel light rays, from an object more than 6 m away, are focused at the plane of the retina when accomodation is at rest.
- Clear image of a distant object formed without any internal adjustment of the optics of the eye.
- Absence of emmetropia = Ametropia

Progress of refractive state of eye

- Birth : +2 to +3 D
- 90% of children at age 5 yrs are Hypermetropic
- 50% of children at age 16 yrs are Hypermetropic
- After the period of growth has passed the refractive state tends to remain stationary, until in old age a further tendency of hypermetropia is evident.

Refractive data in adult

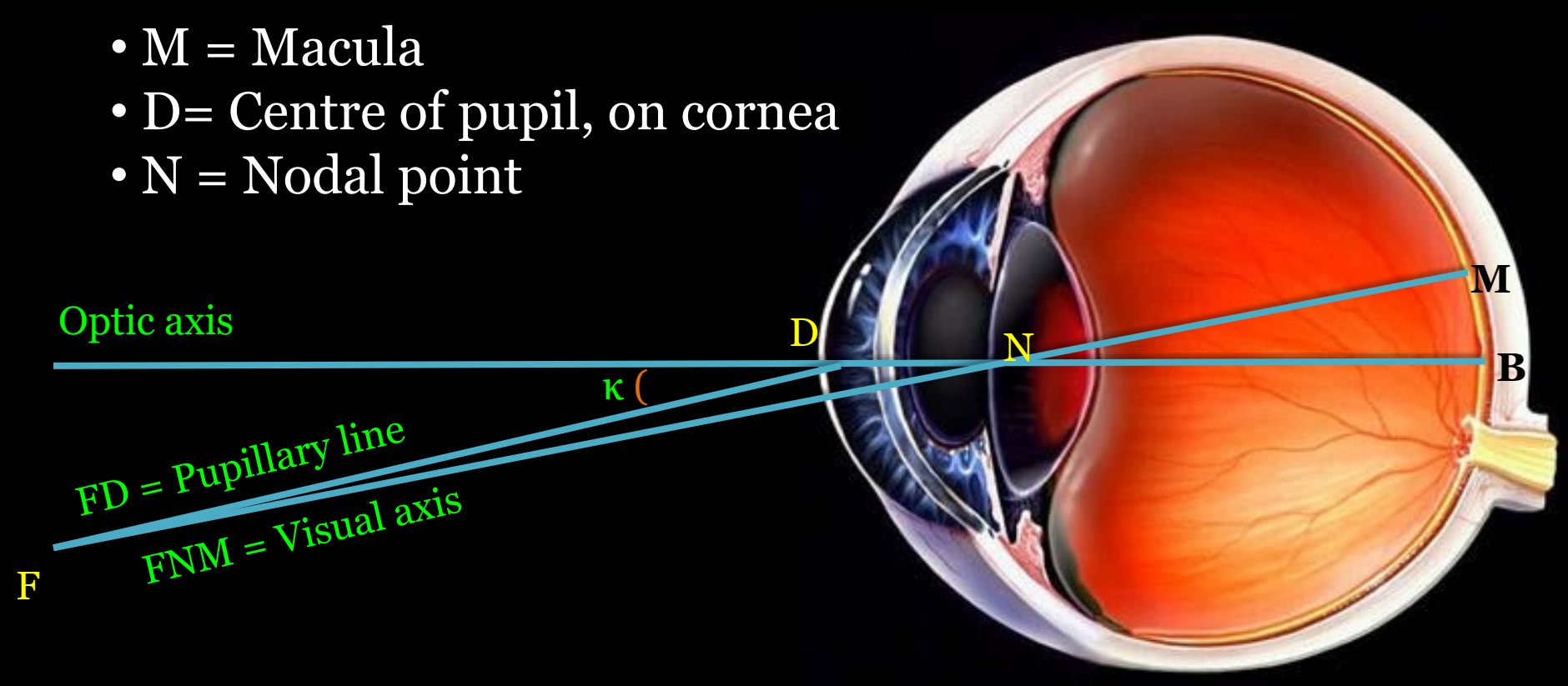
- Normal axial length ≈ 24 mm
- Change in axial length by 1mm = ±3D

- Refraction at corneal surface= +40 to 45(+43)D
- Change in Corneal Curvature by 1mm = ±6D

- Refraction by unaccomodated lens= +16 to 20(+17)D

Angle kappa (κ)

- M = Macula
- D= Centre of pupil, on cornea
- N = Nodal point



κ = *"Between the visual axis and pupillary line, hence roughly corresponds to angle α".*

Anisometropia

- Anisometropia is a state in which there is a difference in the refractive errors of the two eyes, i.e., one eye is myopic and the other hyperopic, or both are hyperopic or myopic but to different degrees.

- This condition may be congenital or acquired due to asymmetric age changes or disease.

