Accommodation and its Anomalies

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Definition

- Mechanism by which the eye changes its refractive power by altering the shape of lens in order to focus object for near.

- Theories Of Accomodation:-

➢ Helmholtz Theory (most accepted)

➢ Schachar Theory.

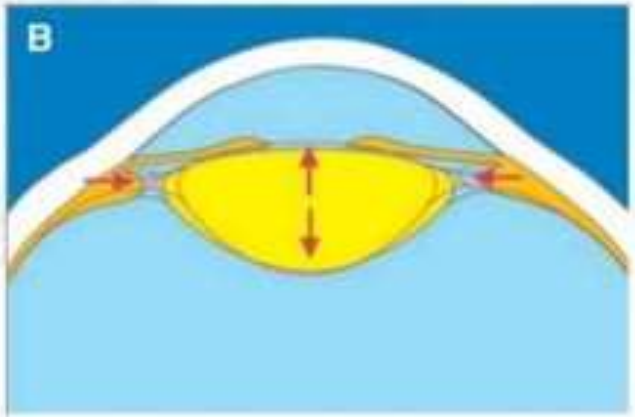
➢ Coleman Theory.

Relaxation Theory of Helmholtz

- Proposed by Thomas Young
- Elaborated by Hermann von Helmholtz
- Most widely accepted

Relaxation Theory of Helmholtz

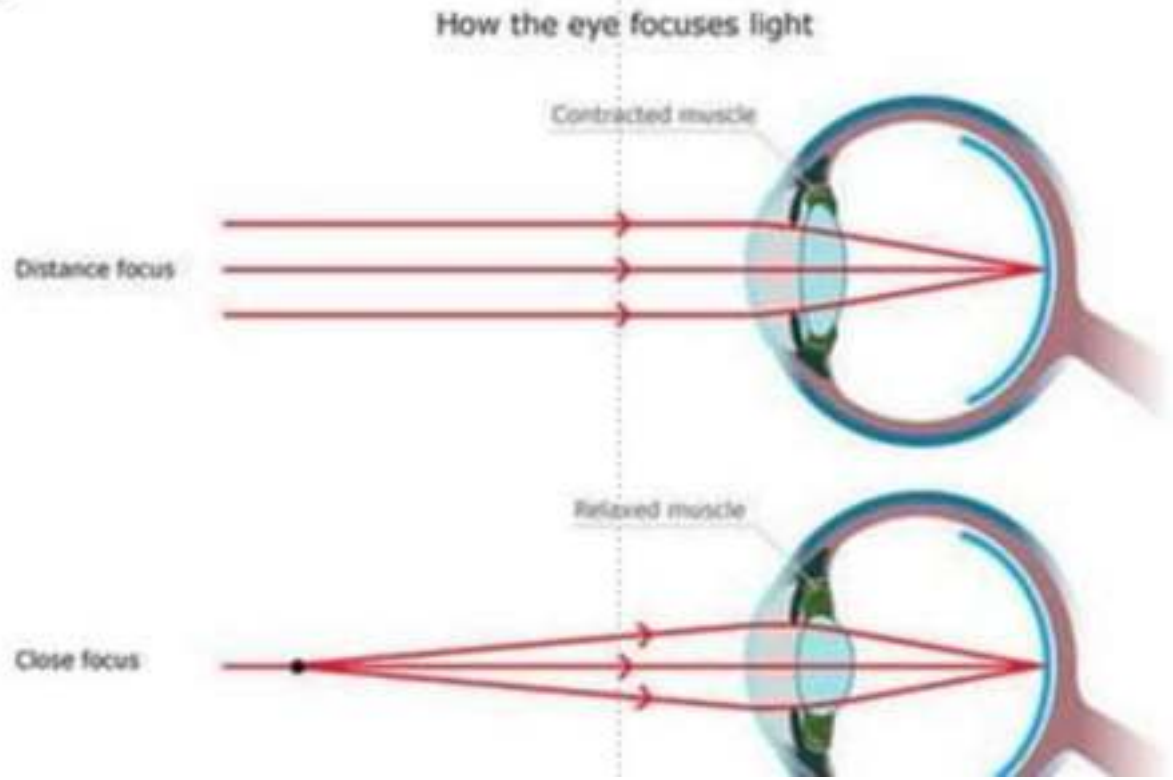
- eye is at rest and focused for distance
- ciliary muscle is relaxed
- eye makes an effort to focus on a near object
- ciliary muscle contracts
- bulk of the anterior ciliary body moves forward
- release in tension on the zonular fibres
- elastic capsule moulds the lens into a spherical form



Laxmi
eye institute

Relaxation Theory of Helmholtz

- Increase in surface curvatures causes an increase in optical power of the lens and therefore an increase in power of the eye



Helmholtz's Theory: Disaccommodation

- Lens undergo following changes:-

➢ Increase the curvature of lens.

