Pupillary Muscles

INDEX

Date	Title	Pg. No.	Remarks
	IOL for Presbyopia		
	Presbyopia &	13	
	Hypermetropia	17	
	Pseudophakia		
	Aphakia		
	Myopia / Patho	22.	
	Orthok	20	
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A oyster can take five years just to make one pearl.

Namaan

INDEX

S. No.	Date	Title	Pg. No.
		IOL	1
		Anndio	7
		Multifocal	11
		Acc IOL	13
		Toric IOL	14
		CL	16.

the longest recorded flight of a chicken was 13 seconds.

DELTA STATIONERY

Ciliary Muscles

Sphincter Pupillae

↓ cholinergic N (PNS)

↓ 3N

Occipital Cortex → Edinger Westphal Nucleus ← Frontal Cortex

(Near 3N in floor of Aqueduct)

Dilator centre

↓ 3N (Main Trunk)

Branch to IO

Short root of Ciliary ganglion

↓ Short ciliary N (Short PCA)

↓ Choroid to Ciliary body in Iris

Dilator Pupillae

↓ Adrenergic fibres

Cervical SNS

↓ Hypothalamus

↓ Inhibitory to Edinger

↓ Partial decussat midbrain

↓ Cilio spinal centre of Bridge

↓ Ventral roots C_8-T_3

↓ Cervical sympathetic chain

↓ Sup Cervical ganglion

↓ Ant loop of Ansa

↓ Sup Cervical ganglion

↓ enter skull & Carotid plexus

↓ Cavernus plexuses

↓ Travel over Gasserian ganglion along 1st division of 5th N

↓ Nasociliary N

↓ Long Ciliary N

↓ Traversing suprachoroidal space to reach Iris & terminate in dilator Mal

Pupil

- Small
  - Old
  - Hypermetrope
  - Blue Eyes
- Big
  - Young
  - Longer
  - Reason

Pupillary reflexes

Light

- Direct
- Consensual

Rods & Cons (Retina)
↓
Optic N
↓
Decussate chiasma
↓
ON tracts
↓
Upper end of tract
↓
Pretectal Region
↓
Pretectal Nucleus
↓
Decussation at Mid brain
↓ explains direct & Consensual
Edinger Westphal
↓
Constrictor fibres
↓
Iris

- ARP
- Distal to chiasma
  - ✗ Direct in same eye
  - ✗ Consensual of Opp.
- OT – Hemianopic Rxn both eyes
- Abs LGB → Pupillary rxn unaltered

- Hippus — MS
- RAPD — ON curitis

Near

- Convergence
- Accomodat"
- Miosis

Fibres from Medial rectus
↓
Afferent (III N)
↓
Mesencephalic N of V N
↓
Pretectal region
↓
Relay to EWN
↓
III N
↓
Sphincter of Iris

Psychosensory

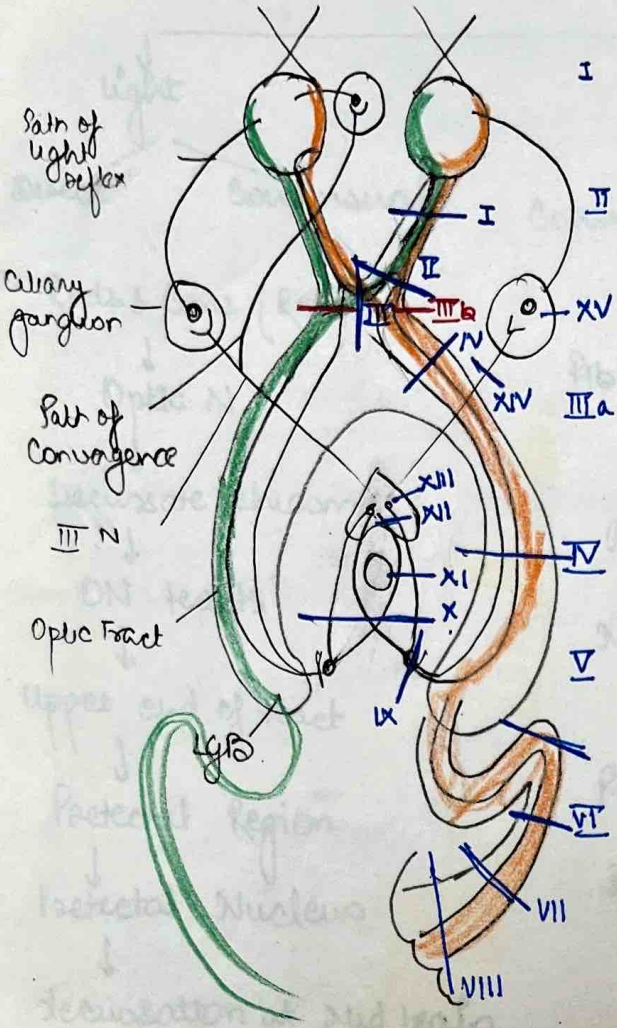
↓ dilat"

Sensory & emotional stimulat"

1st sti → Rapid dilation by dilator

2nd → Rapid onset Slow disappearance (Inhibition of constrictor tone)

Visual Pathway



I		Optic N	Ipsilateral blindness
II		Proximal part of ON	" + Contralateral Hemianopia OR Sup Quadrantanopia
			Traquair Jxn Scotoma
IIIa		Sagittal Sx of Chiasma (Medial)	Bitemporal H. (Heteronymous)
IV		Optic Tract	Homonymous H
V		Lesion of Temporal lobe	Quadrantic Hemianopic defect
VI		Lesion of optic radiation	Homonymous H
VII		Ant to Occipital cortex	Contral Temporal Crescentic defect
		Lesion of Occ. lobe	Homon Hemi (sparing Macula)
IIIb		Lateral chiasma	Binasal Hemi
IX		Sup to Brachium & tectum	
X		Central decussation	
XI		B/t decussation & Contralat. Centre	
XII		Partial lesion of XI	
XIV		Lesion of III N	
XV		Ciliary ganglion	

Psychosensory Rxn

Same Side

Unilateral Amaurotic Paralysis	× Direct ✓ Consensual	✓ Near	✓ Lid reflex

Contralateral H: paralysis — Wernicke's Rxn

Contra H. paralysis

Bilateral reflex paralysis — Bil ×, ✓, ✓, ✓ — Bilateral Argyll Robertson Pupil

	Ipsi	Cont
D	×	✓
C	×	✓
D	×	✓
C	✓	✓

Unilateral Argyl Robertson pupil

Absolute pupillary paralysis — ×, ✓ — Adie Pupil

Rhodopsin Cycle

- Scotopic vision
- In Outer segment of rods

Rhodopsin

Chromophore → 11 cis retinal → Abs of photon

single peptide transmembrane protein → Opsin

Rhodopsin (11-cis) —hν→ activate transducin

Rhodopsin (11-cis) → Trans → Bleaching

Rhodopsin —hν→ Bathor (pico)

→ Lumir (micro)

→ Meta I (Milli)

→ Metarhodo II

→ Activates Transducin

→ 11 cis Trans retinal + Opsin (RPE)

11 cis Retinal (Isorhodopsin) ← dark

Pathways

Photoreceptors
↓
Bipolar cells
↓
Retinal ganglion cells

- P Cells
- M cells
- K cells

P Cells:
- Smaller
- Thinner axons
- Small calibre
- » Macular region
- Colour – high spatial freq resolution (form)
- respond to constant stimulat° & short latencies
- 90% of Retinal ganglion cells
- ↓
- Parvocellular layer of LGN
- ↓
- 3-6

M cells:
- Larger
- Thicker
- fast conduct°
- low spatial
- x sel to colour
- high temporal
- motion related info & stereo
- ↓
- 1-2

K cells: Colour

Intralaminar region

LGN – 6 layers
- 4 pari – 235
- Contra – 146

↓
Striate V_1 (transforms info & distribute)
↓
Extrastriate

Visual perceptions

Light Sense
↓
light, dark adaptation

It Min → It falling on retina gradually
↓ in I
↓
Pt x longer perceived

It Num of fovea »
Rods » Sensitive to low illumination

- Scotopic — Bat
- Photopic — Squirrel
- Mesopic — Evening Man

Form Sense
↓
Shape of obj
» accurate at fovea
↓
VA is capacity to see fine details of obj in visual field
» Central vision

- Recognition (Snellen)
- Resolution (Acuity grating)
- Localization (Vernier Acuity)

Sense of contrast
diff in luminance
~~sharp outline~~
Pt region
x definite borders

Colour Sense
↓
Cones Photopic

x chr

S M L
B G R
Red < < Blue
Blue > Blue green

Trichromatic
(Basis of Young Helmholtz theory)

- Young Helmholtz or Trichromatic
  - x → Dichromats
  - Complementary colour after images
    - Spectrally opponent — R vs green, Y vs blue
    - Aspectrally non oppon. — Black–white
- Opponent process Hering theory
  - RG
  - BY
  - WB

✓ Colour contrast
✓ Colour-blindness data

IOLs FOR PRESBYOPIA

Monovision		Dominant eye - emmetropic Non dominant eye- slightly myopic	Uses Monofocal IOLs
Multifocal	Refractive type Excellent distance and intermediate, fair near vision	3 zones Central distance zone, intermediate zone and near zone decentered inferonasally	Iolab, Pharmacia, TrueVista , AMO Array, mPlus, ReZoom
	Diffractive type Excellent near and very good distance vision; less pupil dependent	AcriTwin manufactured in pairs combines multifocal and monovision principles: Lens in the dominant eye: 70% distance and 30% near power Second lens is reversed intensity:70% near and 30% distance power	Tecnis ZM900, ZA900, AcriTwin, Panoptix, Fine Vision, LISA Tri
	Combination type DISADVANTAGES: loss of contrast sensitivity, glare, haloes	Apodized surface to provide smooth zones LISA stands for: L: Light distribution: distance 65 % and near 35% I: Independent of pupil size S: Smooth transitions between zones A: Aberration correcting	ReStore (+2.5D and +3D), AcriLISA
Extended Range of Vision		Echelette design: elongates depth of focus zone	Symfony, Wichterle
Accomodative IOLS	Changing position	Passive shift: hinged haptic; active shift: spring or magnet driven	Crystalens, Tetraflex, 1-CU
	Dual Optic	Two optics, connected by spring like bridge through haptics	Synchrony, Sarfarazi
	Changing Power	Change in thickness or change in curvature Fluidvision: fluid stored in haptics reservoirs, redistributed on near gaze; Liquilens: high refractive index fluid placed inferiorly	SmartIOL, FluidVision, Liquilens, Quest, NuLens
	Electronic focussing	ISensors that detect very small changes in pupil size; and change the molecular configuration of the liquid crystal to alter the power of the lens	Elenza Sapphire
	Artificial Crystalline Lens	Injected through a small, peripheral capsulorrhexis that is later plugged Lens epithelial cells must be removed, killed or passivated Capsule opacification is a problem	Tercopolymer

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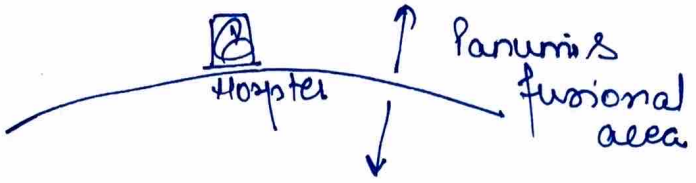
Binocular Vision & Stereopsis

Imaginary line in space – Horopter – Ext projection of corresp retinal points



Horopter & Panum's ∝ distance at which eyes are fixated

Outside Panum – ∠ – Physiological diplopia

Brain suppresses

demonstrated by
far obj & finger at
nose

Binocular vision graded

Simultaneous Macular perception

fusion

Stereopsis

Physiology of Vision & Developing Brain

Sleeps » Blurred vision ∴ protected from ↑ level of stimulat" at birth

Newborn - short eye, hyper, immature fovea
↑ Binocular, ↓ peripheral view, Cortex immature

Sensitive period — 0yrs 3yrs — Crucial
Use it or loose it

Milestones

At Birth — fix and look at light held few inches away

1mth — fixation of light » steady
preferance for looking at a face

3mth — Binocular vision, eye co-ordinat"
Eye follows torch/person moving
Smiles to visible smile
Stops crying ♀ enters room
recognises familiar faces & obj

4mth — Recognition pattern similar to adults
↳ Upside down
↳ > Rt

6mth — Preference for looking human face
clear .. .. ♀ than strangers
familiar toy recognition
efforts to adjust position to see toys develop

9mth — Look for hidden toys

Blood-Ocular Barrier

- Post segment of globe
  - Walls of Retinal capillaries
  - Bruch's Membrane
  - RPE
- Ciliary region
  - 2 layered ciliary epi
- Iris
  - Iris capillaries

Intraocular fluid

- Ant segment
  - Aqueous H
- Post segment
  - Vitreous H

→ IOP — 10-20 mm of Hg
→ nutrition to Avascular structure of eye
↳ Bld plasma

collage type II + GAG + 99% H_2O

Stagnant fluid

a) flouroscein + Alb.
b) Lipid Soluble — Sulphonamides, CPM
c) Plasmoid Aqueous — Vasodilator Drugs

Paracentesis → Inflammation → Choroiditis
Massage of globe → Stretch on Capilla → IOP

Aqueous Humour

Na^+
Vit C

formation

↓RI
from Plasma by Ciliary epi cells

- Communicat°
  - gap jxn b/t Non Pig & Pig Cells
- Barrier
  - Tight jxn

formation

Ultrafiltration. | Diffusion | Secretion # → 95%

circulation

Ciliary Body – Max form

→ Post chamber → Thru Pupil → Ant chamber → Trabecular meshwork → Schlemm's canal → Collector channels → Aq. Veins → Episcleral veins

* ① Shallow AC – Relative pupillary block

→ Choroid & Suprachoroid → Episcleral tissue

* i) Organic adhesion b/t peripheral iris & Cornea → adherent to AC of lens
- Inflamm
- Fibrosis after Neovasc

elimination/Outflow * clinically »

Aq. formn / production → Factors controlling IOP ← Choroid & Vitreous bld vol

EOM tone

Outflow | Prolonged effects

Block → ↑ Pressure of episcleral veins

Temporary → Volumetric changes → VH

- Hydrostatic pre in Capillaries → Pulse & resp. rhythms
- ↑ permeability of capillaries → Plasmoid Aq. → ↑ Osmotic pressure → Clogged drainage
- Osmotic pre of bld & diffusion → Hypotonic / Hyper → ↑ IOP / ↓ IOP → glycerol oral, Mannitol i.v → ±20 drinking test

Anatomy

Uvea Retina

Cornea Sclera

- Cornea – layers – Epi → Bowman → stroma → Dua → Descemets → Endo
  Transparency – Lattice
  B.S Avascular ∴ Nourish from. diffusion of tissue fluid
  N.S → ~~Tri~~ V N

- Sclera – Thickest in area around ON
  Episclera
  Sclera (Lamina fusca)
  Conjunctiva

- AC – Aq Humour, Canal of Schlemm, Trabecular Meshwork
  2.5 mm deep.
  Right fxn – 1% Aq flow
  Foam vacoules – >>
  Iris
  Lens ← (AC) → A Cornea
  In Pupil

- Lens
  Epi
  Capsule
  Oldest
  youngest
  Infantile
  Fetal
  Embryo
  Adult
  Lens Capsule < Thick A>P / Thin – Post pole
  Susp lg/Zonule of Zinn

- Uvea : Iris, Ciliary Body, Choroid

Iris → Thinnest – Att to Ciliary body

Ant ↑ Flat cells – Cuboid – Stroma
Post ↓ —— Pigmented layers (Retina)

2 Muscle discuss

Ciliary Body < Pars plicata / Pars Plana

N.S – V N
Motor – from III N

Ora Serrata The ciliary body extends backwards as far as Os at which point retina proper begins abruptly, the transition from ciliary body to choroid. Ant on Nasal side

- Choroid – Vascular

Epichoroid/Lupra

Lamina Vitrea
or
Membrane of Bruch

- Post chamber, Vit H → V Body → Lig of Weigert. In the region of ora the vitreous cortex is firmly attached to retina & pars plana ⇒ Vitreous Base.

Canal of Cloquet

Retina

O
|
I

Rods & Con. (Photoreceptors)
↓
RPE
↓
Outer Nuclear layer — Rod
↓
Outer Plexiform layers
↓
Inner Nuclear layer — Bipolar
↓
Inner plexiform.
↓
Ganglion cell
↓
NF layer

Refractive Sx for Rx of Presbyopia

- Corneal procedures
  - Non Ablative
    - ↳ Monovision CK (Conductive Keratoplasty)
    - ↳ LTK Laser thermal keratoplasty
  - Laser ablation
    - ↳ Monovision hyperopic or myopic LASIK / C LASIK / Epi LASIK
      - N
      - D
    - ↳ Presbyopic bifocal LASIK or LASIK PARM Pres by Ayalos Rozakis method
    - ↳ Presbyopic multifocal (PML) LASIK
    - ↳ Presbyond Laser Blended vision
  - Corneal inlay
    - Acufocus I
    - Biovision Invue I
    - Presbylens
    - Refractive annular & lenticule
    - Multifocal refractive inlay
    - PEARL (Allogenic RL)
    - Raindrop NV inlay
- Lens based or Intraocular refractive procedure
  1. RLE
  2. PRL
  3. Monovision with IOL
- Sclera based procedures
  1. Ant Ciliary sclerotomy with tissue barriers
  2. Scleral spacing procedures
  3. Scleral ablation with laser. Ex: Y-AG

Intracor Rx

rings

ion OL.

CM

R.

Presbyopia Surgeries

Corneal Procedures

- on Ablative
- LASER ablation
- Corneal Inlay
- IntraCor

n Ablative →

→ MonoVision CK — ND

→ LTK — discarded in favour of CK

SER ablation Corneal procedures →

onoVision Hyperopic / Myopic LASIK | C LASIK | Epi LASIK

1 – NV 2 – Distant vision

esbyopic bifocal LASIK or LASIK PARM →

conc. zones

orneal flap 8.5 - 9.5mm → Hyperopic ablation — Myopic – NV,
Myopic " – 4mm zone – DV
Ring of prolate – NV

Reposition flap. ←

Presbyopic Multifocal LASIK (PML) →

Corneal flap 8.5 - 9.5 mm → Astigmatic ablation →

Central Corneal ablation. — Distant

- Multiple Paracentral zone ablations — To fx near & Intermediate.

Presbyond LASER Blended Vision → D – DV ND – NV
ND ↓ NV + (+ve) spherical aberration in centre of the eye
Image disparity ↓. i.e Blend zone

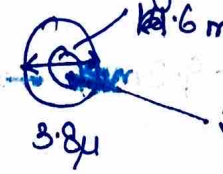
Refractive

Corneal Inlay

✓✓ → Precise & safe
Computerized
× Inlay move
× Corneal topography changes
No Astigmatism induction
Avoid dry eye related flap.
Prevent Neurotrophic keratopathy

- Acufocus Inlay
- BioVision.
- Presbyler
  - Non
    - ↳ M
    - (Cor
  - Refractive Annular & Lenticule
  - Multifocal refractive Inlay
  - PEARL Presbyopic all Refractive lent
    - ↳ L
    - L
  - Pain drop Near Vision Inlay

Acufocus Corneal Inlay (ACI)



Injected or placed under LASIK flap.

BioVision Onvue Inlay → Hydrogel lens Central clear zone
10μ thickness 3.6-3.8mm dia. thickness & Pow ac

Presbylens

Presbylens → Corneal Inlay → changes shape of cornea
Produces multifocal system. Polymer 1.5mm dia

Refractive Annular Add lenticule – Acrylic polymer. 3mm dia.
Operate distance & near focal points.
Index of refraction
+power
Carved +1.25 to +3.00D Add.

Multifocal Refractive Inlay → Acrylic Hydrogel
Neutral Central Zone
3D.
2 images on Cornea like Multifocal IOL

Presbyopic Allogenic Refractive Lenticule → Human Corneal tissue
out of SMILE. (-2.5 to 3.5D) Myopia.
Hyperopic

✓
Easy lenticule implantation
Bio Compatible lenticule.

✗
- Manual cutting & obtaining suitable size
- Potential risk of stromal Rejection

Rain Drop Near Vision Inlay → Hydrogel in ND
✓ → Transparent as Natural tear
→ Suited for Dim light
→ Resemble tear droplet
– Bio Engineered to transport nutrients

(28 – Distant V

Intracor Treatment → ...
5-8 at different corneal depths of cornea.
for ↓ hyperopic eyes & Emetropic eyes

Lens Based

- RLE
- PRL
- Monov...

Sclera Based Procedures

↓

∝ Schachar theory.

Any procedure which ↑ distance b/t Lens equator ... reverse Presbyopia

- Anterior ciliary sclerotomy & tissue barriers
- Scleral spacing procedures
- Scleral spac... Ex YAG ...

Contact Lens in Presbyopia

- Monovision CL.
- Modified Monovision CL.
- Bifocal CL.

Monovision CL

1. eye — distance
2. " — Near.

∴ × Binocularity

Modified Monovision CL

- Distant
- Bifocal

∴ ✓ Binocularity.

Binocular Bifocal CL.