Refractive errors

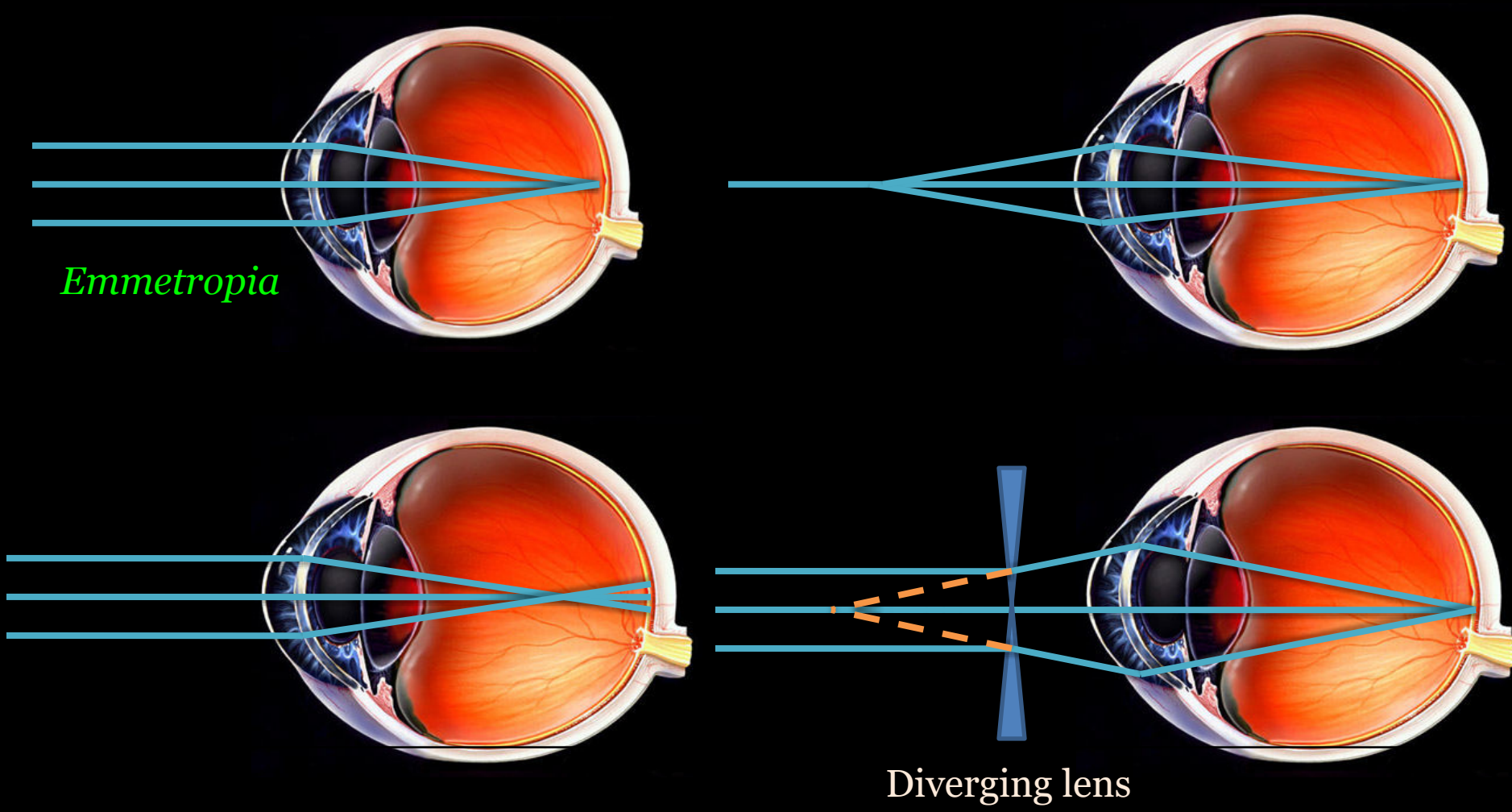
Anomalies of the optical state of the eye

- **Myopia**
- **Hypermetropia**
- **Astigmatism**

What is Myopia ?

- Diopteric condition of the eye
  where parallel incident rays from optical infinity
  focus anterior to light sensitive layers of retina
  when accomodation is at rest

Myopia - Optics



Optics of Myopic eye

- Far point is at a finite distance inversely proportional to the degree of myopia
- Weakest concave lens that diverges rays just sufficiently to focus them at the retina is to be used
- Poor visual acuity is compensated to some extent by enlarged image size due to the nodal point being further from the retina

Causes of Myopia

- The causes of myopia are not known.
- Epidemiological correlation suggest…
  - lengthy periods of close work are probably a contributory factor
  - there is some genetic predisposition to myopia and its severity

Types of myopia

- Axial
- Curvature
- Index
- Positional

Axial Myopia

- AP diameter increased to 25.5 to 32.5 mm
- 90-95% cases
- There may be…
  - pseudoproptosis resulting from the abnormally large anterior segment,
  - a peripapillary myopic crescent from an exaggerated scleral ring,
  - posterior staphyloma

Curvature Myopia

- ***Corneal curvature*** steeper than average, e.g., keratoconus,
- Radius <7-8.5 mm (normal); 1 mm=6 D

- ***Lens curvature*** is increased
- moderate to severe hyperglycemia (intumescence)
  lenticonus (ant/post)
  spasm of accomodation
  spherophakia

Index Myopia

- **Increased index of refraction** in early to moderate **nuclear** sclerotic cataracts in the elderly.
- Many people find themselves ultimately able to read without glasses or having gained “second sight.”