➢ Increase in the A-P diameter.

➢ Decrease in the equatorial diameter.

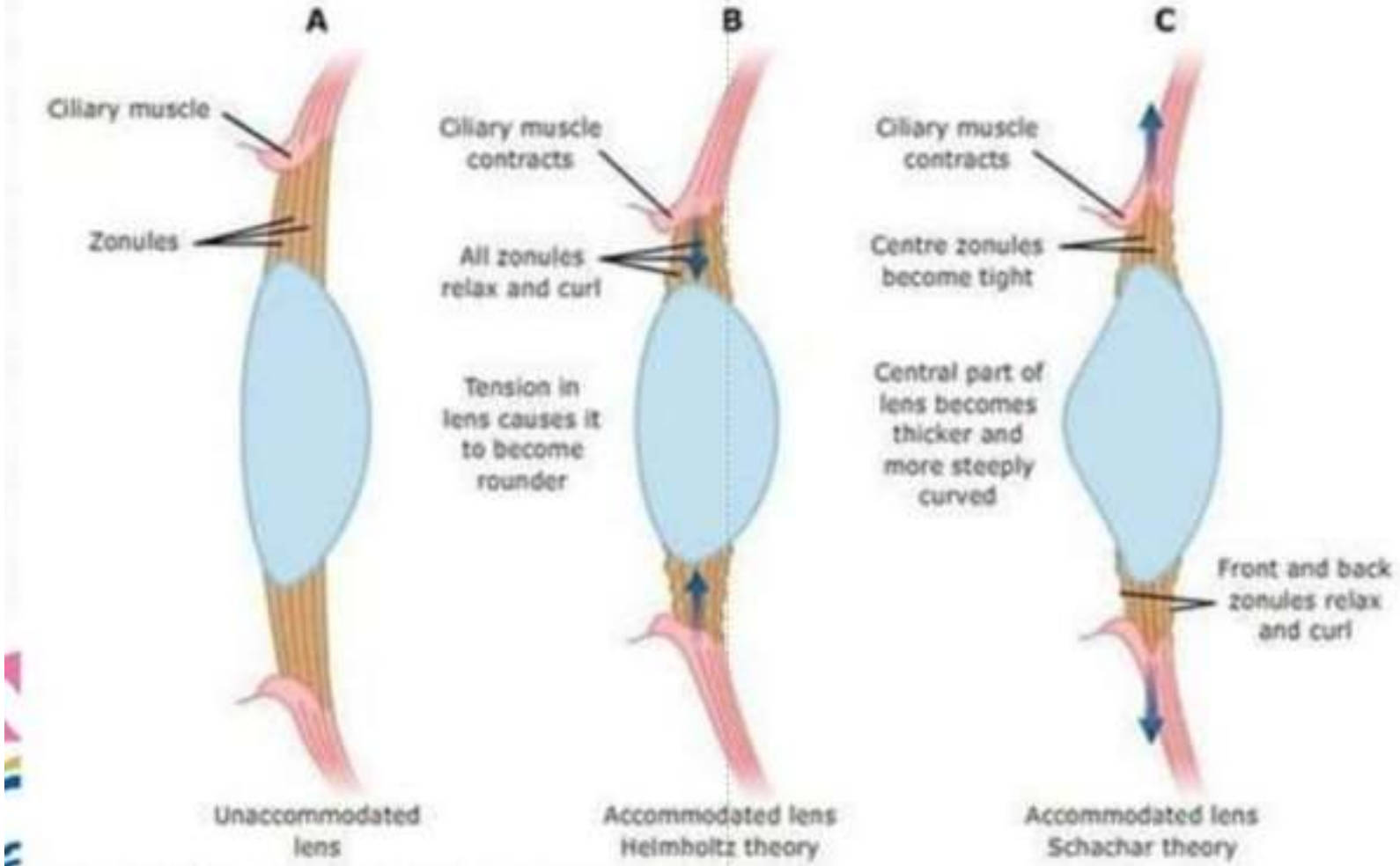
➢ Forward movement of anterior pole.