- Annular
- Segmental
- Aspheric
- Diffractive

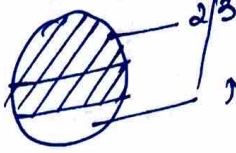
Annular. → Centre distance.] types.
" " near]

✓
× movement of lens req
↓
Axially symmetrical

×
∝ Pupil diameter
↓ Contrast

Interface Treatment → Creation of

Segmental Bifocal



On translatory movement of eye over Cornea
Orientation – Prism Blast (Base down) for
Truncating lens.

Aspheric. Bifocal – Distance in centre & progressive
add in periphery like Varifocals.
✓ Intermediate also

Diffractive Bifocal → ½ Bright ∴ good light source
✓
No Translation req
No dependent on Pupil size

Presbyopia

→ Physiological insufficiency of accomodation due to reduced amplitude, leading to progressive fall in near vision
40-45yrs

→ falling near vision due to age related decrease in amplitude of accomodation or ↑ in near pt

Causes

- change in Lens
  - change in elasticity of lens
  - ↑ in size & hardness of lens
- ↓ in Ciliary mal power
  - ↳ Uncorrected hypermetropia
  - ↳ Premature sclerosis of lens
  - ↳ Be-Senile weakening of ciliary mal
  - ↳ Chronic simple glaucoma.

c/f.

Symptoms

- ∝. Working distance, Length of time
- Nature of close work.
- ⇒ Difficulty in near vision
- ⇒ Asthenopia
- ⇒ Intermittent diplopia

Signs.

- NPA, NPC
- Dynamic R.
- Near Add.

Treatment

Optical — ∂x — Modes

↳ Add → Distance - ∝th of near.

Sander's Rule

Rule

- Correct distance
- 50% reserve.
- Ask working distance
- Weakest Convex lens
- Intermediate Vision

Age	Add	Working dist
45	+1 +1.25D	+0.5D 50cm
50	+1.50 +1.75	+1.0D 40cm
55	+2.00 - 2.25	+1.5D 33cm
60	+2.50 +3.00D	+2.5D 25cm.

Sander's Rule

Add given leaving 50% reserve Accom.
Intermediate Vision 1/2 Add ∴ progressive lenses

Modes
- Spectacles
  - ↳ Single vision
  - Bifocal
  - Trifocal
  - Varifocal
- CL
  - ↳ Bifocal
  - Multifo — Intermediate, Astigmatism
  - Monovision — Eye (N) — Other (D)
  - Modified " — Single vision Bifocal
  - Hybrid Bifocal — Centre — 1E — Near vision, 2E — Distant V

Hypermetropia

→ Def.

→ Etio types — Axial — 1mm = 3D
Curvatural — 1mm = 6D
Index
Positional
Absence
Consecutive

→ Clinical types
- Simple
- Pathological
  - Congenital
    - Mucco
    - C. Post Sub
    - C. Aphakia
  - Acquires — Senile
    Positional
    Aphakia – Traumatic
    Consecutive
    Retrobulbar O. tx
    & Internal O.
- Functional — 3N paralysis

→ Total = Latent (cilioplegia) + Manifest
- Facultative — Acc
- Absolute

→ Symptoms
- Asymptomatic
- Asthenopia
  - Defective Vision ≤ Asthenopia
  - Intermittent sudden blurring of vision
  - Crossed eye sensation

→ Signs
- VA
- Size of eyeball
- Cornea
- AC
- Macula
- Fundus — Papilledis
  Shot silk appearance
  Retinal vessels — Tortuous
- A scan

→ Complications — Recurrent styes
Acc Convergent squint
Amblyopia
↓
PACG

Children
Adults
Spectacles
CL
AAO guidelines
Visual hygiene
Sx

Aphakia

- Def
- Causes — Congenital
  Surgical
  Abs of lens matter
  Traumatic
  Post dislocat"

Optics

- Cardinal data change
- Image format"
- VA
- Acc
- BV

- Hypermetropic
  60D → 44D
  AFP = 23.2mm
  PFP = 31mm

Spec → 33%.
CL - 10%.
ACIOL - 2.5%.

IOL

Total loss

- CF → Limbal Scar
  Deep AC.
  Iridodenesis
  Pupil — jet black.
  Purkinje — 2 Images
  Absence of lens
  Fundus — Hypermetropic
  Retino ↑ "

Rx — Spectacle

CL

IOL

Sx
Keratoplastic
Epi "
Hyperopic
Lasik

↓ Magni
x Abber.
Wide field.
» Acceptable
» Uni-Ocular

- Problem of Near Vision
- Cumbersome
- Cosmetic blemish.
- Coloured Vision
- Image Magnificat"
- Spherical Abberat"
  L for Cushion effect
- Prismatic Abberat"
  L Roving Ring Scotoma
  L Jack in Box.
- Restricted field of Vision

↑ Cost
Cumbersome
Corneal Complicat"

Pseudophakia / Aniphakia

- Calculat^{n} of IOL power.
- Refractive Status — Emmetropia
  Consecutive myopia.
  " hyper.
- Signs — Surgical limbal/Corneal scar
  Deep AC.
  Iridodonesis
  4 Purkinje images
  Jet black pupil, shining reflex
  IOL +nt
- m_x — Spectacle for near vision
  — Progressive glasses

Myopia (close the eye)

Short sightedness. When acc at rest // rays coming from infinity gets focused Pre fovea of retina

Optics – Too powerful
Image blur
Far point — finite ∴ near obj is focused ⊂ out Acc
Nodal pt away from retina ∴ Large image
(Compensate for poor VA)
+ neg Angle, Alpha.
– x Acc. ∴ Convergence Insuffi Exo.

Types

- Etiological
  - Axial
  - Curvatural
  - Positional
  - Index.
  - M. due to excessive Acc
- Clinical
  - Congenital
  - Simple / Developmental
  - Pathological / Degenerative
  - Acquired
- ∝ Age of Onset
  - Congenital
  - Youth-Onset
    - Early Onset
    - Late Onset >40

Acquired

- Index
  - Nuclear Sclerosis
  - Incipient Cataract
  - Diabetic Myopia.
  - Drug induced
    - Cholinergic drugs
    - Steroid Induced
    - Sulphonamides
- Curvatural
  - Corneal
  - Lenticular.
- Pseudomyopia.
  - ↓ Excess Acc
  - Spasm of Acc
- Positional
  - ↓ Ant Sublux.
  - Space (Aviation)
- Consecutive
  - ↓ Surgical Overcorrection
  - Night M

Orthokeratology

- Reversible, Non invasive
- ↓ of Myopia FDA approved.
- Reshaping of Cornea by wearing RGP lens over period of time

Overnight — Rhs wear

⇓

Cornea flattening in day.

Reverse geometry design.

↳ Central Zone — flatter

↳ Intermediate Z — steeper to provide peripheral bearing

↳ Peripheral Zone — necessary clearance & edge lift.

Changes — < Rates of wear

congental

↑AL., (Marfan) overall size of globe.

Simple.

Low <2D — Mod 2-6D

Etio
Simple
Curvatural .2 – 20%.
Role of genetics < 1 – 10%.
Role of Diet.
Theory of Exc near work

Clinical picture

Sympt. – Poor vision for distance
Half shutting of eyes
Asthenopic
Change in physiological outlook.

Presence since birth
↑ ° of error 8-10D
Anisometropia.

Dx
. Unil congental Myopia
L Esotropia
L Amblyopic
Bil – Hold things close.

Rx
Early Dx & correction.
full cycloplegic Refractive error

Signs
Predominant Eyeballs
AC – Deep.
Pupil – Large.
Fundus – Temp. Cr. crescent.
Error > 6-8D.

Dx
Retinoscopy

Types of Astigmatism

- Regular — power changes uniformly from 1 meridian to another (i.e 2 principal meridian)
  - Etiological type
    - Corneal
    - Lenticular
      - Curvatural → Lenticonus
      - Positional → Lens tilt
      - Index → DM, NS
    - Retinal
      - Oblique macula
  - Refractive Type
    - Based on axis & ∠ b/t 2 principal meridian
      - With the rule
        - Vertical > curved
        - steep & vertical
        - Convex cylinder
      - Against the rule
      - Oblique Astigmatism
        - ⊥ b/t not 90 & 180° (10° on either side)
      - Bioblique
        - 2 principle b/t not at ⊥
    - Rel b/t 2 focal lines in rel to retina
      - Simple
        - Myopic
        - Hypermetropic
      - Compound
        - M — Most common
        - H
      - Mixed
- Irregular
  - Corneal
    - KC, Ectasia
  - Lenticular
    - Cataract
    - Maturity
  - Retinal
    - Macular scar
    - Tumours of retina

Clinical features

- Asthenopic symptoms
  - Blurring of vision
    - > Low Astig
    - > ± the rule
    - > hypermetropic
- Tilting of head
- Squinting
- Reading material held close to eyes
- Burning & itching

Irregular
- Defective vision
- Distortion of obj
- Polyopia.

Jx

- Retinoscopy
- Keratometry
- Astigmatic fan test
- Jackson Cross Cylinder Test

Retinoscopy
Slit lamp.
Placido disc
Photokeratoscopy

Treatment

Optical — Surgical

Small — ~~Less~~ ↑

change of axis cautiously in adults
New Astig
Biobligue — CL.
spherical component — as per guidelines.

- Optical ℞
- PTK
- Surgical ℞

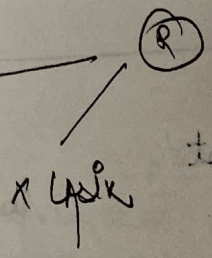
In Cataract ℞x
- Toric IOL
- OCI, URI, SIA
- Post refractive ℞x
- Refractive ℞x

Ant Seg consideration

- ↓ Endothelial cell density & hexagonal ste change
- Thicker CCT in some studies
- AL & CC
- Iris Cyst
- » Nuclear sclerosis
- Deep AC
- > POAG.

P. Myopia & glaucoma

- M. Neuropathy
- OD types
- Vf changes
- Disc Hmg
- OCT changes



CNV

Age related

Myopic
Smaller
Less Exudative
Classic
Self limiting.

Pathological Myopia

Degenerative / Progressive M. > 6D > 26.5 mm
myopia accompanied by deg post seg changes

Etiology

Role of Hereditary ≥ Role of gen growth process

» growth of retina
↓
Stretching of sclera — cholinergic pathways
↑ AL
↓
deg of choroid
↓
deg of retina
↓
deg of vitreous

features of Patho M

RF – ♀
Young
family H/O
Early onset.

Signs Symptoms

Defective Vision.
Muscae Volitantes
Night blindness

Complication.

Retinal tears
Complicated Cataract
Nuclear Sclerosis
VH.
CH
POAG.

Sign

Prominent Eyeball
Large Cornea.
AC deep.
Pupil — Large / sluggish.
Magnitude of Refractive error ↑
Fundus — OD — crescent — Tilted OD
Tigroid fundus
Foster Fuch's Spots
Cystoid deg
Total CRA.
Lattice deg / snail track lesion.
Retinal tears — RD
Posterior staphyloma.
Deg changes in vitreous
PVD
VFA — Contraction of Ring Scotoma.
ERG — Subnormal

Myopic CNV

Pigment dispersion syndrome

Peripapillary Temp crescent
Krukenberg's Spindle
Broad in Bands

Lattice Deg, Myopic CNV

PDS Associations

Low tension glaucoma
Amblyopia
Strabismus
Early Cataract formation
↓ CS
Image minification.
VF defects.

Ass. Syndrome

- Stickler Syndrome
- Wagner
- Ehlers Danlos
- Marfan

Treatment of Myopia

- Optical
  - Concave Lens
  - Min Acceptance.
- Surgical
- Preventive
  - Therapeutic
  - Diet
  - Genetic counselling
- Posture
- Illumination
- Visual hygiene
- Low Vision Aids

Low deg <6D

- <3yr → AAO guidelines
- >3yr → to prevent squinting
  - Normal A-C reflex.
  - for near – to keep books at proper distance
- Never Over correct
- Adults start by Under Correction

High Myopia

Under Correct to prevent Miniaturation & NV problem

- CL
- Spectacles

Therapeutics

Atropine

0.01% ↓

Block muscarinic receptor of ciliary muscle

ATOM2 study

MB = MI

Pirenzepine

2% gel BD

UMP study

Cycloplegia / Mydriasis

MI selective

% of myopic CNV

- Obs
- PDT for Subfoveal
- Argon laser for Extrafoveal
- TTT
- Angiogenesis Inhibitor
- Surgical extraction of CNV lesion
- Macular translocation

Refraction

- Objective
  - Static
    - ↳ Retinoscopy
    - ↳ Autorefractometry
    - ↳ Photorefraction
    - ↳ Electrophysiological method.
  - Dynamic
- Subjective.

Retinoscopy

Skiascopy / Shadow test / pupilloscopy / Koreoscopy.

Principle → Light travel acc to refractive status of eye.

Optics — Foucalt's

1. **Illumination Stage**
   - Illu of subject's retina
   - Immediate source of light
     - Plane mirror → opp
     - Concave → with.
   - Mirror ∝ 1/Immediate source (plane mirror) ∝ fundus spot.
2. **Reflex Stage**
   - reflex. Image of Ill area by subject's dioptric apparatus
   - Working dist. < ID. → Myopia. → Emmetropization
3. **Projection Stage**
   - projection of image by observer
     - with (+) along → Hypermetropia
     - against (−) → Myopia.
     - No movement → Working distance = Myopic D

AAO guides

<1 | <2 | <3

-5 | -4 | -3

+6 | +5 | +4.50

+2.50 | +2.00 | +1.50

+2.50 | +2.00 | 2

-4 | -3 | -2

+2.50 | +2.00 | +1.50

2.50 | 2 | 2

Isometropia

Myopia

Hypermetropia

≤ 250

Astig

Anisometropia

Myopia

Hypermetropia

Aniso

Dynamic Retinoscopy

Static		Dynamic
Rest	Acc	active.
Dim.	Room illumination	Normal
Req.	Working distance	X
6m.	Fixation target	40 cm.
Ametropia is determined.		Acc lag & lead.

Pre-Requisite

- Dark Room
- Trial set
  - Spherical
    - 0.25 – 4D ↑ 0.25
    - 4.5 – 6D ↑ 0.5
    - 7 – 14D ↑ 1
    - 16 – 20D ↑ 2
  - Astigmatism
    - 0.25 – 2D → 0.25
    - 2.5 – 6 → 0.5D
  - Prisms
  - Accessories
- Trial frame
- Phoropter
- Distance Vision chart
- Near Vision chart.
- Retinoscope

Slots

In Trial frame

a) Occluder
b) Cylinder
c) Spherical
d) Near Add

Retinoscope

- Reflecting / Mirror
  - Source of light behind pt
    - Single mirror
    - Combination
      - Priestley Smith's
        - Plane
        - Concave
      - » accurate.
  - Central aperture 3-4 mm
    - Adv of hole of this size ⇔ Circular dark patch
    - 25cm
    - Use slightly concave mirror.
- Self Illuminating
  - Spot
    - Convex lens of 20mm focal length
      - Plane mirror effect
        - distance b/t Convex lens & bulb
        - Image behind retinoscope
          - Against movement
          - With movement
            - b/t Examiner & pt
            - hazy media ↑° of anisocoria
  - Streak
    - » Astig.
    - Concave mirror effect
      - b/t Examiner & pt
      - With movement
        - hazy media ↑° of anisocoria

Procedure

1m @ 2/3 m

Non Cyclopegic (dry)

- Not presbyopic
- If Myopic
- do Blue (fog)
- To relax accomodation

fog → acc

Occluder →

- Densely Amblyopic
- Objects to fog bcoz of diplopia
- If don't know ☹ / ☺ to fog

Cyclopegic (Wet)

- Children
- x fog
- Hypermetropes

Table Pg - 141

C/I : Shallow AC

Pt can look in any direction

Observations

Direction & Movement of red reflex

- ↳ x → Working dist Myopia ID
- ↳ ☹ → emmetropia, Hypermet, Myopia < 1D
- ↳ ☺ → Against
  - ↳ Myopia 1D

Brightness & speed of move^{n} of red reflex

- Bright, fast → ↓ degrees → Working dis
- Dull, slow → ↑ D

Width of red reflex

- Narrow → ↑ D
- Wide → near neutralizat^{n}

Orientation of Red reflex

- ↳ Horizontal
- ↳ Oblique
- ↳ Scissoring

Neutralization of red reflex

Plane Mirror

Find axis

Find power

- ⊖ C
- ⊖⊖
- C

⊖ C → Wrong axis * 6 = resultant

+ve cylinder notation ← -ve

1) against
2) least ⊆ reflex
fastest & brightest

Streak

Mainly to find cylinder

↳ Break in alignment b/t reflex in pupil & band outside

Break goes away along axis

↳ Width of streak varies as it is rotated around correct axis

Narrowest → correct axis

↳ Intensity of reflex band in pupil is brighter when streak aligns ⊆ true axis

Brighter when along true axis

End Point

Over correction 0.25D → reversal

Forward → ⊆

Backward → Against

↳ Skew (Oblique motion of streak / reflex)

- ↓ → final localization. Enhance Intercept on Protractor
- confirmation of axis

Straddling 45° off axis both direction

Toward Correct → It narrows

Widens

How to determine rough estimate

Amount - Retino - HD - Cycloplegic

Power Cross → cylinder at 45° ⊥ to power

Problem in Retinoscopy

- Red reflex not visible — small pupil, Hazy media, ↑° of RE → Mydriasis
- Changing retinoscopic findings -
  - Static
  - Dynamic
    - for near vision
    - Acc in play
      - fogging
      - Cycloplegia
    - → Mainly used in patient of 3rd N palsy
- Scissoring shadow

trial lens

- Spherical aberration
  - + ↑ Brightness in centre
  - − conflicting shadows → Irregular
- Triangular shadow — Conical

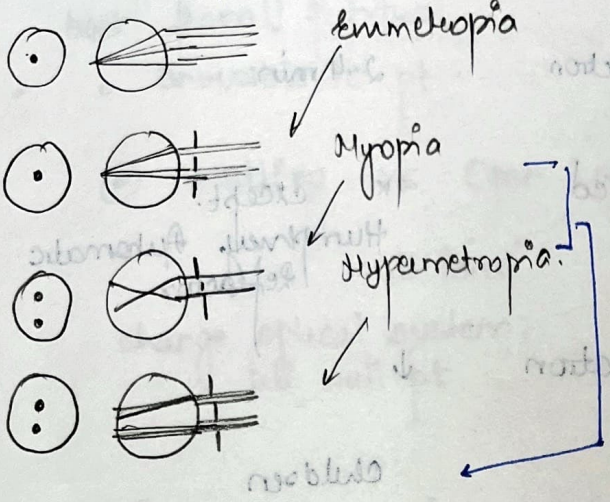
Cornea —

Lens —

Autorefractometers

Scheiner's principle

Double pinhole aperture



It can be coalesced by moving pinhole to far point of eye

⇓

Calculate power

Optometer principle

Postfield

Single converging lens placed at focal length from eye.

Light enter at different vergence & that can be calculated.

Early refractometer

- Subj
  - Badal optometer
  - Young's
  - ↓
  - Instrument accomodation
- Obj

Modern AR

- Subj
  - Vision Analyser
    - ALA + Over Refr System
  - SRIV Programmed Subjective refractor
    - Optometer principle
    - SC.
    - Best
  - Subj autoref + ⊕ ⊖
    - Only screening
- Obj

Instruments

Subjective → Visible light ≅ Lensometer

Objective → Imposed light

0.75 – 1.50D difference

Chromatic abberation.

photoreceptor: 4-8 min

Light reflected from. Time req for reflection

Other layer of retina 2-4 min

≅ BCVA

Info provided

× except. Humphrey Automatic Refractor

Pt · turn knobs > 5yrs

Pt co-operation ↓

Age

Children

Macular dis ≅ clear ocular media.

Hazy media.

VA

> 6/18

< 6/18

RP ≅

✓

✓

× problem

Over refraction

✓

Expected results

Only prelim findings

Objective AR

Characteristics

① Fixation target & Control of Accomodation

② 1° & 2° source of electromagnetic Radiation.

1° — NIR (Near IR) 780-950 nm
- efficiently reflected back from fundus
- invisible to pt.

2° — Back scatter from fundus
- ↓ Axis Powers.

③ Nulling vs Open Loop Measurement principle.

Null point — change optical system till null pt

Non Null/Open Loop
- » quick.
- Analyzing kind of radiation exiting from Eye.

④ Allowance for Ocular refraction b/t Visible light vs NIR.

Visible 630 nm ⟷ NIR 820-900 nm

0.75 - 1 Ds hypermetropic

⑤ Allowance for plane of reflection.

NIR — Ant layers of retina

Light is returns Polarized. ~~light~~ plane ↓ Diopteon.

Visible — Non Pol. Humphrey Autoref.

Reflectance of fundus ↑ towards red end.

0.003 — 400 nm.

0.1 — 700 nm.

⑥ Vertex distance Consideration

full R.E. determined at plane of Cornea.

Scheiner Principle

Aquity Systems 6600
Grand Seiko
Nidek, (Marco
Takagi
Topcon.

Retinoscopy principle

Instruments

- Direction
  - B&L
- Speed
  - Nikon NR 5500
  - Nikon Retromax
  - Tomey TR-1000
  - Carl Zeiss Meditec
  - Nidek OPD Scan

Basic working features

- Nulling refractors
  - IR-LEDs for aperture of S. disc
- Concept of Radioptometer
- Specialized photodetection device
- Corneal reflex
- Meridional reflexes
- Refr power end pt.