- **Decrease in refractive index** of **cortex** – diabetic myopia

Positional Myopia

- **Anterior movement of the lens** is often seen after glaucoma surgery and will increase the myopic error in the eye.

- Axial myopia of buphthalmos is countered to a large extent due to posterior displacement of lens-iris diaphragm and flattening of the cornea

Clinical course

- **Simple**
- **Pathological**

Simple Myopia

- Rarely present at birth, but often begins to develop as the child grows.
- Usually detected by age 9 or 10 years in the school vision tests
- May increase during the years of growth, stabilizing around the mid-teens, usually at about 5 D or less.

Pathological Myopia

- 2-3% population
- Increases by as much as 4 D/yr
- Usually stabilizes at about age 20 years and frequently results in myopia – 10 to 20 D.
- If progress is rapid from age 15-20, likely to reach 20-30 dioptres
- Commoner in women, Jews and Japanese

Pathological Myopia-Etiology

- Developmental defect affecting posterior segment
- Retina grows extensively stretching sclera
- Adjuvants- growth influences during puberty and physical debility
- Excessive convergence- stretching

Pathological Myopia

- Associated vitreous floaters, liquefaction, posterior staphyloma and chorioretinal changes.
- Degeneration is not necessarily comparable with degree of myopia
- Genetic predisposition in offspring as per laws of recessive Mendelian inheritance – if both parents affected, close supervision needed

School/ Physiologic/Pseudo-Myopia

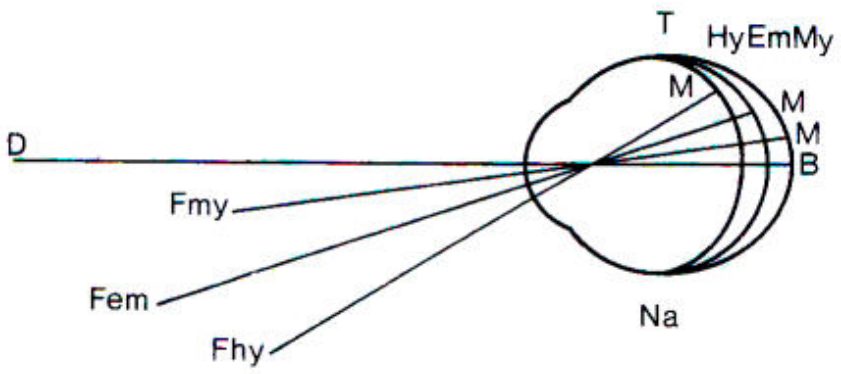
- ≤ 2D
- Excessive near work causing accomodative spasm
- Inherited predisposition-more in Orientals and Jews

Clinical features of Myopia

Symptoms

1. Blurred distance vision.
2. Squinting to sharpen distance vision by attempting a pinhole effect through narrowing of the palpebral fissures.
3. Eye strain seen in patients with uncorrected low myopic errors
4. Closer working distance at near that typically gets closer and closer as the person sustains working at near.
5. Delayed dark adaptation
6. Floaters, photopsiae
7. Visual deterioration

Signs



- Small eyeball
- Smaller cornea
- Shallow anterior chamber predisposes to angle closure glaucoma since size of lens is normal
- Apparent divergent squint

Clinical Signs – *Apparent convergent squint*

- The problem begins at near and spreads to distance leading to a cascade of changes in the findings over time
- Results usually in **apparent convergent squint** due to excess convergence

Clinical Signs – *True divergent squint*

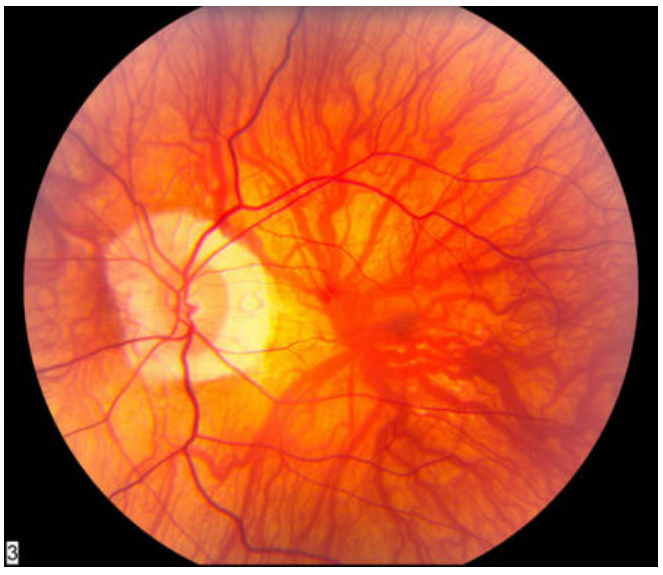
- Excess convergence for near work disorients accommodation which may increase causing ciliary spasm or
- more frequently, attempt at convergence is given up, its latent insufficiency causing muscular imbalance till
- advantage of binocular vision is given up, one eye is relied upon for vision while the other deviates outwards causing **true divergent squint**

Pathology

- Eye appears large and prominent – pseudoproptosis
- Deep anterior chamber
- Large, sluggish pupil
- Post segment sclera is thinned up to 25% of normal
- Post vitreous detachment – Weiss ring
- Liquefaction – muscae volitantes, large floaters