Schachar's Theory

- Proposed by Ronald Schachar
- Alternative theory
- Contradicts the classical Helmholtz's mechanism


ciliary muscle contracts
equatorial zonular tension is increased
anterior and posterior zonules are simultaneously relaxed
central surfaces of the lens steepen
peripheral surfaces of the lens flatten

Helmholtz's and Schachar's Theory



Shortcomings of Schachar's Theory

- Based on his theory, Schachar introduced a new surgery in 1992 i.e. the use of scleral expansion bands to increase the distance between the lens equator and ciliary muscle.
- Poor results of this surgery challenged the validity of his theory

Coleman Theory

- Ciliary muscle contracts

Initiates a pressure gradient between the vitreous and aqueous compartment.

Creates a hydraulic shift of crystalline lens.

Vitreous applies force on posterior surface of lens.

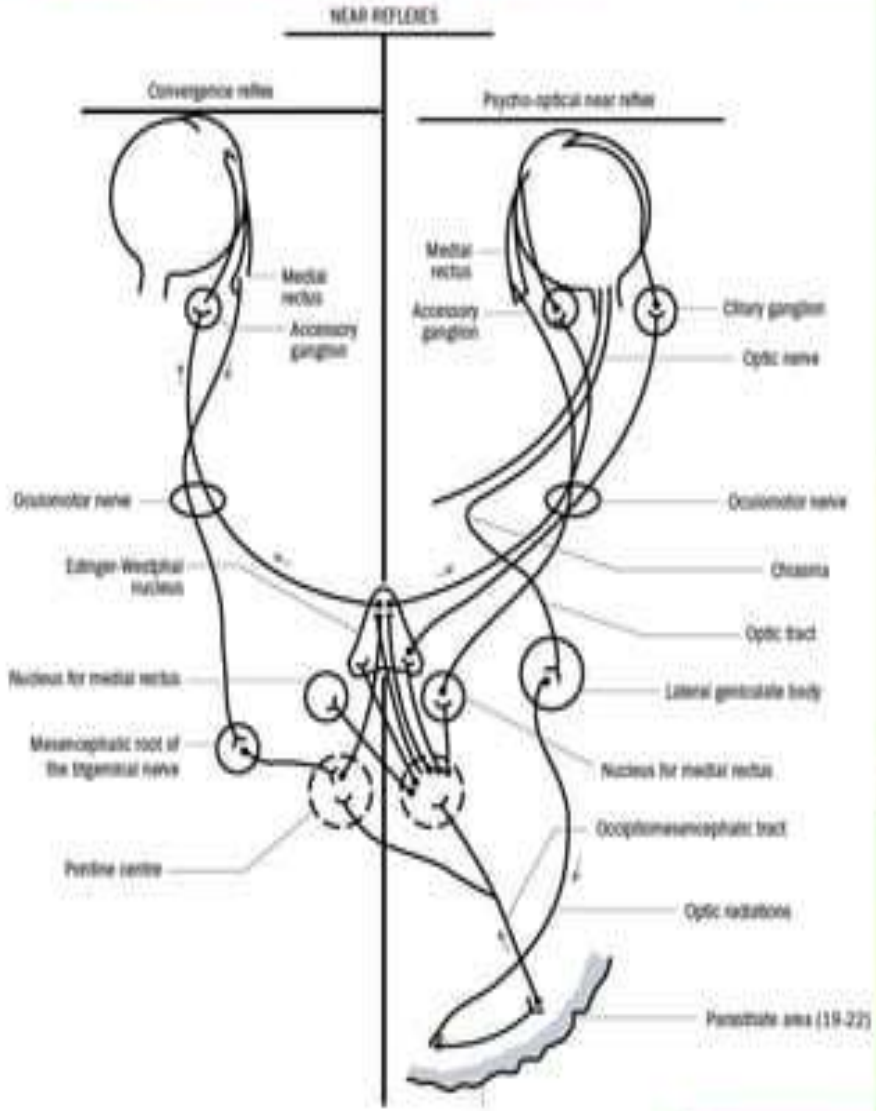
Steep radius of curvature in the center of lens with slight flattening of the peripheral anterior lens.