Best focus principle

knife edge Principle | Ray deflection. | Image size Principle

Photorefraction

Fundus images captured
Research or screening of. Infants, children.

- Point spread method
  Time seq of single flash exposure.
  - Howland & Howland. method of pointspread photorefractron.
  - Gaalman. method of Pointspread
- Retinoscopic like
  - Vision light
  - Infrared videoretinoscopy
  - Computer assisted Infrared Videoretinosc

Obj Refract^{n} in Babies

- Bruckner Test
  - Myopic → Inf Crescent
  - Hyper/Emm → Sup Crescent
    - > 2mm → Hyper
    - Size 2mm
    - < → Emmetrope
- Radical Retinoscopy
  - » Near i.e ↓ Working D
  - Easy in Opaque Media
  - Distance reciprocal neutralized → Dioptric power
- Enhancement Tech
  - of Hyperopia
  - if reflex not enhanced
  - x > 1·50D Hyperopia

Subjective Refraction

Steps

- Monocular Subjective refraction.
- Binocular balancing
- Correction for near vision

Subj Refraction → Phoropter
→ Trial frame
→ Loose lenses

subj → ✗ in kids
as ✗ co-operative

Instruments:

Monocular Subjective Refraction.

Aim – Cylinder lens ⊆ exact power & axis
Best vision sphere

Procedure

- Selection of baseline starting point lenses
- Refining the sphere
- Refinement & finalization of Cylindrical axis & power
- Finalization of spherical lens

Selection of Baseline Starting point Lenses.

- Retinoscopy
- AR
- Evaluation of pt old glasses
- Learn level of UA

VA / Myopic \ Hyper – Poor distant vision poor

Near. good poor ∴ ⇒ chances of Amblyopia in Anisometropia

✗ true for presbyopes.

Refining Sphere

- fog/occlude other eye
- Put next lens & then change
  - To minimize accomodation
- Best Vision sphere
  - Myopic → Weakest Concave
  - Hyper → Steangest Convex
- Hold for few sec.
  else pt accomodate

Refinement & finalization of cylindrical Lens axis & power.

Astigmatic Clock dial & fogging techn.

- fog the eye (+++) Myopia i.e Compound Myopic Astig
- If pt accomodate » blurring. ∴ he relax
- Astig dial. sharpest & darkest (a)
- Add Cylinder of ↑↑↑ (-) power ⊥ to axis in (a)
- Lowest no. ×30 (blackest line)

If Pr D/t = Lowest ×30° = C
C + ½C = final

- Stem Loaad ⇒ - makes

Jackson Cross Cylinder

2 cylinder at ⊥

+0.25 for power along

+0.5 for axis handle //

- first refine axis
  - Handle // to axis of cylinder in Trial frame
  - flip (*)
  - + in direction of +
- Refine Power
  - Axis // to cylinder

Astigmatic fan & Block Tech.

(Maddox V test)

VA > 20/40

VA < 6/12

- Best vision sphere put circle of least diff on retina.
- Simple myopia (+) ∴ δ = ½ Astig
  - ↓
  - Now sharpest line = axis
- Maddox arrow = blur axis
- Blocks

Image back to focus
∴ one is block out blue remove fogging

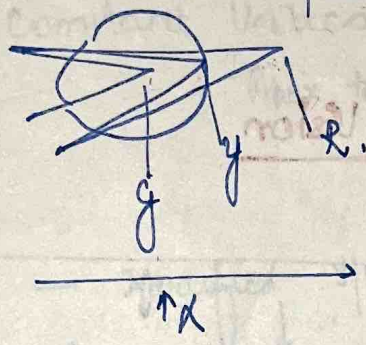
Further Refinement & finalization of spherical lens

Finalizing sphere & fogging tech. using Snellen's VA.

Duochrome Test

Pinhole test

Duochrome test — Chromatic Aberration. Yellow on Retina.



Blind ✓

hyper + myopia -

Over	Under	0	U
↓	↓	↓	↓
Red better	g	g	R

Red clearer → Myopic, big eyeball
Accomodat ✓ ∴ fog first
x < 6/9 vision

Ideal: R=G
R>G

Pinhole — At this pxn if correction. then it tells correction in trial frame is incorrect

Power { poor Vision : 1D
good Vision 0.5D

Confirm the absence of Bilateral Refractive error.

Binocular Balancing

- Fogging & alt occlusion method → Modified Humphriss
- Prism Dissociation method (B)
  - fog +1.DS
  - 3Δ Bup & Bdown
  - +0.25 Infant better
  - defog ↑plus Lowest- Minus
- Duochrome test with fogging
- Tuovlle Infinity balance technique → septum. mark same letters from each eye
- Humphriss Method → better than (B)
- Polaroid filters

Correction of near Vision

>40yrs

- NPA Amplitude of Acc.
  - ≤ Distant correct
  - >40 ↓D/4yr
  - 40-48 ↓1.5D/4yr.
  - >48 ↓0.5D/4yr.
- NPC.
- Dynamic Retinoscopy
- Determination of Near Add

Rule of Thumb — Near add should allow ½ pt's acc amplitude to remain reserve

⇓

Donder's.

Determination of Mal Balance

Any manifest deviation
Heterophoria.
Convergence insufficiency
fusional reserves

Modification in Description

- Full cycloplegic refraction. — squint
- An undercorrect Hypermetrope — ↓ Convergence Exo.
- Over " Myopia → ↓ Intermittent Exo.
- Over Correct +1 to +3D → ~~Intermittent Exo~~ Amblyopia.
- Bifocal. — Non Ref Accomodative Eso.
- Exo — Uncorrect.
- Eso — Max spherical correction.

Bifocal — Eso. of Convergence excess.

- Hyperphoria — Decentered lens
- Prism — Comitant Vertical phorias

Apex toward phoria

Latent hyperopia — Modified Humphries

↓

If accepts - (Minus)

↓

Ix Uncorrectn of Myopia

So go back.

Transposition

- Simple
- Toric

$-2.00 \mid +1.00 DC \times 180^\circ$

- Simple add ⊆ sign
- Inverse sign
- Inverse axis

$\Downarrow$

$-1.00 \mid -1.00 \times 90^\circ$

$+3.00 \mid +1.00 \times 90^\circ$ BC = −6.00

$+4.00 \mid -1.00 \times 180^\circ$

x y

a) Simple Transpose

b) (A) x − BC $+4.00 \overline{(-6.00)} = +10.00$

c) (B) BC at 1 to axis in a $-6.00 \times 90^\circ$

d) (C) BC + y (axis as a) $-6.00 - 1.00 \times 180^\circ$

$-7.00 \times 180^\circ$

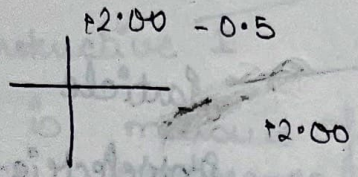
$$\frac{A}{B \;,\; C}$$

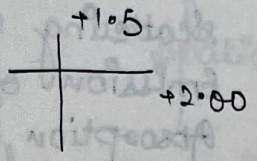
$$\frac{+10.00}{-6.00 \times 90^\circ} \quad -7.00 \times 180^\circ$$

WTR = + at 90° − at 180°

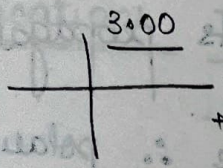
Mixed = +/− & cylinder has to be (<)

$+2.00 \mid -0.5 \times 180^\circ$

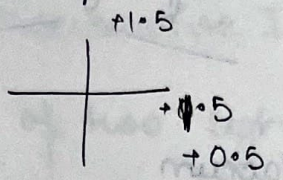


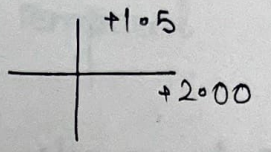


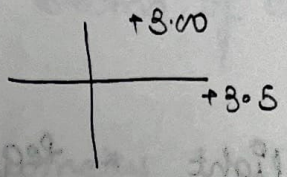
$+1.5$



$+1.5 \mid +0.5 \times 90^\circ$







$K = 1mm = 6D$

$AL = 1mm = 3D$

$+1.75 \mid -1.75 \times 25^\circ$

90

$-3.5 \mid +1.75 \times 105^\circ$

Elementary & physiological Optics

Dual Nature of light

- Wave
  - Propagat" in Vaccum
  - Reflect"
  - Refraction
  - Interference
  - Diffraction
  - Polarization.
- Particle
  - Photoelectric effect
  - Scattering of light
  - Emission of light
  - Absorption of light

Properties of light

× Req medium for its propagat"
Speed = 3×10^8 m/s.
Transverse in nature ∴ polarized.
× deflected by electric & magnetic field.
1 medium – other – velocity & λ changes
of
freq & colour × change

Velocity of particular λ same in all medium
White light is heterochromatic

Visible light & Eye

Media of eye allow 390–600 nm.
Cornea absorbs < 295 nm.
Lens – 350–400 nm.
∴ aphakia everything blue
Eye sensitive to yellow, blue.
Persistence of eye – 0.1 s.
Range of sensitivity = 10^{15}

Fechner Law – change in sensitivity ∝ log of change

Weber's Law – Change of brightness necessary to be noticed ∝ Original brightness

Interference – 2 or > beams of light travelling in almost same direction superimpose & resultant

- Constructive I
- Destructive I

Coherence – is measure of ability of two light beams to produce interference

- Spatial
- Temporal

Significance

Clinical – Destructive in stroma of cornea

Applications –
- Holography
- Laser Interferometry
- Anti reflection Coating
- Excitation & barrier filter
- Cold mirror
- OCT.

Diffraction

Bowing out or encroachment of light in shadow zone as it passes around obstacle or through small aperture

- Fresnel
  - source & obstacle finite
  - Straight edge
  - Narrow width
  - Opaque disc
- Fraunhofer
  - Infinite
  - Single slit
  - Double slit
  - Diffraction grating

Application – Blur circle – Airy disc if pupil < 2.5mm >
» aberrations

– Haloes

Polarization

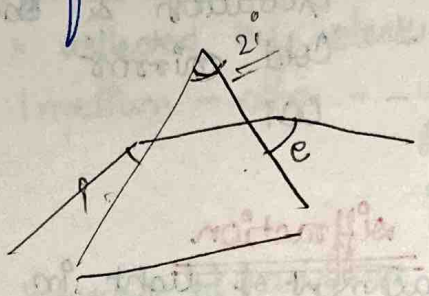
Vibration of wave in a specific direction perpendicular to direction of wave motion

- Encounter ⊆ polarizing substance
- Brewster ∠ → light reflected at specific ∠, reflected light is totally polarized

glass 55° Water 52°

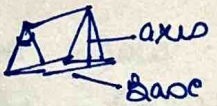
Application

Haidinger Brush
Slit lamp, Ophthalmoscope
Polarizing projection charts - Malingering
Polarized Sunglasses
Titmus fly test
RNFL measurement
IOL defects



Refraction through PRISMS

A prism is refractive medium, having two plane surfaces inclined at an angle.



- Refracting Angle.
- Axis of the prism.
- Base of prism.

Angle of deviation, Refractive index, Refractive ∠, Angle of incidence
min "
Image formed by prism — Erect, virtual & displaced towards apex of the prism.
Power of a prism. — 1D produces 1cm disp. when at 1m.

Uses

Diagnostic Use

- Objective measurement of ∠ of deviation
  - Prism
  - Krimsky
- Subjective measurement of ∠ of deviation
  - Maddox Rod
- Measurement of fusional reserve
- Diagnosis of Microtropia 4Δ BO.
- To assess likelihood of diplopia after proposed squint Rx in adults
- To diagnose Malingering

Therapeutic Use

- To build up fusional reserve in patients ≤ convergence insufficiency. (BO used)
- To relieve diplopia in.
  - decompensated phoria
  - small hypertropias
  - Paralytic squint pt

Ophthalmic instruments

- Slit lamp
- AT
- Gonioscope
- Keratometer.

Prism Bar

Unmounted Loose prism.

Mounted prism on trial lens set

Temporary Wear.

Clips on spectacle prism

Fresnel prism.

guidelines for prescription

- Split the correction equally b/t two eyes
- Esodeviation — BO.
  Exo — BI.

Permanent Wear

Decenter spherical lens prescribed

Prentice formula — determine prismatic effect produced by decentration of lens of particular power. (D) (d)

$P = d \times D$.

If spherical lenses — not req. mount prism in spectacles

	Convex Lens	Concave Lens	Cylindrical lens
Sign.	+	−	− 01 − Power ⊥ axis focal line.
Type.	Converging Lens	Diverging lens	
Forms.	Bi Convex Plano- " Concavo- "	− − −	
Identification	Thick in Centre. Thin in periphery	Thin Thick.	axis ∝. distorted object direction ∝ type.
Size of image	Magnified.	Minified	
Movement of image	Opposite	Same direction.	
Uses	Correction of Hypermetropia, Myopia Aphakia. Presbyopia. – Indirect ophthalmoscopy as magnifying Lens – Oblique illumination Exam. (Loupe & Lens)	Hruby lens for fundus Examination = Slit lamp. −58.6D	Correct astigmatism Cross cylinder. Maddox rod – powerful cylindrical lenses
Image formed	real & inverted with different size & position of obj Virtual, Enlarged & erect.	Virtual, erect & diminished.	Simple – 1 axis Compound – curved equally spherocylinder Mixed

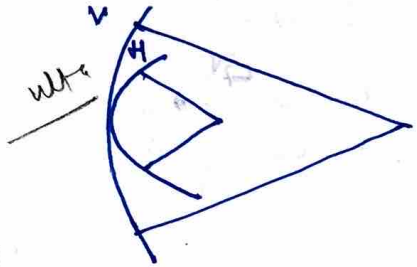
Sturm's Conoid

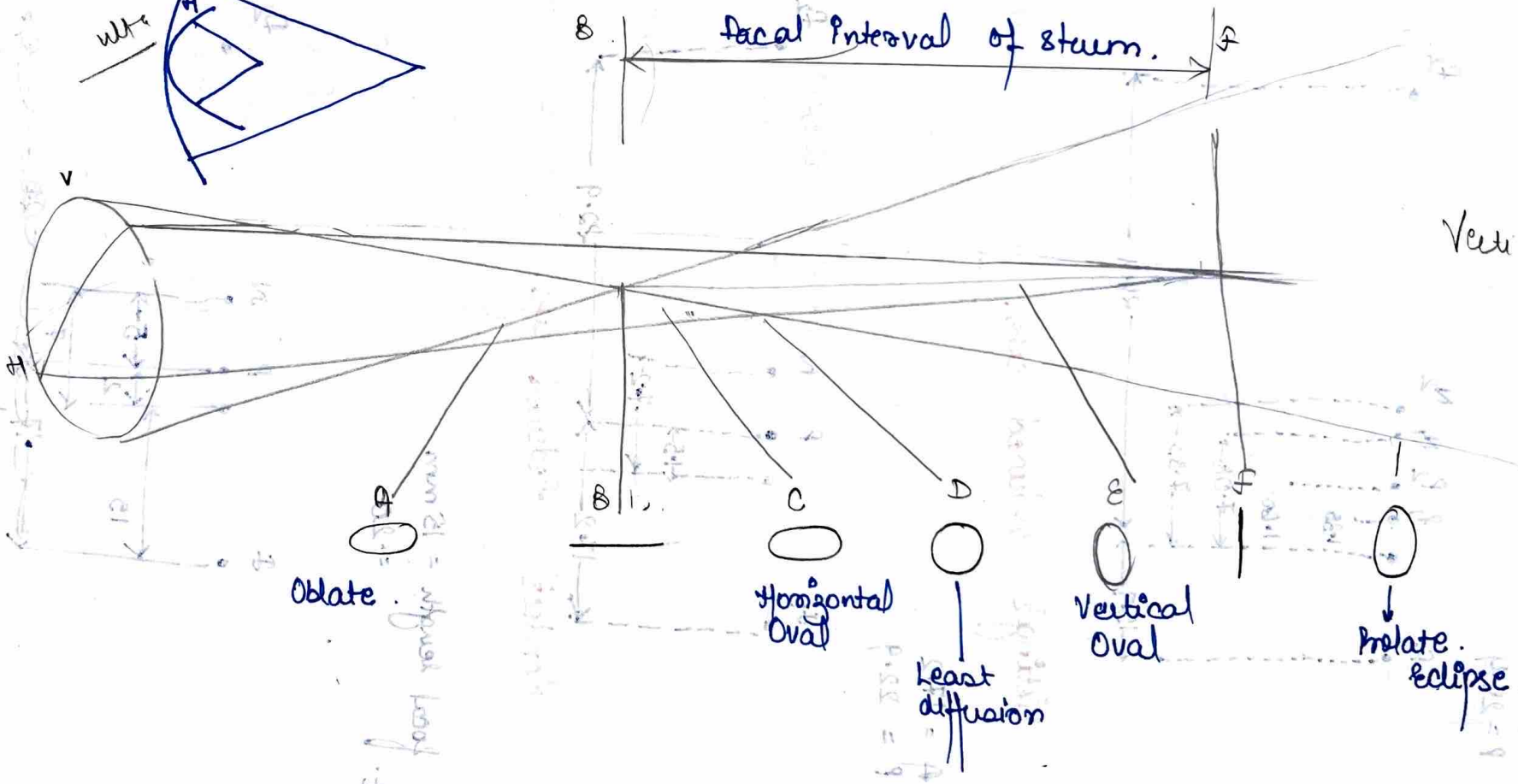
Images formed by different types of cylindrical lenses — Understood by SC.

Configuration of rays refracted through a toric surface — SC.

Toric Surface — 1 principal meridian » curved than Second.

Base Curve = Principle meridian = Min Curvature = Min power

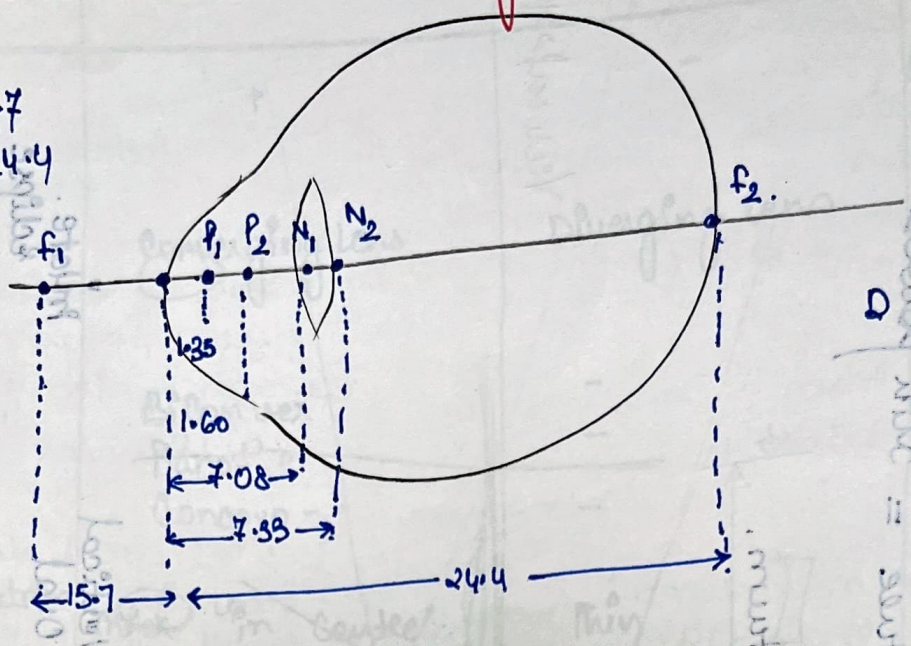




Vertical > Hori

Gullstrand schematic eye.

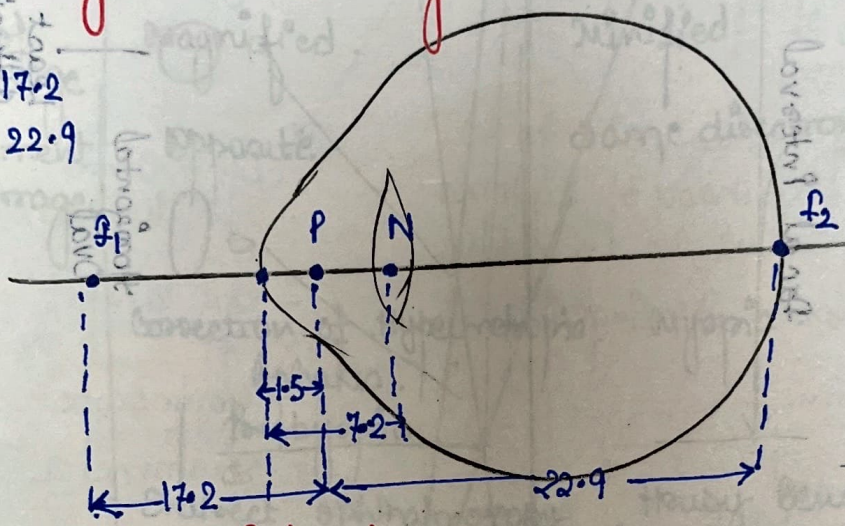
A = 15.7
P = 24.4



D 58.64D

Listing's reduced eye.