Fundus

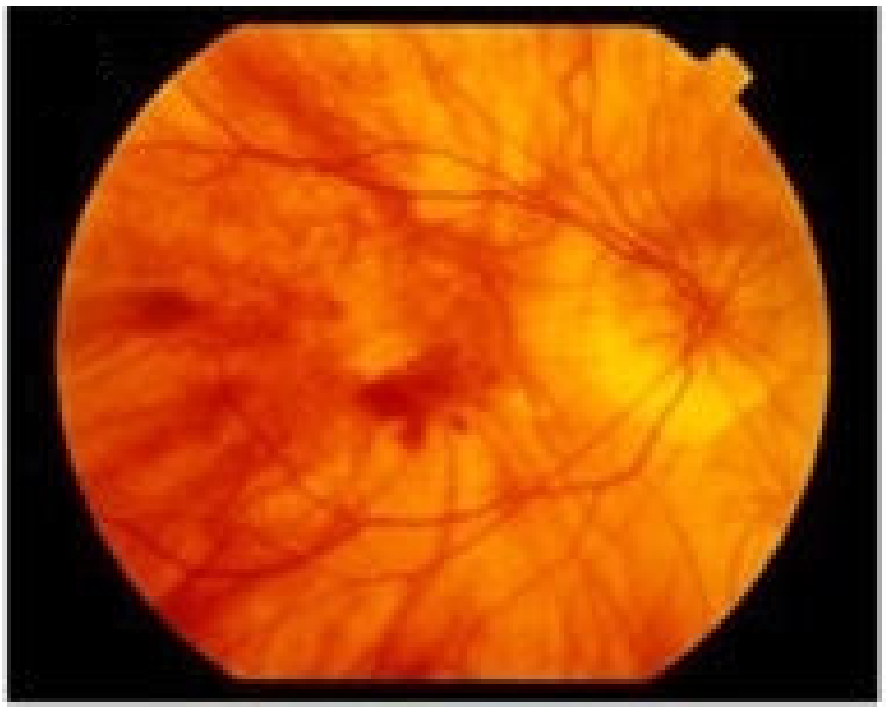
- Atrophy of retina and choroid – depigmentation
- Tigroid fundus with prominent choroidal vessels
- Patches of choroidal atrophy surrounded by pigment associated with haemorrhages
- Atrophic patch at macula associated with loss of central vision