PATHWAY OF ACCOMMODATION REFLEX

AFFERENT IMPULSES EXTEND FROM OPTIC NERVE

CHIASMA

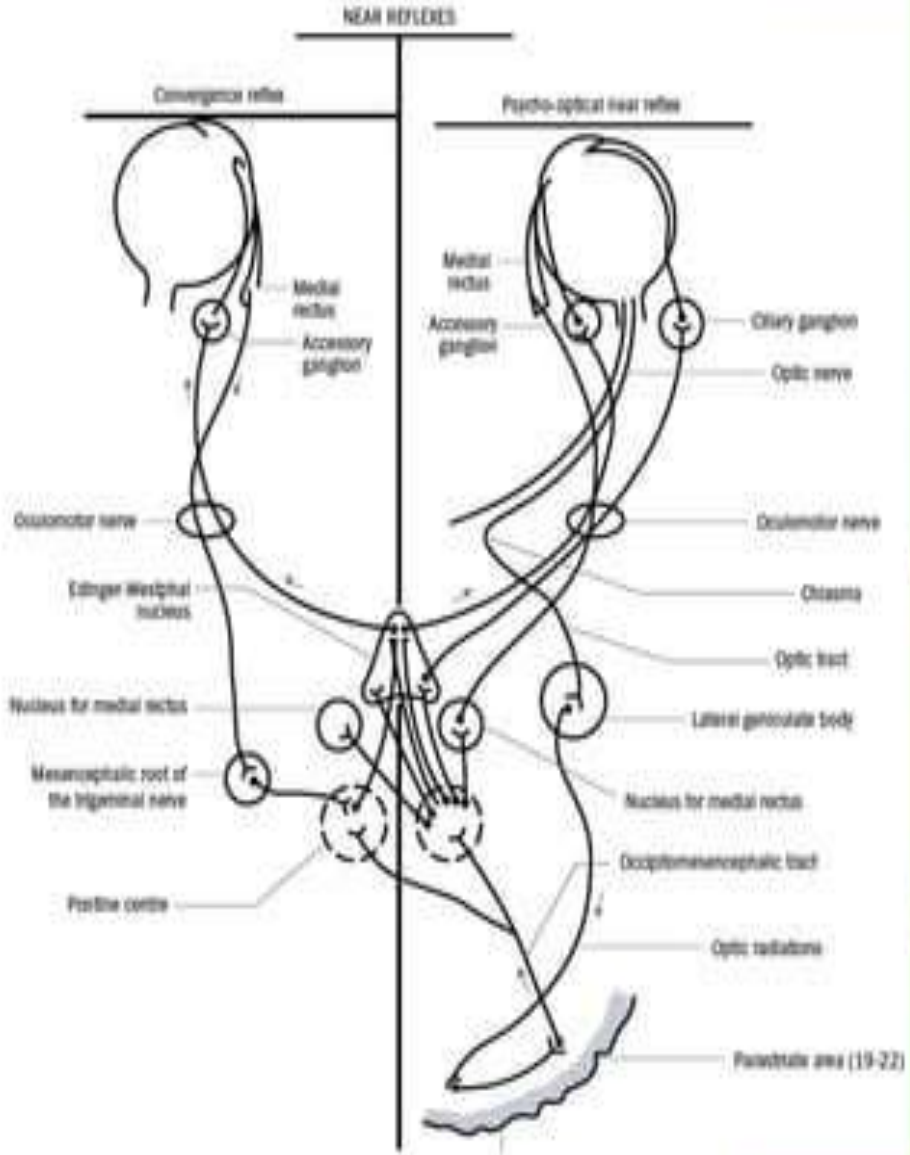
OPTIC TRACT



LATERAL GENICULATE BODY

OPTIC RADIATION

STRIATE CORTEX



- INTERNUNCIAL FIBRES RELAY IMPULSES FROM PARASTRIATE CORTEX TO EDINGER-WESTPHAL NUCLEUS
- EFFERENT FIBRES :