A = 17.2
P = 22.9

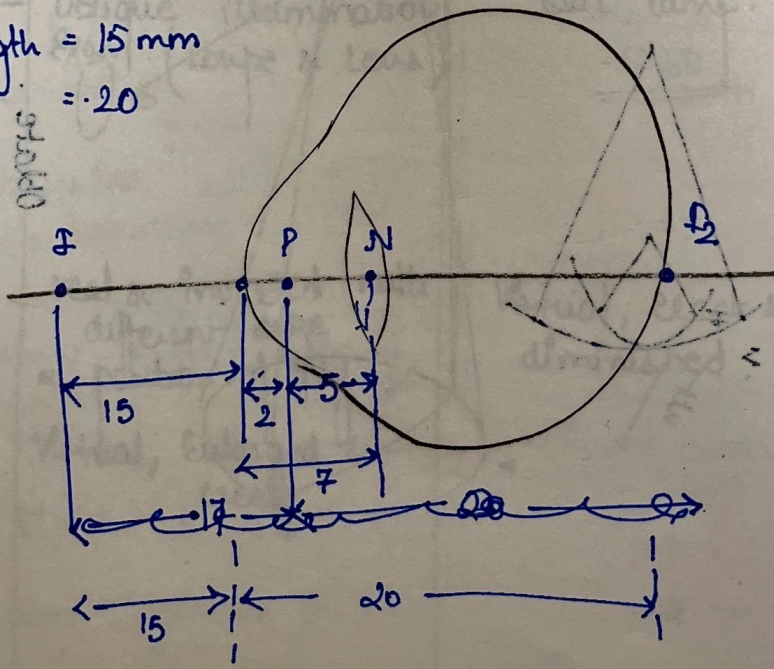


D = 58.20 D
R = 1.336

Dondeis Reduced eye.

5.7 24.4

Ant focal length = 15 mm
Post. = 20



60D
1.336

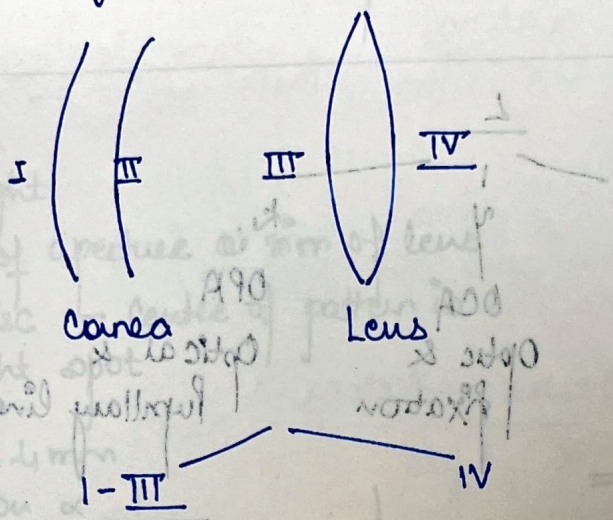
~~Sata~~

Catoptric Images

Purkinje Sanson images.

Across every refracting medium acts as reflecting medium.

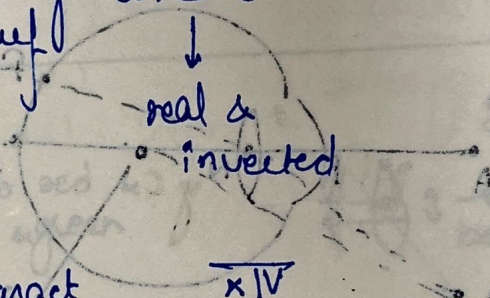
4 images



Convex → Erect & virtual

Reflecting surf

Concave → real & inverted



- Senile Mature Cataract — IV
- Aphakia — I, II — III, IV

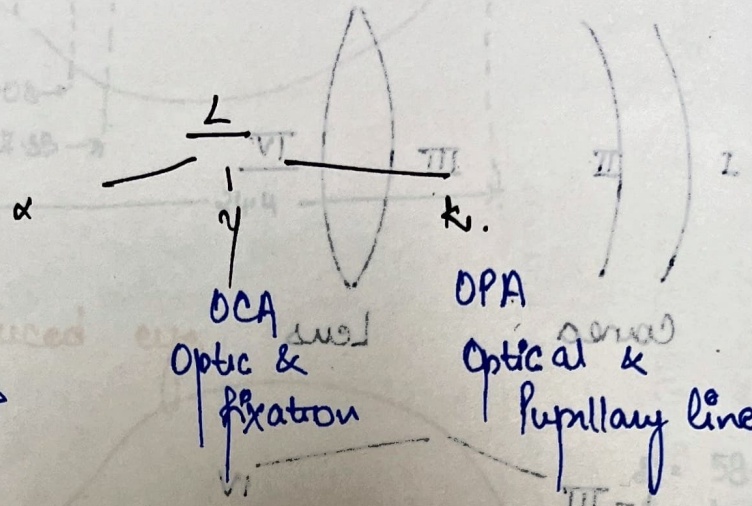
- Keratometry ∝ I.
- Hirschberg ∝ I.
- Changes in Lens during accomodation studied by III, IV

Axes of Eye

Optical — ANR — Coincides ≅ pupil ∴ INR

Visual axis — ONF

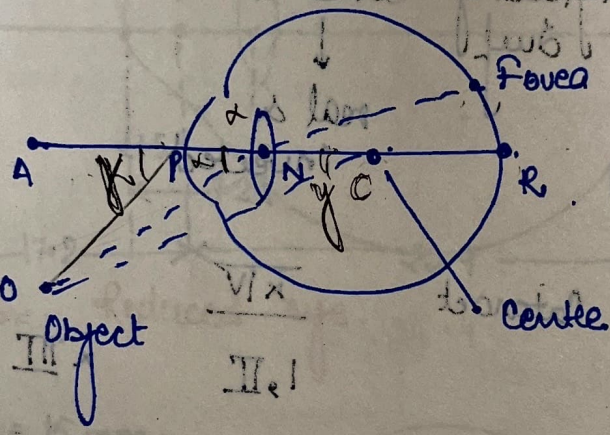
fixation Axis — OC



ONA
Visual & Optic axis

OCA
Optic & fixation

OPA
Optical & Pupillary line



Optical Abberations of Normal Eye

Natural Mech to ↓ abberations
- cutting of peripheral rays by iris
- ↑ refractive index of core of Nucleus than periphery
- ↓ sensativity of peripheral retina.
- Stiles Crawford effect.

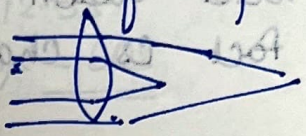
Diffraction of light.

by edge of aperture ⊙ rim of lens
Airy disc ∟ Centre of pattern is a bright spot.

Pupil - 3-4 mm
Diffraction $\propto \frac{1}{\text{size of pupil}}$

Spherical

Peripheral focus far



60D

Adaptation - Curvature of C. ∴ of Lens
Iris blocks peripheral rays

Chromatic

Emmetropic eye is hyperopic for red & myopic for blue & green
Basis of Duochrome.

Adap - Narrow spectral sensitivity band of long & mid wavelength.
cones
- fovea lacking cones
- greatest intensity - sharpest image (yellow)

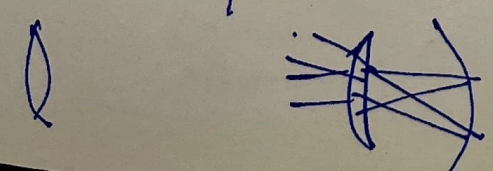
Decentering

- ↕ -0.25 mm below

Oblique.

Oblique focusing rays forming Sturm's Conoid ∴ 2 focal lines >> Biconvex/ave lenses

∴ Periscopic & Meniscus lens considered



Coma

Different areas of lens form foci in plane other than chief focus

Contrast sensitivity

Types
- Spatial
- Temporal

Methods of measurement

- Arden gratings
- Cambridge Low Contrast grating
- Pelli Robson. CS — 3° fm Triplet 0 – 2.25.
- Vistech chart
- Vector Vision Chart
- Fact CS. Chart

Factors affecting CS

- Refractive Error α ↑ freq
- Age ↓
- Lenticular changes α ↓ freq
- Ocular & systemic dis — ON & visual pathway disease glaucoma, Ocular HTN.

Visual acuity Measurements

Vision = form — Visual acuity
light
colour
contrast

def — Measurement of threshold of spatial limit of visual discrimination

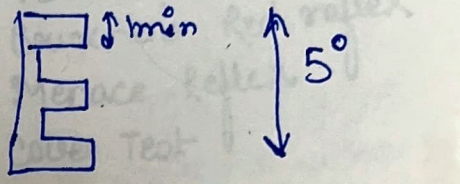
or

Reciprocal of MAR measured in min of arc for std test pattern

Visual ∠ x < 1 min (60s)

1μ = 12.5s
4.5μ = 60s

Snellen — To resolvable 1°



LogMAR | ETDRS charts

- Picture identification
  - Broad Cellu's picture card test
  - Light house test
  - Allen's picture card test
  - Patrino Cards test
- Letter identification
  - Snellen's
  - Sheridan's letter (Snellen)
  - Lippman's
  - Tumbling E
- Direction identification
  - Jaeger's hand test
  - Landolt's C
  - Snellen's E
  - Tumbling E

Vision Test acc to type of chart

Detection Acuity

1) Catford drum.
2) STYCAR (test for young children & Retards) / graded ball's test
3) Schwarting's metronome
4) Bocck candy beads.
5) Dot visual acuity.

Resolution acuity tests

1) Optokinetic drum
2) Preferential looking tests
   - Operant type
   - Teller acuity cards
3) VEP

Recognition acuity (memory) tests

Direction Identification.

- Jaeger's hand test
- Landolt's C
- Snellen's E.
- Arrows

Letter identification

- Snellen's
- Sheridan's letter. (STYCAR)
- Lippman's HOTV.
- Hook's symbol.

Picture I / miniature toys

- Beale Coller's picture chart
- Light house test
- Allen's picture
- Domino Cards test
- Miniature toy test of sheridan

Picture I or Both pattern

- Cardiff
- OKN
- Bailey Hall reading test

Acc to Various age groups

Infants
0-1yr

- Catford drum test
- Preferential Looking tests
- OKNOVIS (Acoustovisiograph)
- ~~Cardiff acuity cards~~
- VER

Indirect
- fixing / follow light
- fixation
  - Central
  - steady
  - Maintained
- Induced Prism test

1-2yrs

Boeck Candy tests
Hoth's Ivory Ball
Sheridan's Ball test
Cardiff acuity test (Vanishing optotype)
Marble game test

Birth - 6mth

- Corneal reflex test
- fixing following light
- OKN
- VER
- Bruckner's Red reflex
- Menace Reflex
- Cover Test

2-3yr

Miniature toys test (STYCAR)
Cantest
Not visual acuity test

3-5yrs

~~Cardiff tests~~
~~Test~~

Tubing E
Landolt's C
Optogen's hand
Sheridan letter test HOTV X
Lippman HOTV test
Allen's Picture Card
Lea's Symbol — Paediatric
Beaker wheel test — LogMAR

Adult

Snellen's
LogMar
Illiterate: E & C

for Amblyopia & Strabismus

20/20 — foot
6/6 — meter
1 — Decimal
0 — logMAR

Night Vision — Landolt's
Camberg
Jaeger
Maggiouee
Wilson charts

Adv Vision loss — Distance — feinbloom Chart
Berkeley Rudimentary Vision test
Near — Minnesota Low Vision Reading Chart (MNREAD)

Near Vision Names

Jaegger's J1
Rombu Test types N5
Snellen's Near Vision test type 20/20.
Lea Near Vision

WHO definition of Blindness

Category		BCVA
0	Normal	6/6 – 6/18.
1	Visual impairment	6/18 – 6/60
2	Economic Blindness	6/60 – 3/60
3	Social "	<3/60 – 1/60.
4.	Legal "	<1/60 – only PL.
5.	Total	NO PL.

Visual field loss

3 (Social) — <10° >5°
4 (Legal) — <5°

Anisometropia.

Diff refractive status
10 – 2%. Size of image
5% – tolerated (2.5 D)
>4D Concern

Etio

Coug — Acquired
- After C. removal
- Wrong IOL
- Trauma
- Keratoplasty of 1 eye
- Asymm age changes

Types

Simple — Comp Astig. — Mixed
S — C — M

BSV status <3D

Uniocular — Alternate Vision

↓
Aniso. Amblyopia

Dx
Retino.
BSV [Fricud.
Worth 4 dot.

Rx — glasses
CL
Anisometropic Lenses
Others — IOL
PRL
RLE — >10D

Aniseikonia.

Upto 5%

Etio

Optical
Retinal — Edema
Cortical

C Types

Asym.
- Prismatic
- Pin cushion ↑+
- Barrel ↑-
- Oblique

Symptoms — Asthenopic
BSV disturbance
Spatial disorientation

Sign — 0.75%.
Oblique Meridional Aniso = Declination
0.3°

Rough estimate
Space eikonometer method.
Rough estimate of °
1.5% ∝ 1D

Rx
Optical — Unil Aphakia.
CL.
Refr Corneal Sx
Aniseikonic Spectacles

Asthenopia

def – Ocular discomfort to symptoms like eyestrain heaviness of lids, headache

Causes

Uncorrected refractive errors

↳ Myopia
- ↑ +ve fusional convergence for near.

↳ Hypermetropia
- ↑ acc for near

↳ Astigmatism
- » Hypermetropic as accomodation comes into play

↳ Anisometropia
- <0.5D
- Unequal blur

Defects of Ocular motility

Mobile fusion.
- Vertical deviation as » limited fusional amplitude

Accomodation & Convergence insufficiency

Acc I
- × Accom
- × Converg
- Read – fewer
- +1.DS → fewer goes +ve
- -ve if vision improves

Convergence I
- NPA > 9.5cm.
- × attain 30° Converg
- < 15 PD
- Uncor Myopes
- Hyper M
- Presbyopes
- Normal PD divergence

c/f

- Non Visual Ocular Symptoms
  - Repeated rubbing

- Headache
- Visual Symptoms
- Other Symptoms — digestive upsets

Mx

Dx

- Refraction
- NPA
- Convergence
- Orthoptic Work up.

Rx

- **Refraction**
  - +1.25
- **Orthoptic Exs**
  - Adductor Exs
  - of C. insufficiency
- **Prismotherapy**
  - BI.
- **general**
  - Analgesics.

Accomodation

∞ A unique Mech by which we can even focus diverging rays coming from a near object on the retina in a bid to see clearly.

Contraction of Ciliary Msl
↓
Change in shape of Lens
↓
↑ in power of crystalline lens

↳ far pt / Punctum ~~proximum~~ remotum — Near pt / Punctum remotum proximum

Range of accomodation

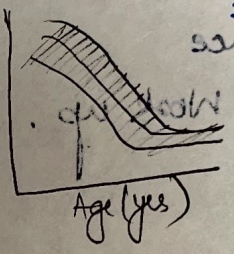
cm

Amplitude of accomodation

D

↳ Emm 7cm – 10yrs
25 – 40
33 – 45.

Hypermetrope – Virtual, behind eye
Myope – Real – in front
Emm – Infinity



Duane Curve

$A = 15 - 0.25(age)$

↳ Depth of field – Range of distance from eye in which an object appears clear without change of accomodation
∝ 1/Pupil size.

↳ Depth of focus – Range at retina in which an optical image may move without impairment of clarity

Range of Accomodation = Depth of field + Depth of focus

Theories of Accomodation

- Helmholtz theory (Relaxation)
- Tscherning
- Schachel's theory
- Cotenary theory.

Relaxation Theory / Helmholtz theory / Capsular theory

Role of Lens Capsule by Fincham.

- At rest (× Acc)
  - By tension of zonules, the sides of lens is compressed
  - Lens surface less curved
- Original theory (At rest)
  - Relaxation of fibres of CM
  - Zonules are kept under tension.
- During Acc
  - Contraction of CM
  - Pulls choroid forward
  - ∴ Zonules relaxed
  - Tension on Capsule relieved ∴ Lens able to attain » spherical shape

In favour.

Against

- Acc → ↓ spherical aberration
- Power of Lens ↑ ∝ age ∴ Myopia should be + ∴
- ↓ Amplitude ∝ hardening of lens

But no body tissue like this.

Why Fincham introduced Lens Capsule concept / Role of Lens Capsule

Helmholtz → Lens change shape bt cannot regain its shape

⇓

∴ Capsule has to come in picture due to elastic properties

Ant > Post.

(b) Theory of ↑ tension (Tscherning theory)

Contraction of CM

↓

Pulls Zonules directly

↓

↑ tension on Capsule

↓

Compression of Capsule at the equator of lens so that poles bulges

↓

∴ Acc occurs (↑ tension of Zonules)

⊖ Against view ∴ no longer accepted.

(c) Schachar's theory.

CM contraction

↓

Tenses Equatorial Zonules

↓

Lens stretched Equatorially (> edge towards axis)

∴ Ant & Post Zonules

Rest → Tense.

Acc → Relax

Helmholtz.

CM contract

↓

Relax zonules

↓

∴ centripetal elasticity

↓

» Sphere lens.

Schachar's

growth of Equatorial diameter

↓

↓ Peripheral space

(d) Catenary (Hydraulic suspension theory) → Coleman ✓

Ant chamber | → Lens zonules & Ant uveous (diaphragm)

Uveous chamber

CM Contraction

↓

Pressure gradient

↓

Ant move' of Lens zonule diaphragm

Steepening of Ant central lens Curvature

flattening Peripheral

But with age lens heavy ∴ ↓ Acc.

Assessment of accomodation

NPA & amplitude of accomodation

NPA = Punctum Proximum

↳ RAF Rule / peince Rule
- ↳ if very low — add plus lenses
  final - (+ lens D)
- ↳ young ↑ — add minus
  final + (minus D)

↳ Using Minus lenses
40cm read
- lens — plus
A = +2.5D + (minus lens D)

↳ Pushup Test → full correction
NVA chart
↓
moved closer ⇒ final plus
Measure linear distance

Accomodative Response

↓

Dyanamic Retnoscopy

↳ MonoOcular Estimation method
fix at 40cm (Near target)
Do retnoscopy

↳ Nott Retnoscopy
fix at 40 cm.

- ⊆ → Away from pt → Lag < → Acc insuff
- Move against ↺ → towards the pt → Lead > → A. Excess
- 2.5D at 40cm

Interpretation

Dyanamics of accomodation

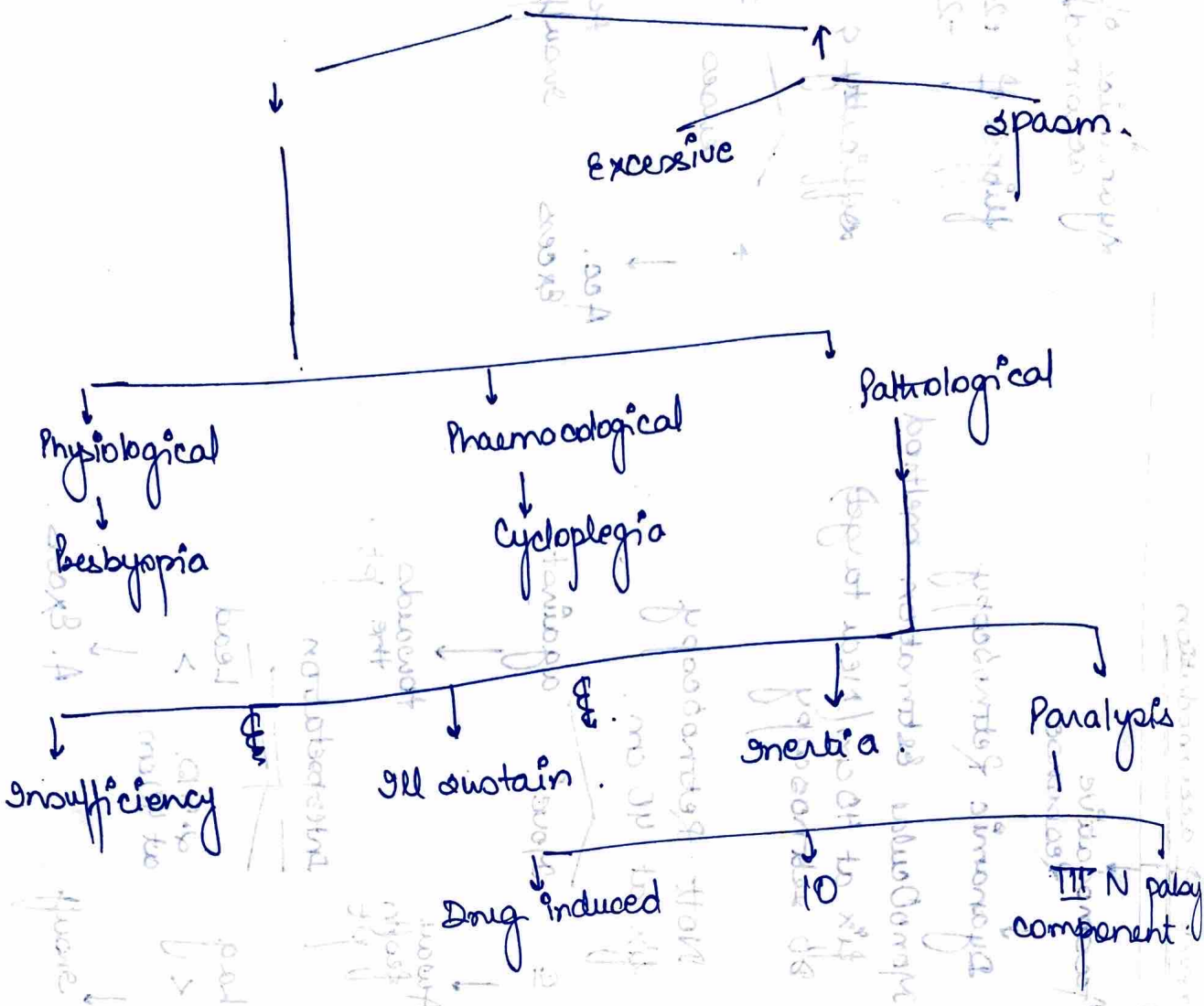
flipper of +2.00DS
-2.00DS

difficulty ↓

\+ lenses −

\+ → Acc. Excess
− → Acc. insufficiency

Anomalies of accomodation



Insufficiency of Accomodation

↓ normal physiological limits for pt's age.
(Normal for pt age is Presbyopia)

Causes

- Premature sclerosis of lens
- Weakness of CM due to systemic dis
- " due local cause - Cyclitis, POAG

C/F 15-45 yrs

Asthenopia »
Headache, fatigue, irritability
- Blurred near work
- Intermittent diplopia

Stable – Lenticular origin
Variable – CM "

Rx

- Rx the Cause
- Near Vision Spectacles
  - Correct Ref error
  - Conv Insuff – Bi prism
  - " Excess – full spherical correction
- Acc Exs → Test Card Exs
  - ∝ CM ∝ Lenticular
  - full correction
  - CInsuff – Simultaneously

ill sustain

Range of A – Normal
Cannot be sustained.
Precedes on near work.