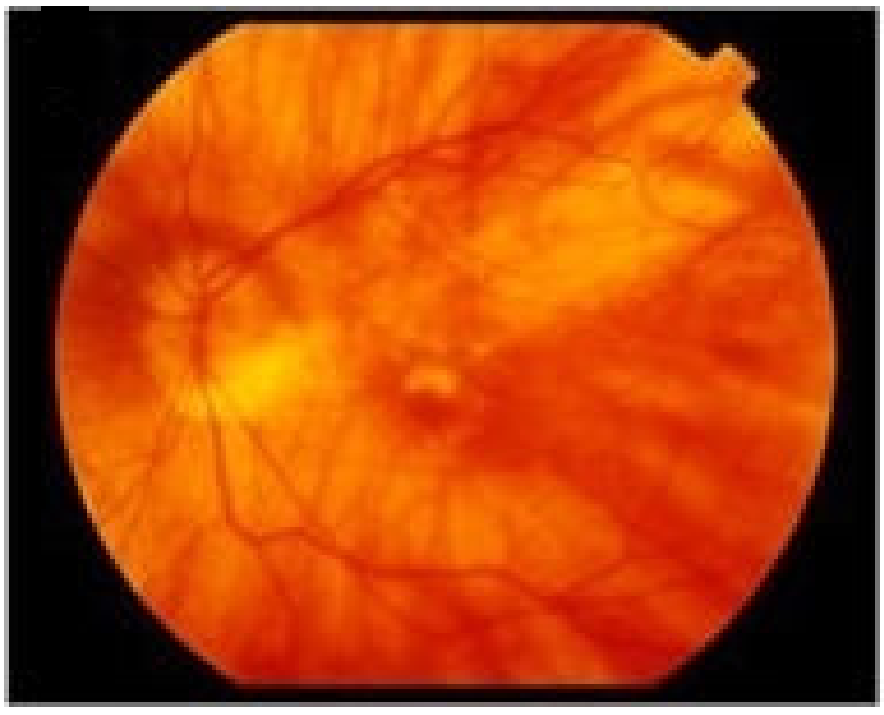


Fundus

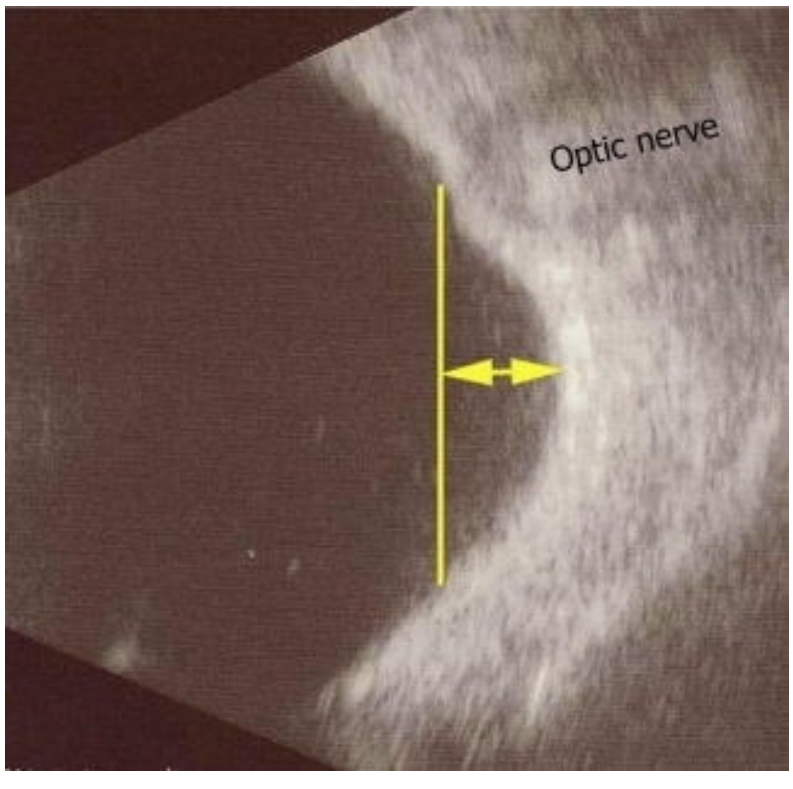
- Appearance of dark pigmented area at macula-Foster-Fuch's fleck – rare, sudden, proliferation of pigmentary epithelium with intra-choroidal haemorrhage or thrombosis
- Macular bunches of dilated capillaries or aneurysms
- Myopic crescent – temporal or annular
- Nasal supertraction crescent

Macular haemorrhage





Posterior staphyloma

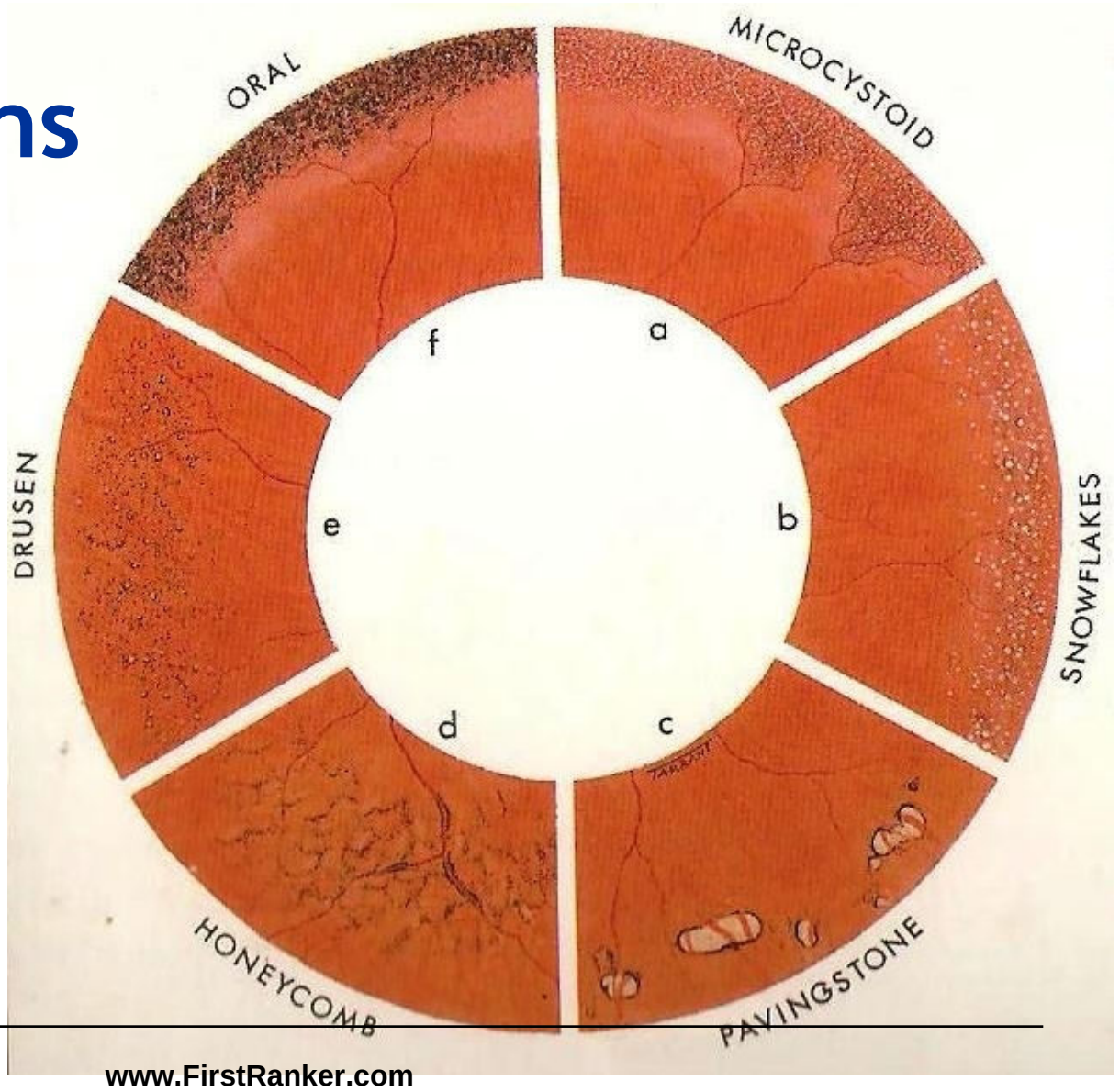


- Herniation of posterior pole
- Crescentric shadow 2-3 DD temporal to disc,
- Sudden kinking of retinal vessels as they dip over the edges,
- Gross atrophy