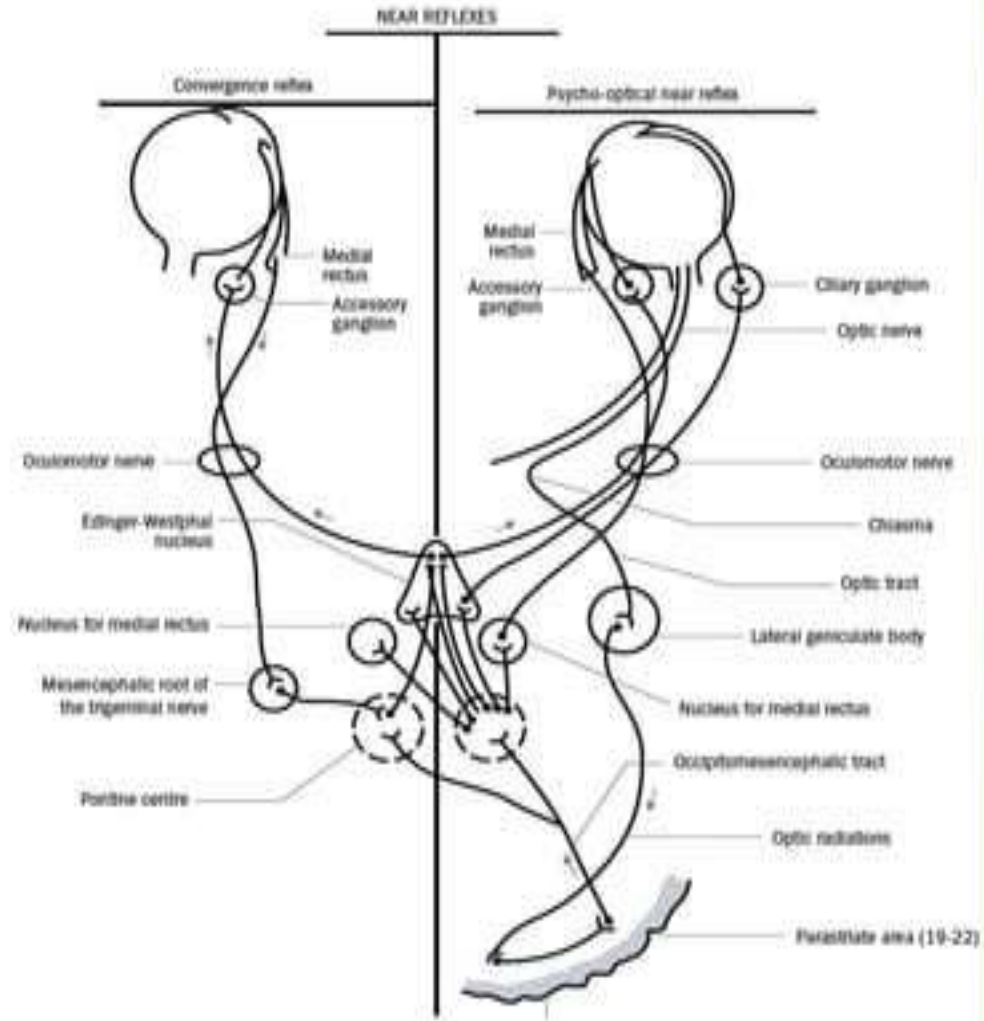
FROM EDINGER-WESTPHAL NUCLEUS

↓

TRAVEL ALONG 3RD NERVE

↓

REACH SPHINCTER PUPILLAE AND CILIARY MUSCLE



- Physical Accommodation

Actual deformation in the shape of the lens measured in dioptres(D).

Physiological Accommodation

Contraction power of the ciliary muscle expressed in myodioptres.

- **Far point / Punctum remotum:-** Maximum distance at which an object is seen clearly when accommodation is relaxed and refractivity of the eye is minimum.
- **Near point / Punctum proximum**:- Nearest distance at which the eye can see clearly with maximum effort of accommodation and refractivity of the eye is max.

- **Range of accommodation** :- distance between far point and near point.
- **Amplitude of Accommodation** :- Total accommodation exerted between far point and near point.

It decreases with age .

Can be assesed by Near point of Accommodation(NPA)

Amplitude of accommodation=100/NPA.

• Range of Accomdn - a(mtr) = $r - p$

p = dist. of near point

r = dist. of far point.

A (Amplitude of accomodation) = $P - R$

P - refr. power of eye when accomodated for p

R - refr. " " " " " " r.

- **Near point of Accommodation:-** Measured by

Using a linear target.

By RAF rule (Royal Airforce)

Using minus lens.