Initial stage of true.
Insufficiency.
- Stage of convalescence
- " " general tiredness
- Pt relaxed in bed.

» Near Work.

Sustain near work.
Improve visual hygiene

Inertia

Difficulty adjusting A. according to distance of obj of regard so as to gain clear vision.

Rare.
Some effort to focus

& refractive error.
Acc. Exs.

Paralysis

Cycloplegia

- Drug induced
- IO – Dip, Syp, EM, Alcohol mild Head Inj
- III N component – ICSOL

Blurring of Near Vision
Photophobia
Diplopia – Nearer & Small as Acc.
Abn receding of Near pt
Other signs of III N palsy

Self recovery
Dark glasses.
Convex lenses

Excessive Accomodation.

→ Acc than normal

Intermittent process.
under voluntary control.

Causes

- Young hypermetrope
- Young Myope – ≤ C Excess
- Astigmatic Error.
- Presbyopes in beginning
- Use of ill fitting glasses

Precipitating factor – Poor visual hygiene.

C/F

- Varying degree of blurred vision →
- Symptoms of acc asthenopia →
- far & near pt brought nearer to eye
- Near vision difficulty
- Macropsia
- Miosis

Head ache, Backache
– Near point close
Macropsia.

Rx

- Optical Rx
- General Rx

↓ Near work.

Gen Condition → ↓ Holiday to neurotic pt.

Optical Rx
General Rx

Spasm of Acc.

Continous process out of

- Drug induced – DFP, Ecothiophate
- Iridocyclitis
- Spasm of near reflex
- Lesions of Brain stem
- Toxic rxn of Exogenous poison LAs, Sulphonamides

Relaxation of CM – Atropine
↓ Work.

Convergence

It is disconjugate movement in which both eyes rotate inward so that lines of sight intersect in front of the eyes.

x ↓ like accomodation
can be ↑ by Exs.

Types

- Voluntary
  - x by everyone.
  - Convergence of visual axis at will
- Reflex
  - x under complete voluntary control
  - Tonic
    - inherent in EOM
    - goes ⊆ GA
    - » childhood
    - ↓ ⊆ age.
  - Fusional
    - stimulated by retinal disparity
    - image disparity out of Panum's
    - ↑ for BSV
    - ↑ type of optomotor reflex
    - D = I&D N = 35D
    - Ocular Exophoria
    - ↓ fatigue
    - ↑ Asthenopic (+)
  - Accomodative.
    - stimulus – Blurred Retinal image
    - Part of NearTriad.
    - ↑ Convergence when we try to accomodate
    - AC/A Ratio – ↓ not change.
  - Proximal
    - Awareness of proximity
    - ↓ Haploscope
    - ↓ Synaptophore
    - Linear relat"
    - ↓ fixation distance
    - = 1.5Δ PC.

Some parameters in Convergence

- Angle of Convergence
  - Meter angle
  - PD
- NPC.
  - RAF rule
  - Donder's rule
  - Livingstone Binocular guage.
- Amplitude
  - Prism Bar
  - Synaptophore

Angle of Convergence

∠ b/t 1° lines of sight during Convergence

∝ 1/ fixation distance

∝ IPD

MA

1mA = 1mm distance.

2mA = ½.

ID = 1mA

PD

1mA = 3Δ Convergence

using BO.

Near point of Convergence

Closest point at which object can be seen singly during bifoveal vision.

always closer than NPA.

< 8cm.

Measurement → Measures all types of Convergence

Plastic Rule.

RAF Rule

Livingstone Binocular guage.

Prince Rule

At break pt - Obj test + nondominant eye diverge.

Subtester + diplopia.

Some instruments Zero point = 27mm in front of spectacle point. ∴ (+)

Normal 7cm 5-10cm.

In Converg. Insuff. > 25-30cm.

Measurement of Amplitude of Convergence

Prism Bar Method

6/12 at 33 cm
30

Break pt. — diplopia ✓
Recovery pt :
Blur pt — Before Break pt

Distance 6m
measure Break pt
Blur pt
Recovery pt

AC : A Ratio

Synaptophore Method.

By — Simultaneous Macular perception slides.

→ Measure divergence
• Break pt
• Recovery pt
Convergence
• B.
• R.

→ Amplitude of convergences for near by synaptophores
- 3 PDs

Convergence Insufficiency

Inability to maintain inadequate binocular convergence for any length of time c/out undue effort.

Etio 1° / Idiopathic — Overwork. ↓ health

- Refractive error
  - ↑ Hyper M > 5D (↓ Acc C)
  - Myope — don't need ∴ ↓ AC.
  - full + correction also. don't need ∴ ↓ AC.
- Presbyopia — in start c/ spectacles ↓ Ac.
- Mal imbalance — ∈ Exo
- Consecutive CI — Recession MR. Resect LR.

Cf » Near worker, School child

- Asthenopia.
- Change/Uncomfortable c/ glasses.

⇒ Symptoms of Mal fatigue —
- Eyestrain
- Headache
- difficulty in changing focus
- Itching, burning, soreness

⇒ failure to maintain BSV
- Blurred Near vision
- Intermittent Crossed diplopia
- 1 Eye will be closed.

Dx
- NPC > 10 cm.
- ↓ fusional C for near
  - x. attain 30° of C.
  - < 15-20 PD. for near
- Prism Convergence ↓ PC ↓ PD = Normal
- Exophoria at near c/. Ortho at distance CI confused c/ ∈ DDA.
- NPA — combined C & A

DD

Conv insuff Vs Conv paralysis

Conv insuff Vs Acc effort Syndrome

no ∈ to c/2 OA

Rx

Peq

Children — poor fusional c. signs of exotropia

Adults — ↓ Symptoms +nt.

⇒ Optical Rx — full to Hyper under to Myope Presbyope

⇒ Orthoptic Rx

⇒ Prismotherapy
- BI — selecting prism in children
- at avoid

⇒ Surgical Rx.

MR resection ∈

Conv insuff ≤ Acc insuff.

Before Rx Cl rule out AI

Etio
- Early Adic Synd.
- Sequelae to head trauma
- Viral Encephalopathies
- Infectious Mononucleosis
- Diphtheria
- Conversion Rxn.

Clf
- ↓ NPC
- ↓↓ NPA
- AC/A ratio ↓ or absent

Rx →
- Orthoptic Exs — + glasses
- + lens for reading & Bl prisms
  - fresnel prism.
  - 2 piece executive bifocals ≤ decentered + lenses ≤ prism power in lenses ½.
- Surgery — X Tx
  - MR resection

Convergence Paralysis

Total lack of ability to overcome any amount of BO prism. Rare

Etio - 2° to Organic lesions in regions of Corpora Quadrigemina or 3rd N Nucleus
- Head Inj
- Encephalitis
- Disseminated Sclerosis
- Tabes D.
- Narcolepsy
- Tx

Clf Conv — Absent
- Exotropia & Crossed diplopia — on attempted near fixation only
- Adduction — Normal
- Accomodation — Normal
- Parinaud Synd :- CP + Vertigoze P
- Dorsal Mid Brain — CP + vgk + light near dissociation ± ↓ Bil 4th N ud retraction.

Dx Bielschowsky Criteria.

Evidence of Intracranial dis	Sudden Onset Crossed Horiz diplopia at near fixation	Reproducible findings on Subseq Exam
Preserved Acc & pupillary Rxn		

D.D - Txn Cl

Rx
- Bl prism — diplopia at near
- + lens ≤ Bl prism — weak Acc.
- Occlusion

(X) → Sx.

Convergence Spasm

Intermittent C ≤ Spasm of Acc

Etio
- Fxnal — hysteria
- Organic — Head trauma, Encephalitis, Tabes

Clf Extreme Conv — ± Bil Abducens palsy
- Homonymous diplopia
- Blurring of vision
- Miosis
- Induced myopia — 6D.

Psychi Exam

Rx
- Neurological Exam
- Rx of Fxnal spasm of C
  - Prolonged atropinization ≤ + lenses
  - Pt Monocular Occlusion
  - Psychiatric work up & therapy.

Differences

Final Conv Insuff

Several dioptres of Conv amplitude can be demonstrated

Pupillary Constriction ⇓ followed by dilation when Conv cannot be maintained.

Conv Paralysis

Immediate diplopia

Total lack to overcome any amount of BO

Pupillary constriction + Inability to converge

Convergence Insufficiency

Exophoria

Helped by Plus lenses

Worsen due to relaxation of CI

Accomodative effort syndrome

Esophoria

Breaks into Exophoria

Improve.

Orthoptic Exs

- To improve NPC
  - Advancement Exs
    - Jump Conv. Exs
- ↑ amplitude of fusional Convergence
  - Conv Exs ± Prism
    - Using synaptophore
    - Using Convergence Card.
    - Physiologic diplopia Exs using stereogram in uncrossed position
    - Computer based Conv Exs
    - Conv Exs using diploscope
- Training of Voluntary Convergence
- Relaxation Exs.
  - Physiologic diplopia exs using stereogram in crossed position
    - Divergence Exs on synaptophore ± prisms

Intro Von graefe.

Conv > = < Exo] Exs

Criteria for good Orthoptic Mx

- Pt shd be symptom free
- good Binocular Convergence
- Voluntary C. shd be possible
- good fusional reserves.

To improve NPC

Advancement Exs
- fuse till Nose
- Bring closer
- Diplopia occurs
- goes Back
- again repeat
- If suppression — use red filter.

Jump Convergence Exs
- before full wk of convergence.
- By any of other methods

Conv Exs ×

Synaptophore

Divergence Exs
- stereopsis slides
- strongest stimulus
- ask to maintain.
- while tubes diverged.
- 5min/visit

Training of Vol Conv

Aim ⇒ Double the light out aid of finger

Fix distance finger – 2.

Fix finger distance light – 2.

↓

As finger removed light – 1.

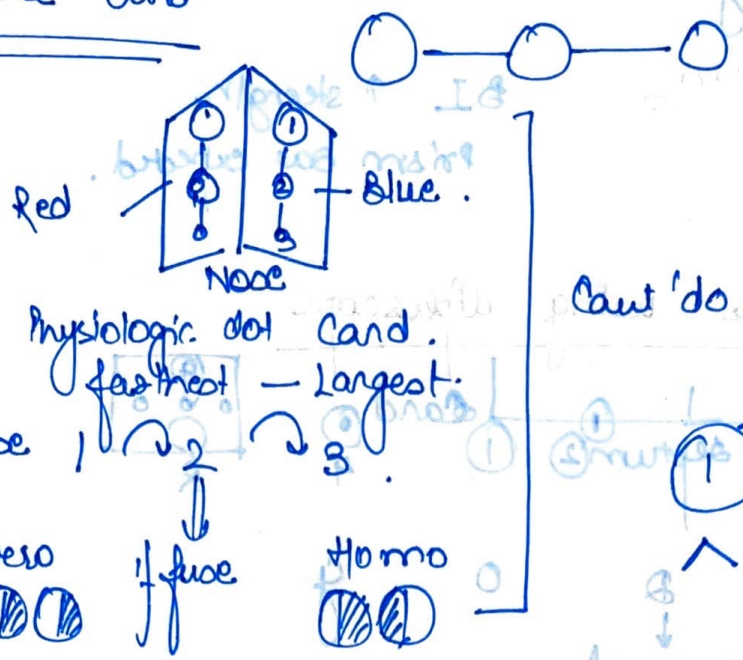
↓

again bring finger till

Exs to ↑ Amplitude of F.C.

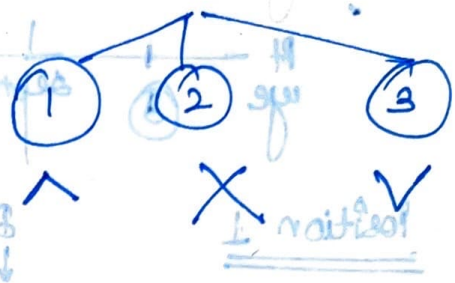
c prism & synapto → Orthoptist see if he is converging not diverging

c Convergence Card



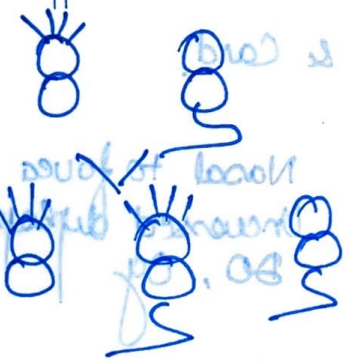
Physiologic dot Card.
fastest — Largest.
fuse 1 → 2 → 3.
Hetero if fuse
Homo

Can't do → for c lines



Physiological diplopia using stereogram

Uncrossed position.
2 obj.
1 pencil in b/t.
If focus on pencil → effort



Ds. Acc for distance
Converg for near.
Conv >> Acc

Stereogram
Pencil
Obs
2 → 4
2 → 3.

Crossed position
stereogram is in b/t pencil & obs
• Pencil
• stereogram
• obs.

Acc for near
Conv for distance
<<
relaxing Convergence.

Computer based

Converg

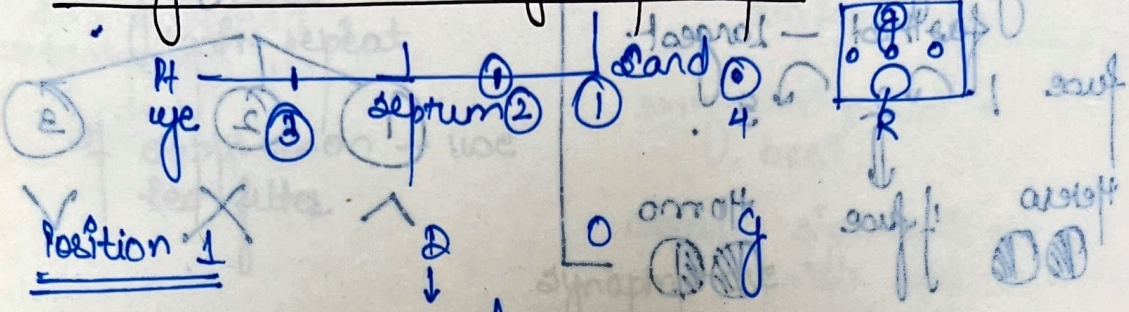
Random dot stereogram.

Using Prism

BI ↑ strength.

Prism bar expected.

- Convergence exs using diploscope

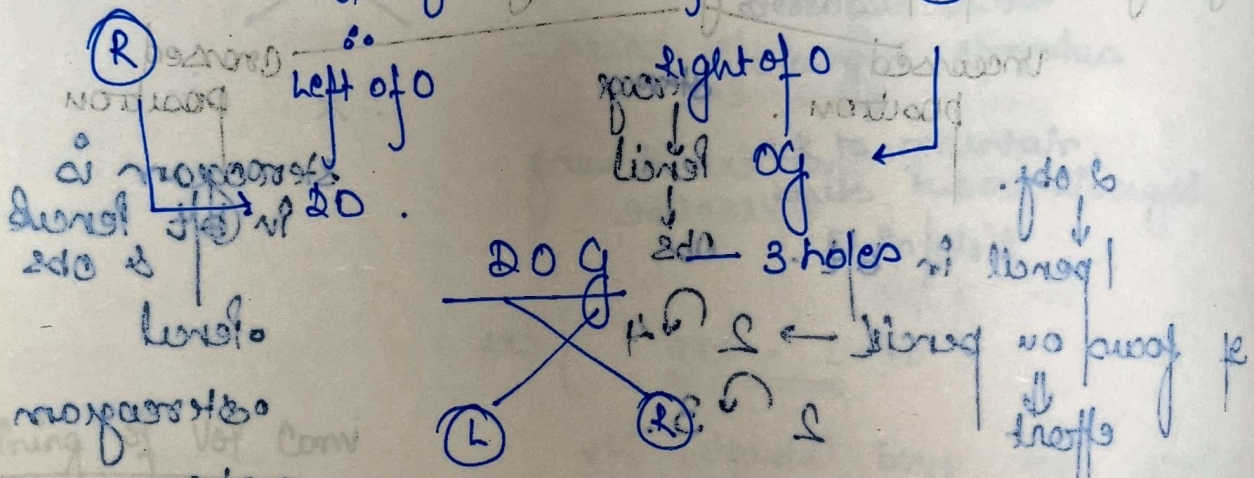


Position 1

temporal

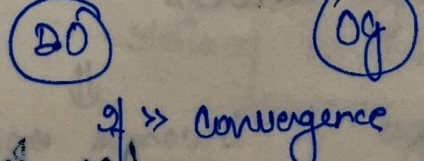
Right eye

Left eye



Position 2 → Midway b/t septum & Card

Closer than 1.



» Convergence

Position 3

Pt in b/t Pt eye & septum
Pencils is kept.

L R

OG DO.

Nasal to fovea
⇓
Projected temporally

OGDO

Position 4 – Obj beyond card. is fixation pt

L R

DO OG.

Temp to fovea
⇓
Projected nasally

DOG

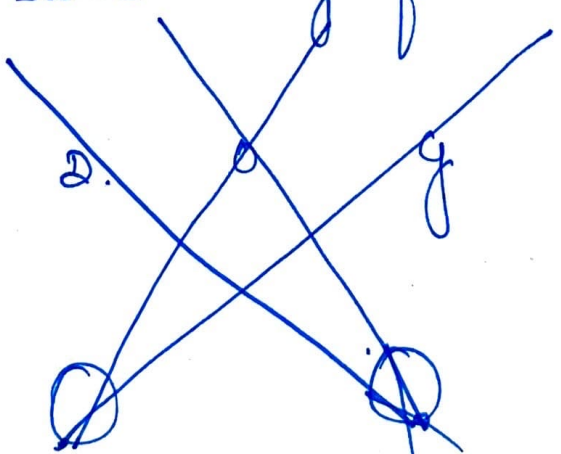
2-3 min for 2-3 time/day

DOG
↓
DOG
↓
DG
↓
OGDO.

④ for fusional divergence.

① ② ③

Aim to switch easily from all positions



CONTACT LENS

Classification

Depending upon Anatomical position occupied

- Scleral
- Semiscleral
- Corneal

Nature of material used

- Rigid Non. gas permeable → PMMA
- RGP → CAB, Silicon.
- Soft → HEMA

Mode of Wear

- Daily Wear
- Extended Wear
- Disposable CL

Depending upon Water Content

- Low → -40%.
- Medium → 40-50%.
- High → >55%.

Contact lens Material

- Focons hydrophobic rigid
- PMMA + RGP → -2i
- Silicons philic Non Rigid → +2i

CL design

Single Cut

Lenticular Cut

Thick central lenticular portion

Terms used

- Wettability
  - Complete — $\angle = 0^\circ$
  - Partial : 70°
  - Non wetting : 150°

- H_2O content $\propto$ O_2 transmissibility $\propto$ thickness $\propto$ mech strength of lens
- O_2 permeability — transmit gaseous substance
  - DK value.
    - O_2 transmissibility — DK/L.
    - Light transmission
    - Refractive index
    - Heat resistance
    - Dimensional stability
    - Flexure

Ideal Material

- Bio Compatability
- Optical property - μ = tears
- Gas permeability
- Tolerance
- Moulding
- Sterility
- Stability.
- Surface chemistry
  - Anion
  - Cation

RNGP (Obsolete)

PMMA or Acrylic

↑ optical Quality
Stability
light
Excellent Moulding
Non Toxic

impermeable to O_2
Corneal abrasion
resist Wetting

To overcome

RGPs | semi soft lenses

Material

Earlier ✓ | x | Now ✓

CAB. good Wetting | scratched Nasp.

Silicon. ↑ O_2. | Lack of Wettability
Surf deposits

Styrene ↑ O_2. | ↓ surface durability
Brittle

• Silicon acrylate → O_2 Wettability

• fluoropolymers – f ⇒ Extended wear ✓ → ↑ O_2
× Surface deposits.

f siloxanyl Methacrylate

Pf alkyl... conat Siloxane

Hydrophobic Soft Contact Lens

Hydrogel — OH

Cross link

\+ HEMA | − HENA

» stable.