Peripheral Degenerations

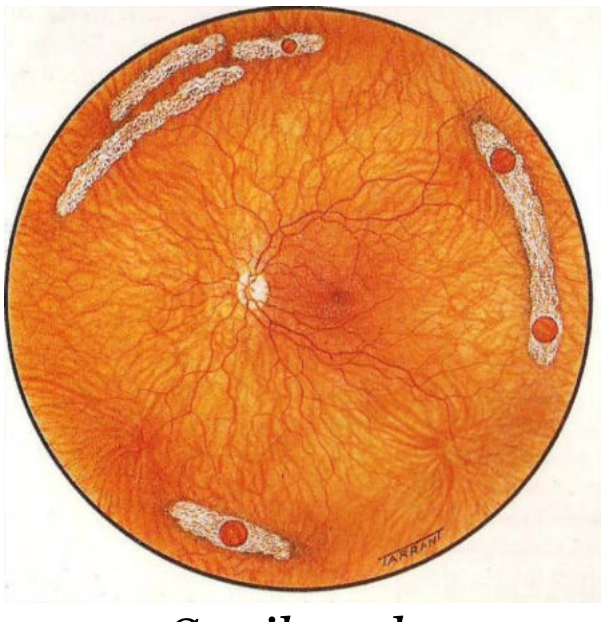
Not requiring prophylaxis:

Paving stone

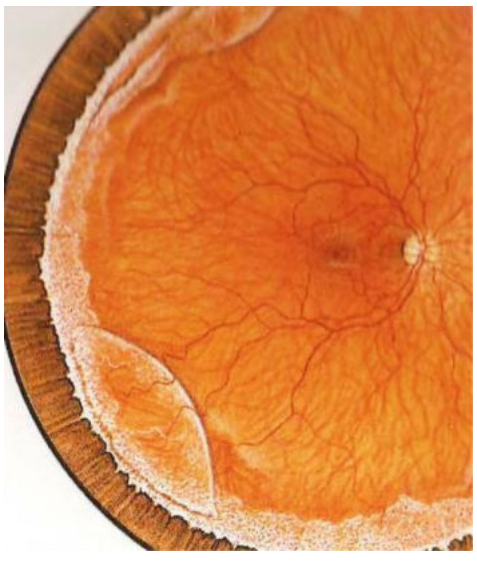


Predisposing Degenerations

Lattice, snailtrack, retinoschisis, white without pressure

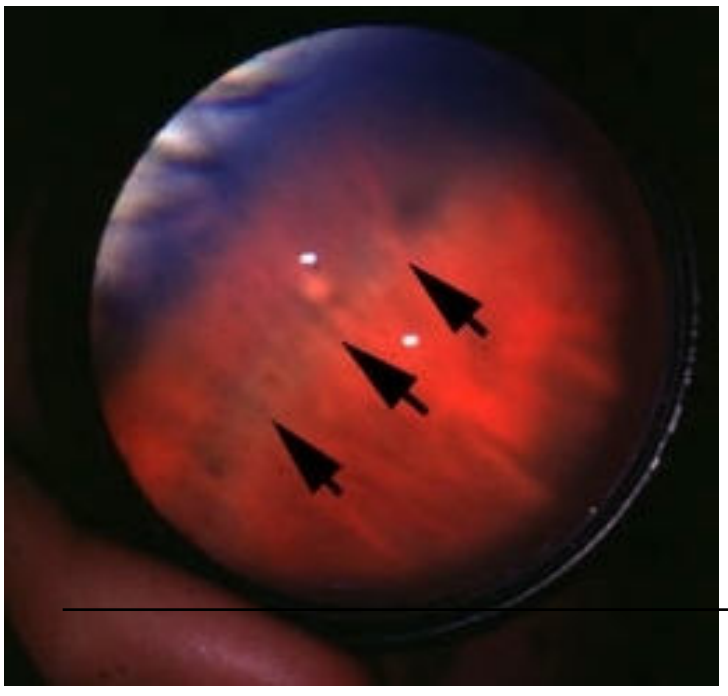


Snailtrack



Retinoschisis

Lattice degeneration



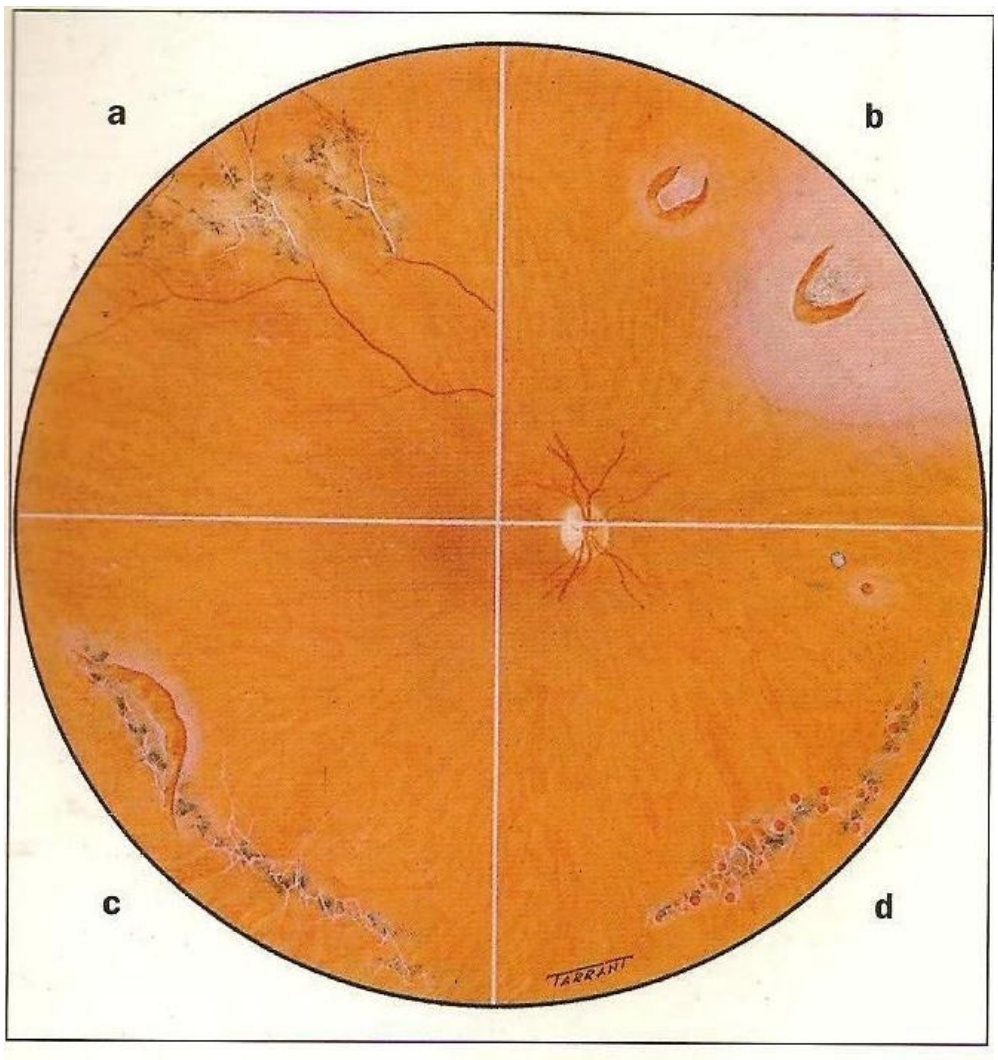
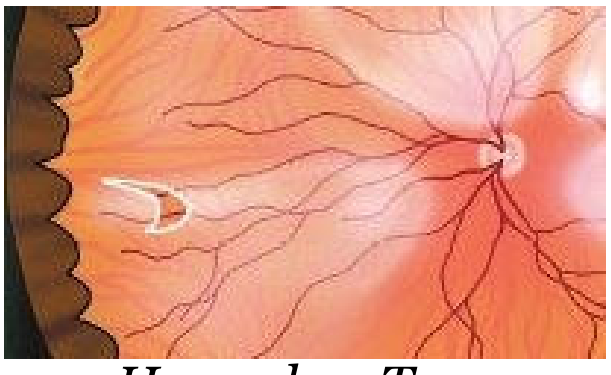


Figure: Lattice degeneration: (**a**) radial lattice degeneration; (**b**) lattice degeneration on the flap of a U-tear; (**c**) tractional tear along the posterior margin of lattice degeneration; (**d**) small round holes in lattice degeneration.

Complications


Horseshoe Tear

- Atrophy – scotomata
  – macular most incapacitating
- Vitreous degeneration + floaters
- Tears + haemorrhages
- Detachment – post traumatic or spontaneous associated with peripheral degenerations due to vitreous adhesion
- Lenticular opacities, esp. posterior cortical
- Open angle glaucoma