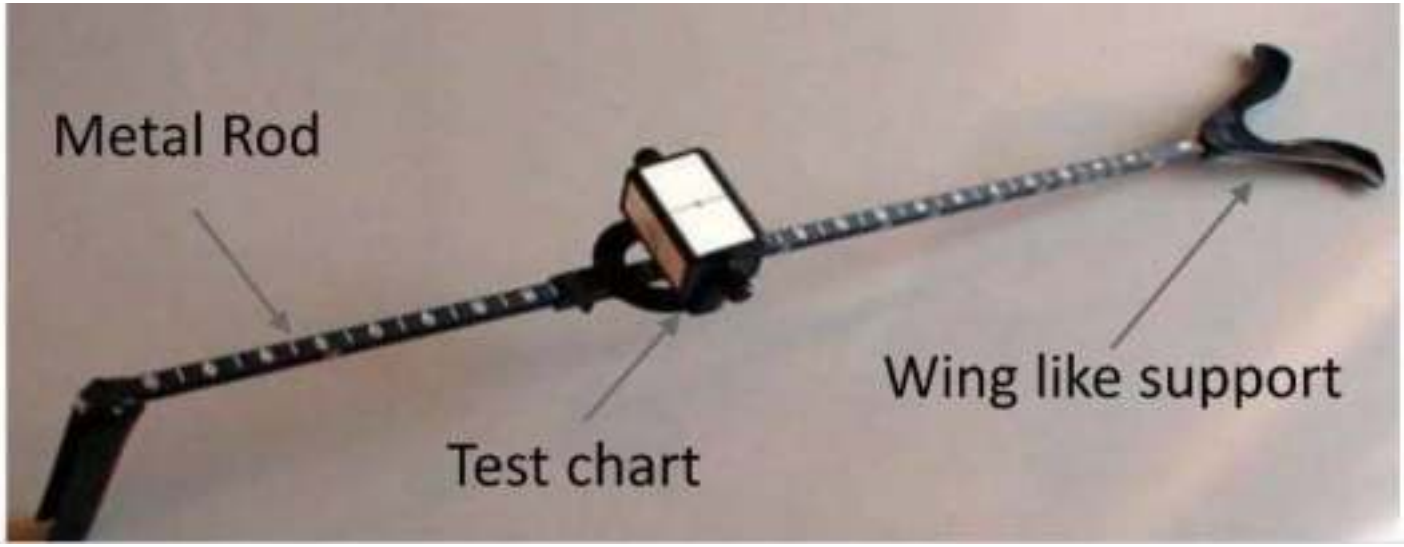
- **Near point of Convergence(NPC):-**

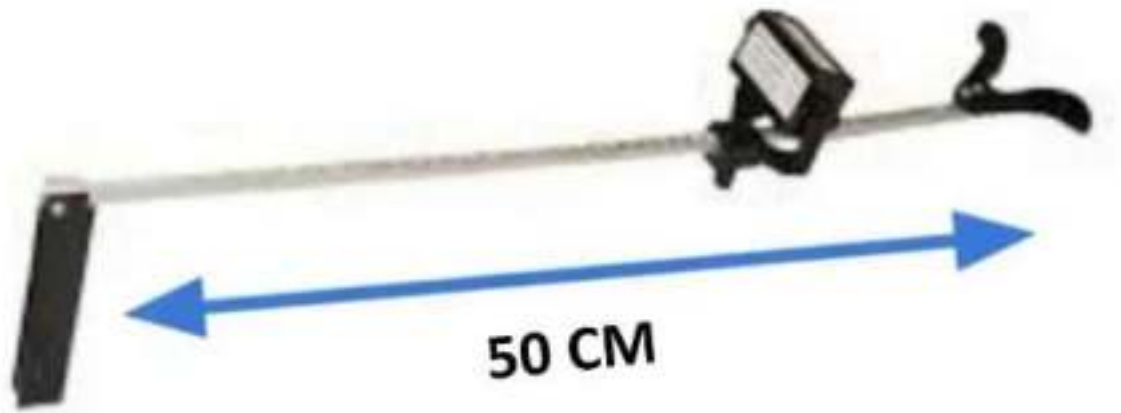
It is a closest to eye which can seen single , it is constant for the age but can change in a few disease.

Assessment of Accommodation

- **RAF Rule or Prince's Rule:-** A sliding target with 6/9 letters, numbers or fine lines is moved from or towards the eye until the closest point is found at which it can still can be seen clearly. During the examination pt. has to wear his or her full optical refractive correction. The NPA is determined for each eye separately and then for both eyes together.

The NPA is measured in cm marked on one side of the instrument bar. The side of the bar marked in diopters will indicate the amplitude of accommodation in diopters. The third side of the bar shows the age corresponding to the accommodation.


Metal Rod
Test chart
Wing like support


50 CM

- **Measurement of Amplitude of Accommodation using minus Lenses** :-

This test is performed for each eye separately and during examination, the patient has to wear his or her full refractive correction. The patient is asked to fixate the best corrected near vision target at 40 cm distance and minus lenses of progressively increasing power are added before the eye till the patient reports the first sustained blur.

- The power of this minus lens plus +2.5 D (for 40 cm distance of testing) is equivalent to the amplitude of accommodation in dioptres.
- **Push-up Test :**
- The patient is asked to fixed it the best corrected near vision target at a distance where the target is seen clearly. The near vision chart is then moved closer till the patient reports first sustained blur. The linear distance measured between the chart and patient’s spectacle plane gives the NPA.

Assessment of Dynamic Accommodation

- Dynamics of accommodation can be assessed by testing accommodative facility. An accommodative flipper of +2.00 DS with +2.00 DS is used to test accommodative facility by rapidly flipping the lenses.
- Difficulty with plus lenses is seen in patients with accommodative excess.