Other characteristics

• Amount of hydration ↓ / ↑ 38-45% / upto 85%
• degree of swelling of CL.
• Avg dia of pore in hydrogel.
• O_2 ∝ Hydration / Central thickness

Material for Hydrogel

✓

× Eg

HEMA

× Biodeg
can stand chemical & thermal sterilization

↑ Hydration — VP added

HEMA-VP

Tendency to colour change

Hydrocurve
" Flex
Flexicon.

Soflon
Medigel 70
Viglens 70
Soflex 668

MMA-PVP

Glycidyl Methacrylate

Manufacturing Techniques

Lathe Cut

Spin Cut

Moulding.

Stages in Manufacturing

CL Blank.
Semifinished Blank.
" Lens
finished Concal CL

Tear film & Contact Lens Interaction

- Positioning of lens & tear film
  Lens tear film
- Optical Considerations — μ of tear = 1.337, Cornea = 1.376 — If ∝ then Astig ↑ & ≤ CL
  0.04 diff = 5D CL → 0.50D Astig but ↑ ≤ power of CL.
- Effect on Corneal Nutrition — Harm to cornea =
  - Retard evaporation of tear, ↑ Hypertonicity
  - Physical barrier for O_2 delivery
  - Trap Waste
  - Traumatize Epi cells
  - O_2 in post lens tear film exhausted in 90s HL, SL (40% H_2O)
    Non O_2 dependent pathway 1/18 efficient.
    tear pump efficiency ∝ Vol of tears behind CL
    % of exchange ≤ each blink
    freq of blinking
  - SL — 11.5 - 15.5mm — covers complete cornea but there is aqualung effect. two rings
  - Detergents & Hypotonicity — Excessive tear secretion
    Impairment of Evaporation
    Altered Blinking Rate.
- Lens Edge flare — Edge flare, ghost image if edge of CL on pupillary area ≤ is surrounded by tears.
- Contact Lens integrity — soft lenses's integrity maintained by tear fluid
- Lens spoilage & tear film — pH ↓ — Protein, ↑ — Mineral deposits
  gelatinous deposit — dry spots
  lysozyme defi — Mucinous ppts

Contact lens

close apposition to eye

vergence of eye altered

Vertex pt

7%

Magnification

Spectacles

12-13mm in front of C. vertex

vergence of rays change

13mm in front

22%

correction of irregular Astig ✓

✗ peripheral Aberration

prismatic

Bilat Aphakia ↓ bcos of Magnificat

Binocularity ✓✓

rain & fog.

cadeuse

» acceptable

female

Optics of CL

- Neutralization of Cornea.

If A = P (afocal Lens)

glass lens → fluid Lens

Ametropia. Rx { Ant — spherical Correction
Post — Residual Astigmatism.

- Correction of ametropia by CL

4 media	Air	CL	Tear	Cornea
	1	1.49	1.33	1.37

Powered L.

Afocal lenses
∝ different curvatures of surfaces of fluid lens
∝ Back Vertex power of fluid Lens in air
= front + back surface powers

∝ difference in Curvature of Ant & post surf of CL

- Power & magnification by Contact Lens

Spectacles 13 mm in front & CL at vertex
Aphakia Rx Image Mag — 7%.

- Influence of tear lens (fluid lens)

Thickness 1mm ∝ 0.12D

Plano tear lens = Base Curve of CL = k reading
+ >
− <

Power of tear lens formed = 0.05 mm diff in BC = 0.25Δ

- Effect on Acc & Conv demand

CL eliminate acc advantage of Myopic spectacles
" disadv of Hyper.

↑ req in Myopic eye
↓ Hyperm

Indications of CL

- **Optical**
  - Anisometropia
  - Unilateral Aphakia
  - High Myopia.
  - Keratoconus
  - Irregular Astigmatism
- **Therapeutic**
  - Corneal
    - Recurrent erosion
    - C. Ulcer
    - BK
    - Filamentary Keratitis
  - Iris
    - Aniridia, Coloboma. Albinism
  - glaucoma
    - drug delivery
  - Amblyopia
    - Opaque CL
  - BCL (Soft)
    - Keratoplasty., Perf
    - Operative
      - goniotomy
      - vitrectomy
      - Endo-Ocular photocoagulation
    - Cosmetic
      - Cosmetic Scleral lenses – Phisis bulbi
      - Unsightly Corneal Scars.
        - Coloured CL.
    - Occupational
      - Sportsmen.
      - Pilots
      - Actors.
- **Preventive**
  - Chemical burn.
    - To prevent Symblepharon
  - Exposure Keratitis
  - Trichiasis.
- **Diagnostic**
  - gonioscopy
  - ERG
  - goldmann 3 mirror
  - fundus photo.

Contraindications

- Mental incompetence
- Disease of lacrimal apparatus
- " " Eyelid
- " " Cornea.
- Episcleritis
- Iridocyclitis
- 7th N palsy
- Occupational Hazard.
- Dry Eye
- Allergic patients.

Designs & parameters of CL

- Diameters
  - Chord dia
    - RGP – 9–9.8 mm
    - Soft CL → 13–15 mm
  - Optic zone dia
- Curves
  - Base Curve.
  - Peripheral Curve
  - Ant Curve
    - Central
    - Intermediate
    - Peripheral
- Blend transition 1 & 2
  - Light post Curve
  - Medium
  - Heavy
- Edge of Lens
  - Edge lift.
    - PPMA > RGP
- Tint.
- Power of Lens
  - Post vertex powers in D
- Central thickness of Lens
  - geometric center of Lens
  - & Post vertex. power of Lens

Initial Patient Work up

- History
- General Ocular Exam
  - check corneal infiltration
  - Tear film
  - Blink characteristic
  - Measurement of corneal Diameter
- Refraction
- Keratometry
- Trial Lens fitting

Selecting Lens from Trial set

- Diameter — 9mm.
- Base Curve Radius — fit 'onK' — flat K.

If Astig + → steep K.

Astig
- 0.5 - 1D → + steep K
- 1-2D → steep K
- >2D → Toricity / 3 +

- Power of Trial Lens

Evaluation of Trial lens fit

a) Position of Lens

- **High ride**
  - Higher position of lower lid
  - Tight UL
  - If both — use small lens
  - Large lens or >>WTR
    Lens small or steep.
  - High minus lens
    Lenticular lens
  - Upward displacement of Optic cap
- **Decentering**
  - ATR
  - Corneal opacity
- **Low Ride**
  - Heavy
  - flat or small in dia
  - Exophthalmic eye
  - Push by UL
  - Inferiorly located Optical cap

b) Base curve determination — Tear Exchange method

c) Finalization of Overall diameter — Large — flat radius

d) Finalization of power.

(c)

Large lens = flat radius

1mm dia change = 0.01 mm radius change

(d)

Over-Refraction.

Base Curve Determination

Flat

Excessive lens movement

High/Low riding lens

Apex
Black
- Lens touching
- x tear

Intermediate
diffuse green

Peripheral
diffuse green

flat meridian
Black band

Remainder bright green

C. Abrasion
Distortion
Lens lag
Indentation near upper limbus

Steep

Little or No movement

Air bubble under surface of Lens

On spherical Cornea

Bright green
- Pooling

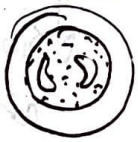
Broad black

Bright green

On Astigmatic Cornea

Bright green centre & periphery.

Black Crescent on Intermediate Z.



Problems

Burning
On blink - ↓ x exchange of tear
C. Edema
Hazy Vision

Ideal

1 ≥ 2mm acceptable

Well centered

apical Appearance faint

mid peripheral touch (Dark band)

peripheral clearance bright green.

flat
black band

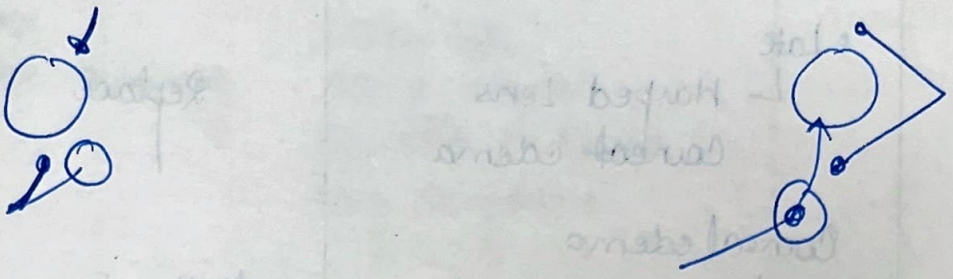
Steep - faint green pool
dark band - I.
B. green - S.

03 Post fitting Pt Mx

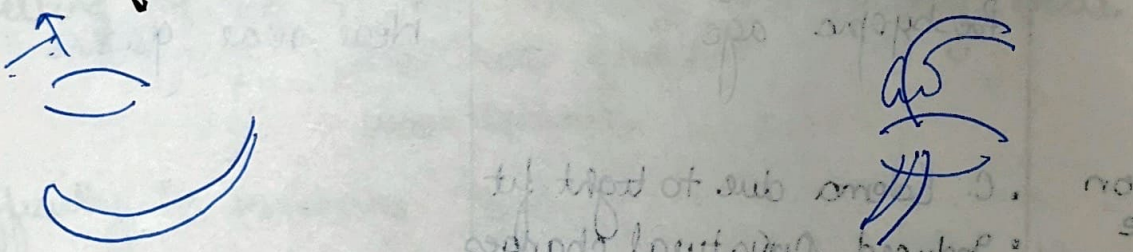
- Ordering Rigid Lenses
- Examination of ordered Lens
- Evaluation of ordered Lens fit
  - Lens position
  - L. movements
  - Fluorescein pattern.
  - Quality of vision
  - Comfort
  - Physiological response
- Educating pt
- Care of CL — clean Hand
  Treat Lens carefully
  Spotless lens
  Care — store hollow side up
  Use antiseptic wetting agent
  No sleep / shower
- Identification of R/L lens.
- Insertion & Removal tech
- Recentration of Lenses
- Normal Healing schedules
- Eye advise — x rub eyes
  blurring +nt, clean, remove
  Perseverance
  Germicidal Soaking agent
  Swimming
  check up.
- Postfit follow Up — Schedule — first after 24hrs
  - face turn, Blinking Note, Lid Shocking, Congestion of Bulbar Conj — History, VA, Inspection, Slit Lamp
  - 2 — 72
  - 3 — 1wk
  - 4 — 1mth
  - 5 — 3mth
  - 6 — 6 mth

Tech.

Inserters



Removal



Rigid Lens Problems

Problem	Causes	Remedy
• Blurred Vision at distance	◦ Excessive watering] Early ◦ Incorrect power]	
	◦ Late └ Warped Lens Corneal edema	Replace
	Corneal edema ┌ Physiological └ Mechanical	flatten lens ↓ dia steeper ↑ dia
	◦ Oily/mucous deposit	Blink Clean lenses
• Blurred vision for Near	Presbyopia < age Defective power Decentered Lens Conv insufficience	change Conv Exs
	Myope → Early Presbyope	Eff. effort
	Presbyope age	Wear near glasses
• Blurred vision when CL are removed & spectacles are worn	◦ C. Edema due to tight fit ◦ Induced Corneal changes └ Long wear	
• Inevitable awareness of presence of Lens	Damaged edges foreign matter on Lens Low grade Conjunctivitis	
• Feeling of burn, hot & scratchy eyes	Immediately — × clean Lenses ½ hr later — ill fitting Other — Inadequate blink Exposure to poor environ.	

Problem	Cause	Remedy
Feeling of Lens touching eyelids	Excessive Move^n Flat Post Curve Poor positioning	
Uncomfortable feeling in the Morning	x clean eye dirty Solution Residual C. Edema Conj Congestion.	
Tilting back of head	Excessive Move^n (flat Lens) Poor pupil Coverage	
Excessive blinking	Small lens Job in Lens Scratches in Lens	Look up in adaptive period
Milky fluid coating over lenses in the Morning	Allergic Conj Low grade Inf.	proper wetting solut^n
Swelling of lid in the evening after all day wear	Poor edge finish Loose lenses	
Difficulty in removing lens.	removal tech — faulty Too lax lids Tight fit lens	
Lenses fall out / too frequently get on white of the eye	Eye Causes — Prominent eyes. high astigmatism, excessive Watering Lens — Loose / light, small. pupillary lens, thick lens.	
Discomfort in Eye Movements	loose fitting	

Persisting photophobia	Too tight / too loose C. Edema	Sun glasses
Fluctuating Vision.	↑↑ lacrimation. Small lens.	
Better vision with changes in head posture	Poor centration.	
Watering	Mech irritation.	
Pain immediately after putting lenses	Poor tech. Foreign substance on back of Lens Improper edge	
Pain after few hours of Wear.	C. Edema. Abrasion	Re-evaluate lens fit
Severe pain 3-4h after removal of Lenses	Overwear syndrome	
Feeling of dryness	Inadequate Lacrimal secretion Hot environment	

Scleral RGPs

rest on sclera & create tear fluid vault on Cornea

Types

- Corneoscleral — 12.9 – 13.5
- Semi scleral — 13.6 – 14.9
- Miniscleral — 15 – 18
- Scleral — >18 mm

Ix

- Irregular or Abn Corneal topography
  - → KC.
  - → Corneal ectasia
  - → Traumatized eye
  - Aphakia, Micro-ophthalmos.
  - PMD
  - Keratoplasty
- ↑ R.E & fall problem.
  - ~~Severe dry Eye~~
  - Centration difficulty
  - Intolerance to Hydrogel lenses
- Therapeutic applications
  - Severe dry eyes
  - Lagophthalmos
  - Intractable keratopathy

- ✓
  - Best VA for irregular Corneas
  - Similar comfort to Soft CL.
  - Rx dry eye & Cornea issues
  - Unlimited parameter/shape
  - Only Rx in some conditions
- ✗
  - High Cost
  - Time consuming
  - Filling
  - Insertion & Removal challenges

Essential design features

Large diameter 14-20 mm.
Larger > Corneal RGP
• Completely vault cornea & limbal area
• Central Vault – 200-300μ.
• Optic Section ≤ Naf
• ↑ vault to eliminate touch
• Must wait 30 min ≤ Lens on eye for evaluation
• Peripheral curve // to Scleral Contour
• No. Impinging of vessels ≤ Landing zone.

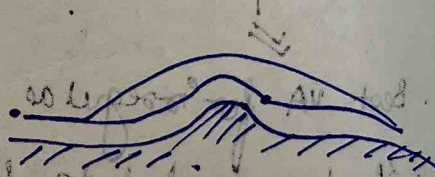
Cleaning Tips → 0.9% NaCl.

Wratten filter → gelatin paper — To check fitting

Rose K lenses fitting.

K Value	Size
Mild – Moderate K flat than 6mm	0.2mm steeper than K value
Adv 5-6mm	
Severe > 5mm	0.3mm flat

Why small OZ in Rose K



Soft Contact Lens

Initial pt work up

a) History
b) Eye Exam.
c) Refraction — Expressed in minus.
d) Keratometry — flat K.
e) Corneal diameter. — HVID — horizontal visible iris diameter.

Trial lens fitting tech

Selecting initial trial lens

1) Overall diameter — 1.5-2mm > HVID.
2) Base Curve — flat K.
   13mm 0.3 flatter than K.
   10.5mm 0.3 » flat.
   • Water Content ∝ 1/steep. flat.
3) Power of Lens — Toric or whatever

Evaluation of trial lens fit

H_2O ↑ — 10min
H_2O ↓ — 20min.

a) Evaluation of Base Curve of Lens

	Ideal	Steep	Flat
Movement of lens over Cornea	0.5-1mm.	× move.	Rapid move^{n}.
		Presence of air bubbles.	
Centering of lens over Cornea.	Well centered.		× Centering.
Effect of blinking	Vision = .	Clears.	Blurs
Compression of Bld vessels		Indentation of sclera	

	Ideal	Steep	flat
Retinoscopic Reflex	Sharp & Crisp.	Clear.	Blur.
Blink effect on Keratometer. mires	"	"	"

(b) Evaluation of diameter of lens
1-1.5mm over cornea.

(c) " " Lens power - if sees clearly.

Characteristics of Ideal fit
Maintain 0.5-1mm movement
" good centration
x Compression of conjunctival vessels
Maintain stable VA ≤ or ≤ out blink.
Sharp & Crisp. Retinoscopic reflex & K. Mires.

guidelines for change in Rigid lens
Centration → ↑ dia
Edge Compression — ↓ by flattening
Steep fit — ↓ Overall diameter & flat base.
) Change of BC x eq. power change.

Insertion & Removal → Taco Test. — To check upside do
Removal — pinch b/t. 2 hands.

Hybrid Lens

RGP centre + Silicon Hydrogel skirt (OAD) -14.5mm
↓
8.5mm

Available

Earlier
↓
Soft Peem.

Synergeyes Duette
Synergeyes UltraHealth
Synergeyes KC, A, B.

Indication

- Astigmatism
- ≤ Unstable vision ≤ soft toric CL
- RGP ≤ comfort issues
- Presbyopic pt ≤ Astig
- Soft multifocal wearers looking for better vision
- Irregular Cornea pts.

✓
Improved Comfort
↓ cost than Scleral — Irregular C.
Easier to remove
» Stable — soft toric.
✓ Presbyopia.

×
» chair time to fit
» Cost than (soft toric, RGP.)
Replacement every 6m
difficult insertion.

Insertion

- Larger plunger
- Tripod finger method.

Removal

Pinch method.

Extended Wear Lenses

Continous Wear Lenses

Classification

- Hydrogel soft Lenses
  - Low water content
    - CSI nor Hema lens — 38-45%. — Very Thin. — $>D_k$ perm — Ripples on lens — Handling difficult
    - B & L — Ultra Thin Membs.
  - Medium water Content
    - Hydrocurve — Hema. — 45-60%.
    - Soft Con + Povidone
  - High water content
    - Permo Lens — Hema-VP + MA — >60%. — become thick — $>D_k$. — Thick $\propto$ Durability $\propto \frac{1}{H_2O}$ Conten
    - Saufton Lens
- RGP lenses
  - Aphakic lens.
  - Plano/Low power Lens
    - Aphakic
    - Myopic
    - Therapeuti

Hydrogel Soft Lenses

Indications

- Elderly aphakic
- younger pt.] ↓ handling
- x Compliance to routine
- Profession ≤ irregular working shifts
- habitual of falling asleep.
- Habitual overwearer.

Fitting

Tendency for loose

BC - 8-9 mm

OVA - 13.5 - 14.5 mm

Follow Up

1st — 24-48h

every 2-3 mth

Problems

» Soft CL problems

»

- Lens deposit
- Infectious keratitis
- Corneal Vascularization.

Light Lens Syndrome

Painful red eye + Immobile lens

AC - cells, flare.

RGP lenses

⇒ If problem then ↓

- Metabolic problem
- Visual problem.
- Allergic problem.
- SLKC
- » Thick lens — ↑ power + lens

Toric Bifocal

Bigger diameter.

» DK ~> 90

- Alignment fit ≤ minimal bearing
- Wide edge ≤ clearance >70μ
- Rounded edge.

Overnight removal every 5 night

Day 1 — 9am

1wk → 2wk → 1mth

every 3mth

Look for —

- Persistent stease
- 3-9 staining
- Back surface debris
- Lens binding, arcuate stain & indentation
- Microcyst

Adhesion phenomenon. » DK value

Steep Lenses

Thin Lenses

3-9 staining — Low riding L.

Thick edge L.

Partial Blinkers.

∴ Complete blink.

Rigid

Advantages

- Better Quality of vision
- More durable
- Correct moderate amt of Astig
  L ↑ amt of tears
- Deposit resistant
- ↓ infection risk.
- Can be modified in office
- Can be used in dry eye & tear film irregularity
- ↓ Cost
- Easy handling

Disadvantages

- ↓ Comfort
- Irregular schedule of wearing — problem
- Spectacle blur ✓
- Dislodge »

Soft

Advantages

- Comfortable to wear
- Easy to adapt
- ↓ wearing issue ∴ intermittent use ✓
- × Spectacle blur
- Large » tight fit ∴ ↓ frequently dislodged.

Disadvantages

- Variable vision
- ↓ durable
- × Correct vision
- » deposit issue
- » Conceal infection
- × Modified in office
- × in tear film abn
- » Costly & difficult to handle.

Rigid

More Exacting
" Time Consuming

Fitting

Soft

Wearing Comfort »

Crisper vision
» Toricity &

» & easy to handle

Optical Quality.

↓ by hydration, dehydration & flexure

Lens durability

Change of Lens parameters

after yrs ↙ Dehydrated steep fit

↓

Trap debris — Red eye

Lens deposits »

» O_2 performance

Reproducibility ✓ ✗

Adhesion phenomenon.

3-9 staining.

Other Complications

Infectious keratitis 1
GPC 2%
Acute Red eye 0%

21
5-30%
4-15%.

CL in Astigmatism

- Soft
  - Spherical
  - Toric.
- Rgp.
  - Spherical
    - >4D.
  - Toric peripheral curves
    - 1.5 - 2.5D.
  - Bitoric.
    - >2.5D.
    - ≤ Tear film ↓ induced A.
    - Quick fitting
  - Front surface.
    - Toric.
      - for residual A.
      - Prism Blast
      - Truncated. Lens.