Night myopia

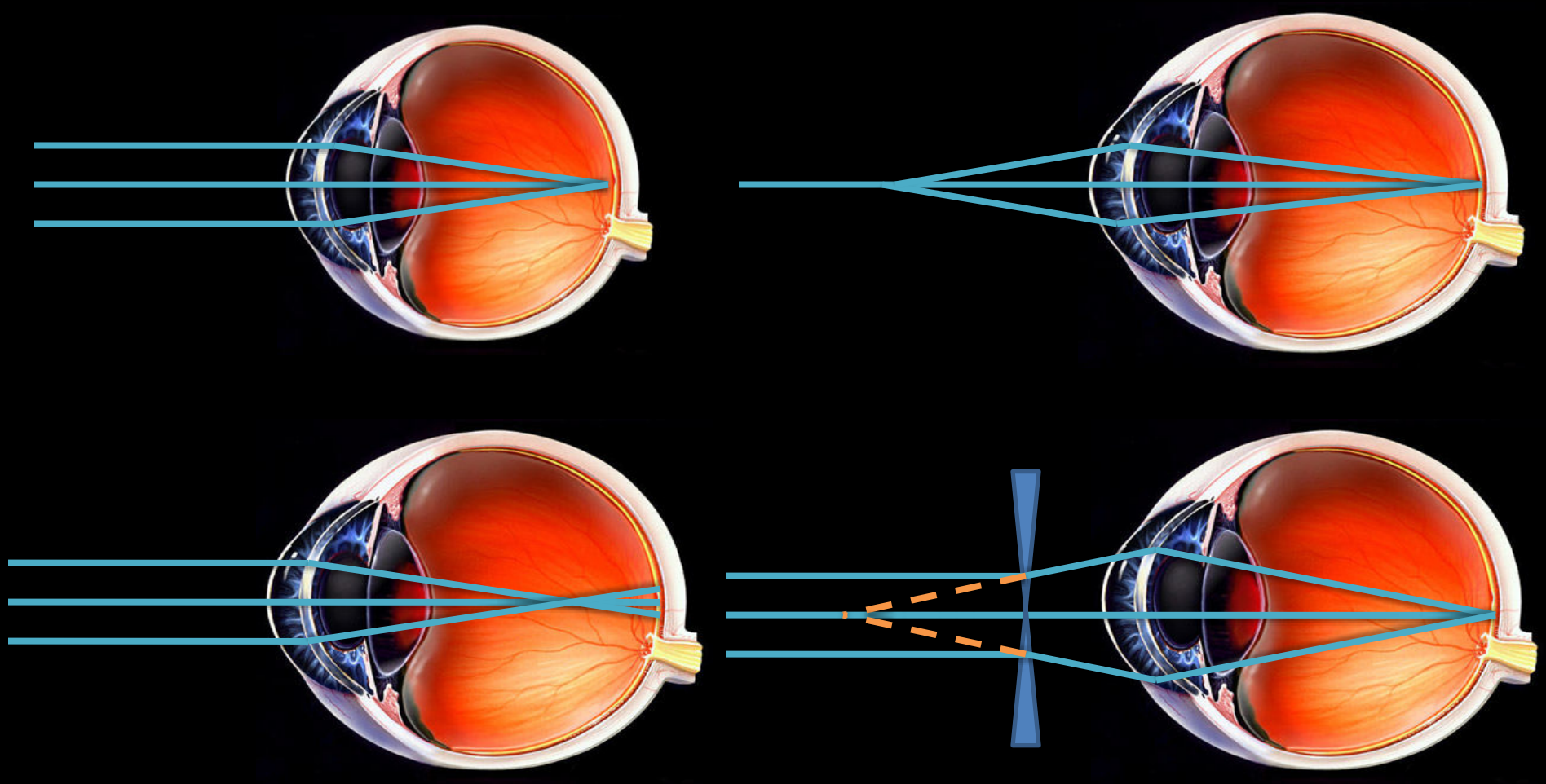
- Manifest in reduced illumination
- ~ 0.5 D
- Cone-rod shift in retina, pupillary dilatation, ciliary muscle activity
- If night vision appears seriously impaired, appropriate correction may be given

Treatment

1. Optical correction after subjective and objective refraction
   - Spectacles
   - Contact lens (including *Orthokeratology*)
2. Visual hygiene
3. Refractive surgery
   - LASIK
   - Wavefront Lasik
   - Phakic IOL
   - LASEK
   - Clear lens Extraction
   - ICRS
4. Pharmacological intervention

Optical correction

Myopia – Optics



Cycloplegic Refraction

- Cycloplegia is the employment of pharmaceutical agents to paralyze the ciliary muscle temporarily to stabilize the accommodative reflex of the eye so that a definitive end point may be measured.
- Benefit of relaxing the accommodative tone is especially important in young individuals.

- Cycloplegic + Mydriatic = Relaxes accomodation + dilates pupil for better reflex

Cycloplegic Refraction

Drug	Actions	Onset	Duration	Remarks
Atropine	Strong	6 – 24 hr	10 – 15 days	Slow, Prolonged
Homatropine	Weak	1 hr	1 – 2 days	Weak, Prolonged
Phenylephrine	Mydriatic			
Tropicamide	Weak	20 – 30 min	4 – 10 hr	Fast, Short
Cyclopentolate	Weak	10 – 30 min	12 – 24 hr	Fast, intermediate

Visual Hygiene

- Proper illumination
- Proper posture
- Clear print
- Better contrast
- Avoid ocular fatigue
- Proper occupation in case of degenerative myopia
- May need special institutions if low vision dictates

Summary

- Refraction is a method for evaluating the optical and refractive state of the eye.
- Myopia is a diopteric condition of the eye where parallel incident rays from optical infinity focus anterior to light sensitive layers of retina when accomodation is at rest.
- Myopia is corrected by concave lenses prescribed after cycloplegic refraction.