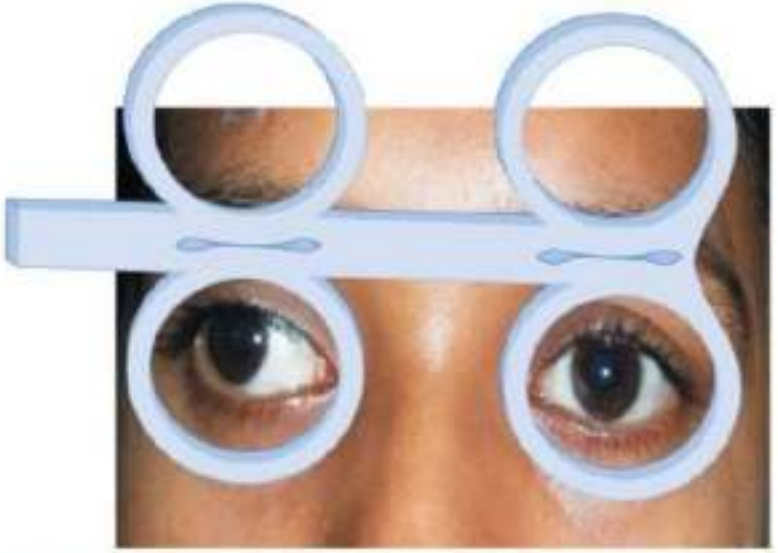


Fig. 4.7 *Testing of accommodative facility with an accommodative flipper.*

Anomalies of Accommodation

I. Diminished or deficient accommodation

1. Physiological (presbyopia)
2. Pharmacological (cycloplegia)
3. Pathological

- Insufficiency of accommodation
- ll-sustained accommodation
- Inertia of accommodation
- Paralysis of accommodation