Soft

- Spherical
- Toric
  - stabilized by -:
    - Double slab off Lenses
    - Prism Blasting
    - Truncation
    - Aspheric back surface.

CL in Aphakia

- RGP
  - Single Cut
    - Small Lenses to be fitted
  - Large Lenticular Cut.
    - → ↑x then ↑.
    - Central OZ.
    - Peripheral thinner flange.
- Soft
  - EW type
  - Elderly & kids.
  - Lathe cut lenticular design.
    - ↓ chances of Mucobial K.

CL fitting in Keratoconus

Ideal fit

3 point Touch
No excessive tear/debris pooling in. OZ.
Good Circulation of tear
" stability & comfort.
Mid & High DK Lenses

Options

- RGPs
- Soft CL
- Hybrid lens system.
- Scleral RGP
- Piggyback Lenses.

RGP

Philosphy

- 3point touch design.
  - Min Apical clearance
  - Min area of touch in mid periphery.
  - Adequate edge clearance

  Small central cones

- Apical clearance (steep fit)
  - ↓ taring to apex

  Small dia, small OZ.
  Small cones

  × Sagging Oval/globus
  Poor tear film; C.Edema
  Poor VA.

  Special lenses
  - ✓✓ Cones ≤ Central apex or displaced apex ≤ 8.
    slightly inf to VA.

- Apical bearing (flat fit)

  Large dia 9-9.8 mm

  ✓ Good vision
  × Progression of ectasia
  ✓ displaced cones

~~Soft Lenses~~ Special Lenses for KC

- Rose K1.
  - Light apical touch ≤ optimal peripheral clearance
  - Multispherical post design ≤ aberrat" central Asp. optics
    - a → Spheric
    - b – Small OZ.
- Rose K2.
  - To Control
    - Spherical aberration
      - a) Aspheric ∴ control SA in high (–) lenses
      - b) Large OZ ∴ × glare
    - Small OZ.
- Sopa's tech.
  - 2 post curve
  - L Central cone
  - L Normal cornea over apex.
  - like Hat.
    - Peripheral alignment
    - Apical clearance
      - 3 diff fitting → OZ 6 / 7 \ 8
- MC. Guine.
  - Oval & advanced cone.
  - ↓ feathery touch
  - ↓ 4 peripheral curves.

Hybrid Lens

RGP central portion & Soft lens skirt.

- Soft Perm. Lens.
  - RGP Lens intolerance
  - displaced Corneal apex.
  - ✓✓
  - Better Comfort – " Correlation & VA.
    - Comfort → Soft
    - VA → RGP.
- Synergeyes
  - FDA approved
    - Synergeyes
    - Clear-Kone.
  - (×)
    - → Breakage
    - L GPC
    - L Corneal NV.

Scleral Lys

✓✓ — Advanced KC. → corneal lenses × work.
C.Sx → C/I.

Boston Scleral Lens prosthetic device

18-23 mm dia.
rests entirely on Sclera. ∴ arches over cornea
∴ space filled ⊆ tears ∴ → masks distorted cornea
topography & improves vision

Liquid Bandage — . × desiccation.
fraction of blinking

Piggyback

Rigid ↷ Soft.

Based on degree of KC

- **Mild** < 45D
  - Aspheric
  - Kera I & II
  - Acuity K.
  - Rose K.
- **Moderate** 45-52D
  - Kera II
  - Quasar KN07
  - Rose K.
  - Woodward KCS.
- **Advanced** 53-62D
  - Kera II/III
  - Rose K.
  - Profile K.
- **Severe** >62D
  - Small dia. lenses
  - S-Lim
  - Dyna Intralimbal
  - Scleral Lens
  - Gas permeable.

Soft Lenses

↓ role for Corneal irregularities

- Silicon Hydrogel
  - B&L — Pure Vision
- Custom toric Soft Lenses
  - Kera Soft
  - Soft K
  - ✓ → Early KC
  - Intolerant to RGP

(x)

C. Edema.

NV → if overwon.

Therapeutic Contact Lenses / BCL.

Use

- Provide mech support.
- facilitate Wound healing
- Help maintain proper hydration
- ↓ discomfort from Corneal surf disorder.
- act as drug delivery system.

Types

↑ Water Content
Thick Lenses

- Descemetocele for support.
- ABK, PBK
- Co-existent Corneal & Ant Seg inflamm.

Moderate
Intermediate

Low
Ultrathin
Membrane

- Relatively dry eyes
- Minimal le movem seq.

Commercially available

Hydrogel — Plano T.
Plano O_4.

Soft Con EW.
Peema Lens.

IX

- Dry Eyes
- Neuroparalytic Corneas
  - ✓ Epitheliotrou
  - × Symblepharon
- As keratoplasty splint -
- As protective lens - drying, eyelash rubbing
- As BCL
- BK.
- Corneal dystrophy
- Drug delivery system
  - Post CSR

Collagen Shields

- Biodegradable therapeutic CL
- Made of Pig skin
- Last 12 - 72hrs
- Used for drug delivery
  protect cornea

Cosmetic Soft Lenses — CIBA vision, Coopervision

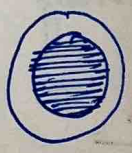
Tented/painted lens used to enhance or alter the appearance of a normal eye.

» soft (Hydrogel)

Essential Measurements –:
- HVID → Horizontal Visible Iris Diameter
- Pupil dia
- VA
- Others.

Ix
- Disfigured Corneas
- Vision disturbing conditions
- Occlusion Rx
- Change colour of eyes

Types
- Iris painted centre clear
- Iris painted centre opaque.

Block pupil lens	Clear edge ≤ light brown tint	Clear pupil & clear edge ≤ dark brown iris	Lens ≤ black pupil & brown iris
			
Occlusion Ant Supp. Non Op Cataract	Cosmetic enhancement	Albinism. Photophobia Post Sx glaucoma.	Corneal disfigurement Scarring decentered pupil.

Always go for large pupil dia.

Care & Maintainence — Cl releasing agents & H_2O_2.

Problems & Mx — Toxic effects

— Corneal Edema.

— Other problems

Pathogenesis	Clinical feature	Rx
a) Epithelial edema Hypoxia of Epithelium.	Earliest change » Soft Lenses EHL's fine dots of variable density ↓. Cogan Dysteophy	=
b) Epithelial Microcysts. ↓ Metabolism.		
c) Corneal Abrasions. Mech Injury. Traumatic insertion/removal Embedded f.b.	Pain, redness, H_2O ring confirmed by fluorescein.	Remove lens Switch over lens. EHL – daily daily – RGP. Topical Ab ↓ Wearing schedule
d) SPKs. • Mech injury • chemical toxicity Saline H_2O_2 Improper rinsing • Associated Ext diseases		• Discontinue CL • Lubricating drops • Ointment
e) 3 & 9 O clock staining Dessicatrou of Cornea Interruptrou of tear flow.	» RGP. Poor lens fit " movem. low riding lens poor blinking	Refit ⊆ large diamter change of lens design. improvement of blinking freq use of eye lubricants.

Complications of Contact Lens Wearers.

Pathogenesis

Sterile Corneal Infiltrates.

Inflamm response to specific Ag

↓

C. Infiltrat^n of WBC from L. vessels.

Preservatives — Ag source

Corneal NeoVascularization

Tight Lens → Excessive deposit

↓

Hypoxia.

Microbial Keratitis

Hypoxia / Trauma + Contamination

↓

Epithelial defect

Predisp — Poor hygiene.

- Inadeq. Lens disinfect^n.
- Contaminated Lens Cases
- Lens Care Solutions
- Swimming
- Associated Dry Eyes

Organism
- Pseudomonas
- Acanthameba.

Clinical features

Small peripheral opacities

Epi / Subepi / Ant stroma

May be early Manifestation.

Various levels

Small, Sup » Common.

>2mm of progressive Vascular ingrowth

Bact — Pain.

Ulcer ± Thick adherent discharge

Pseudo — Wide area of stromal edema ± ring infiltrate + hypopyon.

Acanthamoeba ← Home made Saline
← Swimming
← Exposure to Tap H_2O

Early
- Pain out of ::
- Irreg in Epi
- Patchy stromal

Late
- Ring stromal infiltr
- Radial keratoneuritis
- New branching

Treatment.

Discontinue CL

Careful fitting

Regular follow up.

↑ O_2 transmission lenses.

Discontinuation of CL.

Overnight wear avoided

Early Warning signs

Pathogenesis	C/f.	Treatment
Corneal Warping Chronic hypoxia. Corneal Endothelial changes 2° to hypoxia. → Lactate Accum. → ↑ CO_2. → ↓ pH.	Severe & permanent astigmatism. Bleb response. Polymega / Mosphum	Daily wear lenses > SWL RGP > Rigid PMMA.

CONJUNCTIVAL PROBLEMS

Allergic Conjunctivitis Thiomersal containing CL. solutions	Redness, burning Conj. hyperaemia. Papillary C. rxn.	× Thiomersal Diluted. steroid eyedrops.
Giant Papillary Conjunctivitis Immunological Origin. └ CL deposit = protein – Allergens » Risk in Asthma, hay fever.	Itching, ↑ mucous production in morning, ↓ lens tolerance Cobblestone like giant papillae on Upper palpebral conj.	Proper lens fit frequent use of Enzyme cleaners. Regular replacement of Lens ✓ → Topical steroid

Pathogenesis

Superior Limbic KC.
HST to thiomersal

Dx

- Bilateral & Asymmetrical
- F.b sensation, Redness, CL. Intolerance

inflammation & hypertrophy of superior bulbar conj.
Punctate staining
Micropannus on Sup. Cornea.
fine papillary rxn to superior Tarsal conj

Tx

- Discontinue
- Lubricant drop.
- Use non preserved saline
- perform frequent lens cleaning.

CONTACT LENS RELATED PROBLEMS

- Physical damage to Lens.
- Discolouration of Lens.
- Lens Loss.
- Lens deposit.

- Chipping #.

- fluorescein.
- PE.
- Use of Rifampicin.

» Children.
» Hard
» EWL.

In CL solution — 1SO std — 3 bact

Pseudo. Aeruginosa
Serratia Marcescens
Staph aureus

2 fungus

Candida Albicans
Fusarium Solani

Lens deposits

Increasing freq → EWL > Daily wear Soft Lenses > RGP > Hard

Pathogenesis – Originate from Tear layer, lens handling, cosmetics, topically instilled drugs, atmosphere pollutants.

factors –:
- Personal hygiene
- Defects on lens surface
- CL case regime
- Ass ocular disease like blepharitis

Types
- Protein.
- Lipid

Effect of Lens deposit

Physical / Lens damage
Physiological effect – diffusion of gases
Optical effect – Hazy halo, polyopia
Toxic effect –
Infective
Allergic.

DWL – Replace every 6mth
EWL – every 3 mth.

Aberration of Eye

Def Optical aberrations refer to specific defects in optical system that diminish resolution of an image.

All forms of deviations (refractive errors) are basically aberration.

Classification

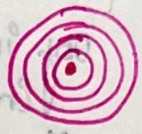
Lower order (LOA)	Higher Order (HOA)
85%.	3%.
Easily studied	limits visual acuity
Corrected by LASIK.	× easily corrected
• Myopia.	• Spherical Aberration
• Hypermetropia.	• Chromatic
• Regular Astigmatism	• Coma
• Tilt of prism.	• Decentering
• Defocus.	• Oblique
• Astigmatic aberration	• Curling

Impact VA of retina 6/2 – 6/1.5 which is reduced to 6/6 by diffraction of light & aberration of eye.

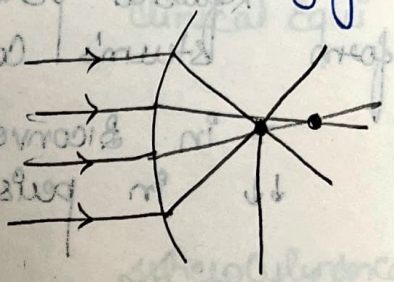
Ways to Analyse

Ray	Wave.
Based on Snell's law.	⊥ to direction of light

a) Diffraction of light → Bending of light caused by edge of an aperture or rim of a lens
∴ Perfect lens not able to focus light to a point due to diffraction.
↓
The actual pattern is concentric bright & dark rings. & at centre is Airy disc (~~dark~~ bright spot)
2mm pupil — dia of spot = 0.01mm.
Optimal VA at. 3-4mm pupil size. ✓
diffraction blur ↑ c small size of pupil.

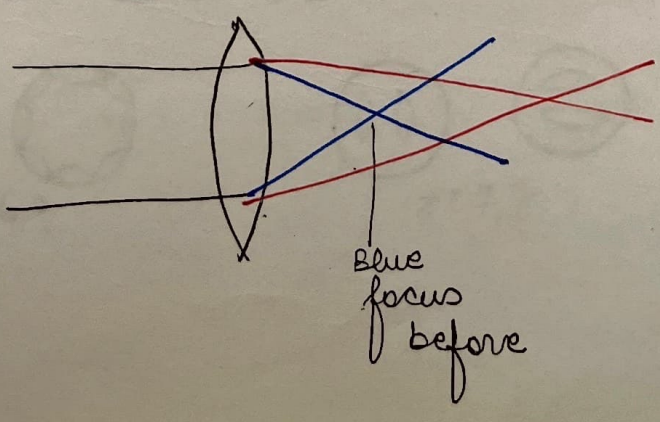


b) Spherical aberration — Peripheral rays refracted more steongly than centre
- factors in eye to ↓ SA → Peculiar curvature of cornea (flatter in Periphery)
- Peculiar str of lens — Central portion » dense
- Iris blocks peripheral rays ∴ refraction of paraaxial rays of light occurs



(c) Chromatic Aberration →
Refractive index ∝ λ of light. i.e blue focused in front of red
Emmetropic eye is hypermetropic for red rays
myopic for green & blue λ.
Basis of duochrome test.

Natural correction Mech
1) Narrow spectral sensitivity bands of long & mid wavelength cones
2) Fovea lacking in blue cones
3) Rays of greatest intensity form sharply defined image (yellow).

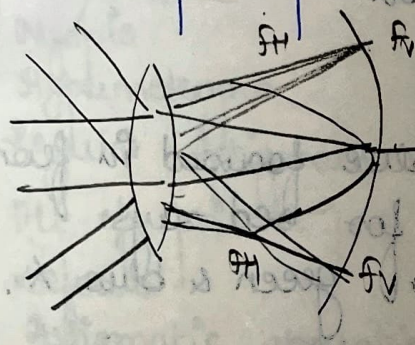


Decentering – Lens & cornea not surfaced on common axis
Centre of curvature of cornea = 0.25mm below axis of lens.

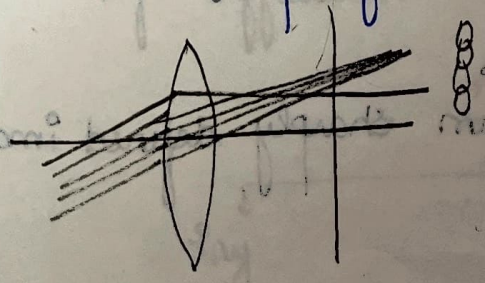
Oblique Obj in peripheral field are seen by virtue of obliquely incident narrow pencil of rays. which is limited by pupil.

↓
Refracted pencil show oblique Astigmatism. Oblique rays form Sturm's conoid ∴ 2 focal lines.

» in Biconvex & Biconcave lens
↓↓ in periscopic or meniscus lenses.



Coma → different areas of lens will form foci in planes other than chief focus.



Zernicke's Polynomial & Z. terms

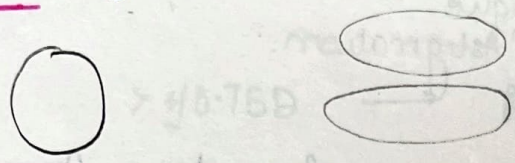
Monochromatic aberrations are defined in terms of Z. polynomial

Pupil Size	ZP
3mm	upto 4th Order ZP
7.3mm	5-8th Orders

Z. Polynomial – Mathematical formula that expres shape of indivi Aberrat
Z. coefficients – Amt of each aberration +nt

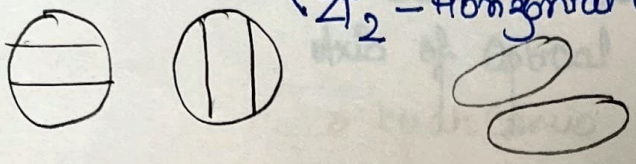
Z_0 Zero Order ZT_0 — Piston Error — x significance

C_0



1st Order (C_1) — Tilt { ZT_1 — Vertical tilt; ZT_2 — Horizontal tilt

Prism. is clinical equi



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2nd Order $C_{2.0}$

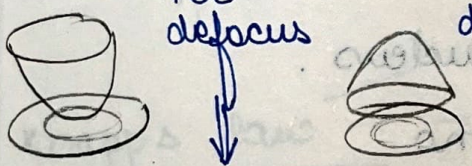
ZT_3 — Oblique Astigmatism
4 — defocus – spherical correction
5 — Astigmatism.

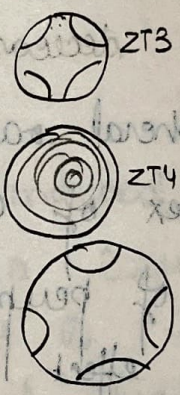
spherocylindrical correction of refr errs

defocus combined ± piston

+ve defocus → Myopia

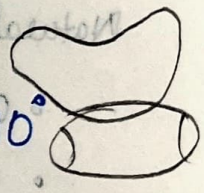
neg defocus → Hyperopia





$C_{2.2}$ → ZT5
Astig at 0 & 90°

JCC (Jackson Cross Cylinder)



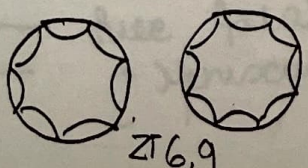
3rd Order

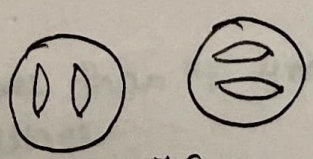
40%

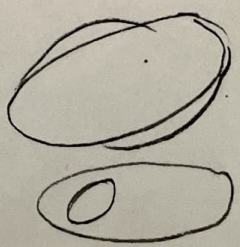
ZT 6,9 — Trefoil
ZT 7,8 — Coma.

$C_{3.1}$ — Coma + Tilt

Decentered grafts & ablations.





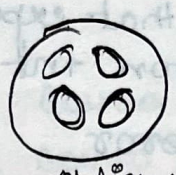


Fourth Order → ZT 10,14 — Quadrifoil.
25%
ZT 11,12,13 → Spherical aberration

C_4 — Spherical + Defocus + Piston.
Seen in Oblate corneas

2nd Order.

Z 10,14



oblique
2° Astigmatism.

Spherical aberration.

9th Order
30%.

ZT 15-20 —— Secondary Coma.

Natural mechanism to decrease aberrations →

- Cutting off peripheral rays by iris
- ↑ refractive index of core of nucleus.
- ↓ sensitivity of peripheral retina
- Stiles Crawford effect → ↑ sensitivity of retina to ⊥ rays than oblique rays
  - ↳ out of self apodizing mechanism.

Refraction Qts

WTR + at 90°
- at 180°

Mixed Astig — Cylinder > sphere.
But if has to make — Cylinder in Minus as easy to grind.

> ±0.75D ⟶ Asthenopia.

Stenopic slit → gives Principal axis
Scaled Cornea
Axis of Optical iridectomy
» Keratoconus pt (E or T charts)

•) Types of Bifocal
Round seg +
D −
C −
Executive ~~Kodak~~

Knapp's law — Applies to induced Aniseikonia
— when a correcting lens is so placed before eye that is F_2 (2nd principal plane) co-incide ≅ Ant focal pt of axially ametropic eye, the size of Retinal Image will be same as though the eye were emmetropic

— Pure Axial
— + Meniscus — closer than 14 4m Convex
— − farther.

Disadvantages

- High Cost
- Fitting Time Consuming
- Insertion & Removal challenges

Ideal fit – Peripheral Curve // to scleral Contour small vessels should not be pinched Try to avoid impingement.

CONTACT LENS

Scleral Rigid Gas Permeable Lenses

Rest over Sclera & create tear vaulte over cornea
O_2 permeable polymer.

Types

- Conco scleral lenses → 12.9 – 13.5 mm
- Semiscleral lenses → 13.6 mm – 14.9 mm.
- Mini Scleral → 15–18 mm.
- Scleral lenses → >18 mm.

Ix

- Irregular astigmatism. ≤ Abn. Corneal topography
  - KC
  - Traumatized eye.
  - Post Refractive Sx. ectasia.
  - Aniridia.
  - Micro-ophthalmos.
  - Neurotrophic Keratitis
  - PMD
- ↑ Refractive errors.
  - Centration difficulty
  - Intolerance to RGP or Hydrogel lenses
- Rx application
  - Severe dry Eye Condition.
  - Lagophthalmos
  - Intractable Trichiasis.

Advantages

- BCVA for Irregular Cornea
- Better to soft CL
- Treats Severe dry eye & Cornea issues
- Unlimited Parameters

Snellen

9 optotypes CDEF LOP TZ

6/12 → Cut off for screening

Snellen		LogMAR
Variable no. of letters in each line		Same no. of letters in each line
Non Uniform	Progression of letter size	Uniform
Variable	Legibility of letters	Similar
↓ accurate	grading scale	fine
↓ accurate.	In LV pt	» accurate

LogMAR

Sloan letter — CDK HNO RSVZ.

ETDRS — modificat^{n} of Bailey love charts
↓
5 letters

Ferry's ETDRS — NAS (National Research Council)
10 letters

14 lines — 6 lines

20/VA — 10/VA — 5/VA

Toric IOL

Shimizu — 1994 — 1st toric — non foldable 3 piece IOL PMMA.

Ix Regular Astigmatism (good vision
× Ocular pathology)

Calculatn — Accurate keratometry
SIA & size of incision

Technique

Marking

Pre-Op
- Upright position — To correct Cyclotorsion.
- Bubble Marker
  - Nutts/Lane Toric ref marker
- Gravity marker & Calibrated horizontal position.

Intra-Op
- Toric Axis Marker
- Newer
  - Iris fingerprinting tech
  - Intra-op Wavefront aberrometry
  - Verion image guided system
  - Real time eye tracking SG 3000

Types

Acrylic
- phobic
  - Acrysof (Alcon) 2005 approved
- philic
  - T flex (Rayner)
  - Acri Comfort (Zeiss).
    - Ankoad toric
    - Zeis toric

Silicone
- STAAR — Staar Surgical Co.
  - 1st FDA approved 1998.

Design

Acrysof
Open loop - single piece
Acrylic polymer
L shaped haptic.
Posterior surf - power

STAAR — 1st toric
plate haptic 1 piece
Silicon. oval mark & large positioning hole ∴ AC & PC fuse. ↓ rotation

Power

0-30 D. spherical
7 cylindrical model

2 Cylindrical power
2 D — 8.5 D
Corneal correct 1.4 D 2.3 D.

Dimension

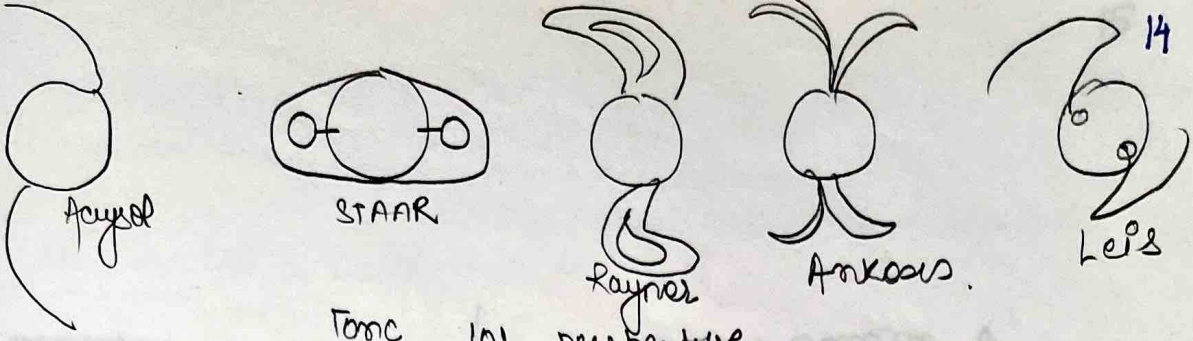
6 mm ⌀ = 13 mm

⌀ ↕ 10.8 — 11.2

MOA

Biomaterial adheres to Capsular Bag — single layer of Epi cells ∴ adherence

Side Holes where PC & AC fuse.



Toric IOL perspective

a) Rotational stability — 10° misalignment — ↓ efficacy 33%.

- IOL material
  - phobic
    - ↑ adhesion property
    - ↓ fibronectin +
  - > philic
  - > PMMA
  - > silicon.
- IOL design
  - dia – 11-13mm
  - ↓ rotation ✓✓

b) Optical effects —

rotates	Astig
30°	↑.
15°	½ effect of IOL
10°	⅓ lost.
3°	10% Loss.

>10° — realignment req, ≤ in 2wks shd be done.

Toric vs OCCI

Toric better → ↓ Option of reversibility ✓

(*) has to be hydrophobic as philic – rotate.

Accomodative IOL + Toric — FDA 2013

— Trulign Toric IOL.

Accomodative IOL :

Helmholtz theory of accomodation
- N&D. vision
- haptic flex
- Material expand & contract in Capsular bag.

CB contract → Zo & Zo. → piston like motion of Ant vitreous

Ant movement of optic 0.5-1D. Amplitude

Treatment of Presbyopia.

✓ ✗

90% — 6/9 — 6/12. J3

Driving.

Reading newspapers

Quality of vision good.

MF
- CS
- CP
- Halos

] × Issues

Blended vision Concept

1 eye → Myopic
Other eye → Emmetropic

✓ — NV, DV, IV
Stereopsis at all distance
× Night vision syndrome

- Single Optic
- Dual Optic
  - High + Ant
  - Post. −
  - seperated by spring like haptics
    - Non acc
      - Tension in Capsular bag & Zonule keep in proximity collapsed
    - Acc
      - Zonules — relax
      - CBag — expand
      - Spring — Kinetic Energy
      - ∴ + moves forward

Synchony
- Zaltaroz
- elliptical

Single Optic

∝ CM (Ciliary mus) contraction → ↑ Vit. Pre → lens forward

Release Zonule tension → Allowing bag to press upon haptics

0.6 mm movement = 1D. acc at spectacle plane

— ## Crystalens / Kelman Tetraflex.

Crystalens (B & L)	Medennium Smart IOL	Kelman Tetraflex IOL
4.5mm aspheric monofocal IOL.	H.phobic ≤ unique thermoplastic properties	5.75 mm square edge.
Long hinged plate haptics ≤ polyamide loops at ends	Temp induced changes	thru 2 mm inc
+1.5D add for near vision.	Bonding wax + Acrylic polymers	Poly HEMA 26% Water
In ∝ CM action (∵ age factor)	Smart material (Solid at room temp)	x hinges
	In Eye — Semisoft. gel. polymer	Angulated forward
		Pubay 4mm Bag
		Index of Vit. Press more ≤ entire bag
		Ateopinization x

Visiogen Synchrony — Helmholz theory

CM relax → ∝ tense → Capsular Bag taut → Compresses ∝ optics together

contract — ∴ relax

Silicone, Single piece

Refractive IOL — Bull's Eye

↓

Diff IOL — 3M diffractive

↓

foldable — AMO array

↓

Rezoom

Array		Rezoom
50	dist	60
37	N	40
15	I	

1,3,5 — Modified Dis

2,4 — Medi

Glare

↓ Halos

↓

Pupil dependant —

Triple edge design — Rounded anterior edge — ↓ Int reflex

Sloping edge design — ↓ glare

Square post edge — 360° Capsule contact

Extended depth of focus IOL.

2 Tech.

- Diffractive Optic design. That extends the length of focus → Multifocal.
- Achromatic technology that corrects Chromatic abberation. → = extended depth of focus IOL.

Technis – Symfony EDOF IOL ZXR00

UV blocking, hydrophobic acylic Biconcavex

Ant – Aspheric
Post – Apchromatic diffractive surface ≤ 6mm optic diameter

- Optic → Pro TEC frosted. Continous 360° post square edge design.
- Haptic → C loop.

13mm

Power +5 → +34D.
0.5 ↑

Multifocal.

Rely on eye's ability to select clear image from 2 or > unfocused images

2 types

Refractive Optics

↓

Bull's Eye design. Lenses

↓

Concentric zone philosphy.

↓

Two zone Lenses

Bifocal IOL

- 2mm near vision → As pupil constricts
- 4mm distant vision

(x)

- Bright light – distant seg blocked
- Outdoor sports can't be enjoyed.

Bull's Eye IOLAB

Dependant

3 zone Bull's Eye.

Annulus type or Bull's eye

In centre also near & distance

∴ not affected by pupillary constriction

(x)

Reading in bright light blocks add portion.

∴ clear near vision.

Pupil

Diffractive optics

Principle of wavefront optics of light

Convex Ant. — 25 concentric annular cut

Step Ht = range of λ of light

82% light

- 41% in phase for dist
- 41% in phase for near
- 18% lost

(✓)

Optical effect is at all points ∴ decentred, eccentric pupil × effect

(x)

- Intermediate vision compromised
- Glare & haloes
- Contrast & Scotopic vision compromised
- 60:40 dist : near distribution.

3M diffractive

Independant

Acri Twin

Rayoptix

Rezoom

ReZiol

Modifications

- Glass — Ht & spacing of diffractive rings ↓ II Zeiss
  — Rings made of smooth rounded edges (AT LISA)
- Night vision / driving — ½ optic diffractive lenses (3mm diffe zone) RESTOR.

Wavefront design modified prolate

- Full optic ⊿L → Technis AMO — N+⊿ — Restore
- Apodization — sloping of diffractive rings from centre to periphery ∴ good intermediate vision. (Intermediate Vision)

slope ∝ periphery

- ↑ DIFF Plus → Acrilic.
- AcriDiff (Trifocal) → hydrophobic

✓ Both near & far. (↓ optical performance)

✗

- Reduced light Intensity — ½
  Bull's eye diff.
  ↓ Intensity ∝ bt ½ of total
  ↓ for N/D.
- Reduced CS — Need brighter light ↓ fxn in dim light.
- Off Axis abberation — ∝ diffractn.
- Perception of rings.

⇓

✓ RESTOR — Alcon.
Restorm — AMO.

Multifocal + Apodiz ⟶ Trifocal

L –
I –
S – Restor — 3.6mm central 12 conc steps 1.3–0.2μ
A – Apodization → appropriate light on retina.
Larger — near
distant

Blue blocking IOL:

Normal human lens turns yellow
↓
Oxidation of tryptophan.
Glycosylatn of Lens protein
] abs of Blue ↑
↓
∴ ↑ damage

Blue light (200-550nm) — Lipofuscin containing RPE damaged
↓
ARMD.

Eg — Acrysof SN60 AT — Hydroxy Benzophenone
" Benzotriazoles

↑ → ↓. Night vision as blue required for Scotopic vision.

(6)

Future IOL design

- light adjustable
- Electro-optic diffractive
- Injectable gel

Smart yellow IOLs

Photochromic Lense

- UV near blue absorption curve but only in photopic conditions
- clear lens in Mesopic/scotopic condition

Made of hydrophobic Acrylic material

Piggyback IOL

↓ AL ∵ strong IOL $AL \propto \frac{1}{IOL} \propto \frac{1}{\text{Spheric}} \propto$ Image Quality

∴ 2 lenses better Image

∴ for short & nanophthalmic eyes

Piggyback – (Minus) ⇒ Long AL
↑ Corneal Astigmatism

↓ Stage → 2 times in 2° IOL in ciliary sulcus

Piggy better than Replacement bcos :-

1) Power of IOL based on post op Refraction
2) Surgeon not sure of plane
3) 1st IOL power calculation irrelevant
4) Piggy + ↓ power ∴ Less changes in vergence distance
5) ↑ depth of focus

Implantable Miniature Telescope

Vision Care Ophthalmic technologies
Late stage of ARMD

2 gen — wide ∠ version — Larger view of central visual field

2 parts

Pure glass optical cylinder.
↓
wide ∠ microtelescope
×2·2
×3
52-60° of central retina

Carrying device for implantation (Bio-Compatible)
↓
clear carrier → C loops
blue light resteichor

2-3mm from C. Endothelium

Rx

Glaucoma Rx
Painted Contact Lens
Lubricants
Cataract Dx
Prosthetic eyes
USG Transplant
L.E, Amblyopia, Squint

Ix

Sporadic Aniridia — Abd USG every 3mth ↑ 5yrs
6mth ↑ 10yrs
1yr ↑ 16yrs

to detect Wilm's tumour.

Aniridia

Purpose – To cover defects of aniridia or ½ loss in cases of trauma.

- ½. → ring ≤ 1 black segment
- iris damage
- complete. → Multi-segment ring

Genetics – Abnormal neuroectodermal dev 2° to PAX6 mutation. PAX6 close to WT1

- AD.
  - 2/3 rd.
  - complete penetrance.
  - Variable expression.
- Sporadic.
  - WARG
  - Miller syndrome
  - 1/3.
  - 30% chance ⇓ Wilms
- Gillespie Syndrome
  - 1%.
  - AR.
  - x PAX6
  - Cerebellar Ataxia
  - Mental Handicap.

C/F

Symptoms – At birth ≤ Nystagmus, photophobia.

Signs – Aniridia » seteo.
- Lids – MGD
- Cornea – Tear film. LSCD.
- Lens – Cataractous, subluxation
- Fundus – Coloboma, hypoplasia.
- Gonio – Rudimentary iris
- Glaucoma – Synechial ACG.

Iris supported PCIOLs

Retro iris fixated.
Iris claw lens

↓ Endo loss
+ID > than ACIOL

Tech Same as ACIOL
IOL fix → 2 forceps & IRG canula (for iris tissue excavation

Sutureless iris fixated.
Bindeflex PCIOL

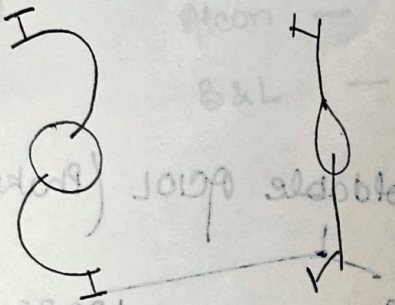
- 6mm
- 15 mm
- C shaped 0.4 mm thick
- 12° angulation
- T shaped anchor

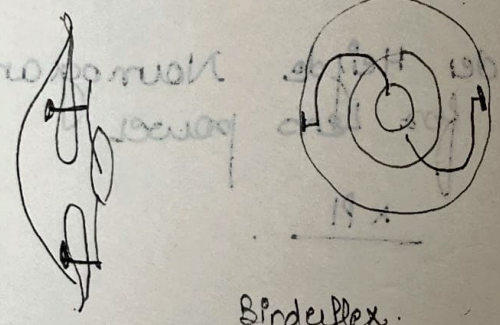
PMMA · Philic acrylic

Tech

1-5
Paracentesis at 3 & 9 O clock ≤ 15° MVR blade
SC or CC tunnel made
PI at 3 & 9 made ≤ vitrectomy machine
Implantation of B. IOL
Removal of OVD

✓ Sutureless Tech
Stable & well centred IOL
Good optical properties of IOL
Simple Tech





Bindeflex.

~~Intra Lens~~

~~Shinagawa — 1994.~~

~~Non foldable 3 piece Tonis IOL made from PMMA.~~

ACIOLs

Angle supported.

Kelman Multiflex.

Tech
- Ant vitrectomy (PPV / limbal)
- Pupil is constructed.
- PI done
- OVD
- Valvular SC Incision 5.5 mm
- Lens glide may be used.
- IOL inserted.
- Remove OVD.
- Incision - sutured

✓
- Easy to implant
- old pt ≤ × gla ≤ good Endo.
- In Bleeding disorder

×
- Shallow AC.
- Ab abn of AC.
- Decompensated cornea
- PBK.
- CME
- UGH.

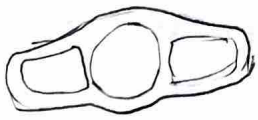
Iris Supported.

Singh & Worst.

Plano Convex lens

↕ 4.25 mm ↕ 7.25 mm

- Progressive Loss of Endothelium
- Other complications



Modern ACIOL
- Vaulting
- Sizing
- Haptic design by choice
- Point fixation
- finishing
- Easy to remove

foldable ACIOL (Phakic IOL)

Vivarte | ICARE.

Van der Heijde Nomogram for lens power

× PI

Aspheric Lens

To reduce Spherical aberations (SA)

// rays do not focus at 1 pt

In front – ⊕ SA — Cornea. — in young] Compensate

Behind ⊖ — Lens

but ⊆ age ⊕ overall ↓ Contrast Sensitivity

Spherical	Aspheric
⊕ SA	
↓ CS under Mesopic Scotopic	> CS under ↓ luminance ↑ spatial freq.
	> Night driving performance
Decentration >0.5mm	∱xn vision ↓

Eg

AMO – Technis

Alcon – Acrysof IQ.

B&L – Akreos AO.

Foldable IOL / Ultrathin IOLs

- Acrismart
- Ultra Choice 1.0 Foldable thin lens
- Modennium Smart Lens
- Slimflex Lens
- Acri Flex MICS
- CaseFlex IOL
- Superflex

Based on Focality

- Monofocal — depending upon power
- Multifocal — distance & near. — several focus area — AT LISA, RESTOR.
- Pseudoacc — Apodization, Ant — Refractive — RESTOR
  - Post — Diffractive
- Accomo
  - ant movement of optic to improve near vision — Crystalens
- Extended depth of focus — Elongated focus area — Technis Symphony.

PRL

B/t cornea & crystalline lens.

- IC sulcus fixated.
  - ICL
  - PRL
- Angle supported. Long haptics
  - NUVITA MA20
- Iris supported
  - Artisan

Material	Characteristic.	Names	✓	✗
Rigid PMMA	Rigid. chemically stable ↑ Index of refraction. Spgr = 1.2 = neutral B.		↑ optical quality Large optical centre Poor biocompatibility Possibility of surf. modificat° good Laser resistance	Large incision Hound × AC. Mild f°b reaction.
Silicon	formulation of polyorganosiloxane ↓ index < PMMA Thicker		good Biocompatibility ↓ CME	Irreversible adherence to Silicon oil Can tear Slipper Limited control during implantation
Hydrogel.	PHEMA Index = PMMA. H_2O content = 3-8%. 4-3mm dry Optic = 6mm		good Laser resistance • " Biocompatibility • " optical quality • " Handling	Lack of long term experience
Acrylic hy. phillic			× Tackiness Freely movable IOLs Easy injectable	PCO ↑
Acrylic Hydrophobic		• Foldable • Controlled unfolding 10	↓ PCO adhere well to Capsule	Possible damage during implantation ✓ Tacky

Based on Material

Based on method of fixation

ACIOLs — In front of iris supported in ∠ of AC. after ICCE & ECCE. — PBK. — Kelman Multiflex

Iris supported — fixed on iris — Suture / Loops / Claws

- Pre-pupillary — Sing & Worst — ACIOLs
- Retro-pupillary — ± capsular support — PCIOLs
  - Retro-Iris fixated.
  - Sutureless Iris fixated Binderflex PCIOLs.

Ciliary Sulcus / Cap Bag Supported

- Haptic style — Loop / Plate.
- PCIOL models
  - J loop
  - Modified C-Loop.
  - Quadri loop.

IOL & Near Vision

- Implantation of IOL + Spectacles
- Small amt of Myopic astigmatism.
- Monovision approach
- Multifocal
- Accomodative
- Extended range of vision IOLs.

Types of IOLs

Method of fixation
- ACIOL
- Iris supported
- PCIOLs

Material used
- Rigid
- Foldable.
  - Silicone
  - Acrylic
  - Hydrogel
    - Hydrophobic
    - Hydrophilic
- Rollable IOL/ Ultrathin.

Based on Edge finish.
Rigid.
Square Edge.
Sharp edged.

Focality based
- Unifocal
- Multifocal
- Pseudo Accomodative
- Accomodative.
- Extended depth.

Spl fxn
- Aniridia.
- Implantable miniature telescope
- Piggyback IOL.
- Smart yellow.
- Blue blocking.

PRLs
- Aphakic
- Phakic (PRL's)
  - PC Sulcus fixated PRLs
  - Angle supported
  - Iris supported

Sphericity based
- Toric
- Aspheric

Future IOL designs.
- Injectable gel
- Electro-optic diffract IOL
- Light adjustable IOL

Intermediate Vision at 60 cm.

Presbyopia Correcting lens
a) Multifocal ✗ good intermediate
b) Trifocal ✓ at 60 cm
c) Extended depth of focus

Haptic Material

1

- PMMA
- Polypropylene.
- Polyamide.
- Polyvinylidene flouride PVDF.

2

Light filters – UV absorbing chromophores
- Benzoteiazole
- Benzopherone

IOL Chemistry/ material

Glass
Polymers

Wet Si lenses → IOL Jump.

- Rigid.
  - PMMA
    - ✓ Inert, Hydrophobic, Non-Autoclave
    - × • Hydrophobic ∴ Bact stick.
      • Shattered by Laser procedures
  - Both +, − power.
  - Ciliary sulcus-fixated 2° IOL.
- Foldable.
  - Silicone
    - flexible — chain & Intermolecular structure
    - ✓ flexible, memory, ↓ inflammat°
    - × surface deposits, decentebation.
  - Acrylics
    - Hydrophobic
      - ↓ H_2O content 2%
    - Hydrophilic
      - swell like sponge
      - philic ∴ repel cells & microbes
      - ✓ MICs ✓
      - × Tech complexities, Whitish discolour

Intra-Ocular Lens

Generations

I	Ridley's PMMA lens	dislocation. 2° glaucoma.
II	ACIOL — Early	Endothelial dysteophy Corneal decompensation PBK. UGH.
III	Iris supported L 4 loop. 2 loop	Iris chafing Pupillary Abn. dislocation & improper sizing.
IV	Intermedial ACIOL ≤. more flexible loops & haptics	
V	Rigid. PMMA PCIOL Tripod design J shaped loops C shaped loop	
VI	Improved, Soft foldable & Modern ACIOL	
VII	Multifocal	
VIII	Toric, Acc, PRL.	