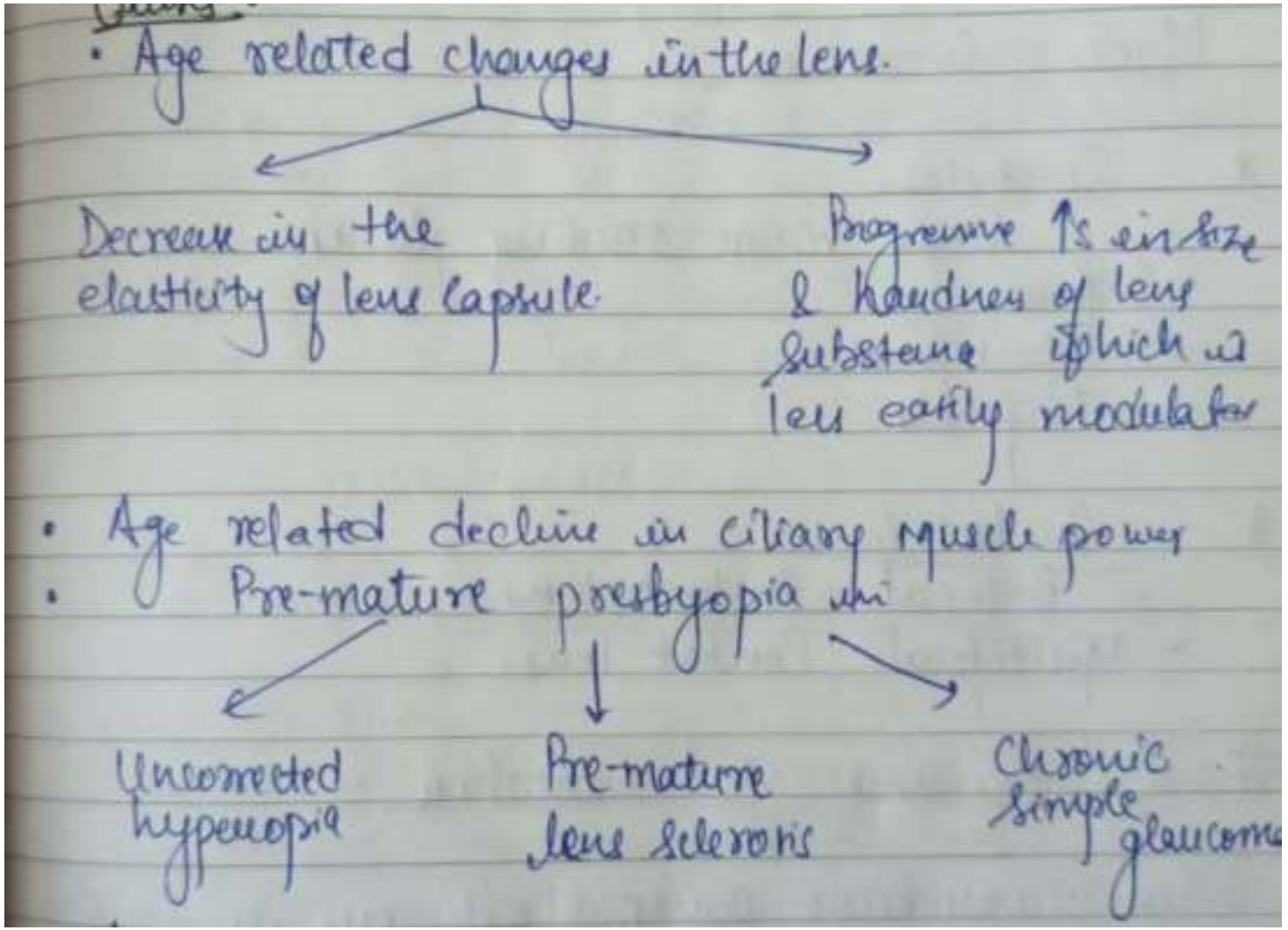
II. Increased accommodation

1. Excessive accommodation
2. Spasm of accommodation

Presbyopia

- Presbyopia is an eyesight of old age and is not an error of refraction but a condition of physiological insufficiency of accommodation due to reduced amplitude, leading to a progressive fall in near vision. This begins between 40and 45 years of age.
- **Pathophysiology**:- In Emmetropic eyes , far point is at infinity and near point varies with age (being about 7 cm at the age of 10 years, 25 cm at the age of 40 years and 33 cm at the age of 45years).After the age of 40yrs the NPA receeds beyond the normal reading or working range. This condition of failing near vision due to age- related decrease in the amplitude of accommodation or increase in punctum proximum is called presbyopia.

Causes:-


Age related changes in the lens.
Decrease in the elasticity of lens capsule
Progressive ↑s in size & hardness of lens substance which is less easily modulated
Age related decline in ciliary muscle power
Pre-mature presbyopia in
Uncorrected hyperopia
Pre-mature lens sclerosis
Chronic simple glaucoma

Clinical Features :-

- Difficulty in near vision.
- Asthenopic symptoms – Due to fatigue of ciliary muscle are also complained after reading or doing near work.
- Intermittent diplopia.

Treatment

- Optical correction :- It is done by supplementing accommodation with convex lenses of appropriate power, required for a clear and comfortable near vision.
- Rough estimate for the presbyopic add for various age levels is as follows:

40 to 45 years: +0.5 to +1.0 D

46 to 50 years: +1.25 to +1.75 D

51 to 55 years: +2.0 to +2.25 D

56 to 60 years: +2.5 to +3.0 D

- However, it should be estimated individually in each eye in order to determine how much is necessary to provide a comfortable range.

- **Basic principles for presbyopic correction can be summarized as follows:**
- Always find out refractive error for distance, and first correct it.
- Find out the presbyopic correction needed in each eye separately and add it to the distant correction.
- The presbyopic add prescribed should leave about 50% of the accommodation in reserve.
- Near point should be fixed by taking due consideration for profession of the patient.
- The weakest convex lens with which an individual can see clearly and comfortably with both the eyes (binocularly) at the near point should be prescribed, since overcorrection will also result in asthenopic symptoms.

Modes of Correction

- **Spectacles:-**

Single vision reading glasses.

Bifocal glasses.

Trifocal glasses.

Multifocal glasses.

Contact Lenses:-

Bifocal contact lens.

Multifocal contact lens.

- Also, there is a modified monovision, where a single vision lens is in one eye and a bifocal lens in the other eye or two bifocal lenses with different near vision power.

Surgical management

- Corneal Procedures

➢Non ablative Corneal procedures

- 1. Monovision CK :- Being considered a safe and effective non incisional and non ablative corneal procedure performed on non-dominant eye for treatment of presbyopia.
- 2. Laser thermal keratoplasty.

➢ Laser Ablation Corneal procedure

1. Monovision hyperopic LASIK.
2. Presbyopic bifocal LASIK
3. Presbyopic multifocal LASIK
4. PRESBYOND laser blended vision

Bifocal Presbyopic LASIK

- Main steps of bifocal presbyopic LASIK are as:-
- Corneal flap of between 8.5 and 9.5 mm is made.
- Hyperopic ablation is done to make cornea myopic, prolate that allows the eye to focus in a range that includes near vision but excludes far vision.
- Myopic ablation is then performed with a 4 mm optical zone. This results in a central oblate cornea for distance vision with a ring of prolate cornea that allows the eye to focus on near objects.
- Reposition of flap is done after cleaning and drying the stromal bed.

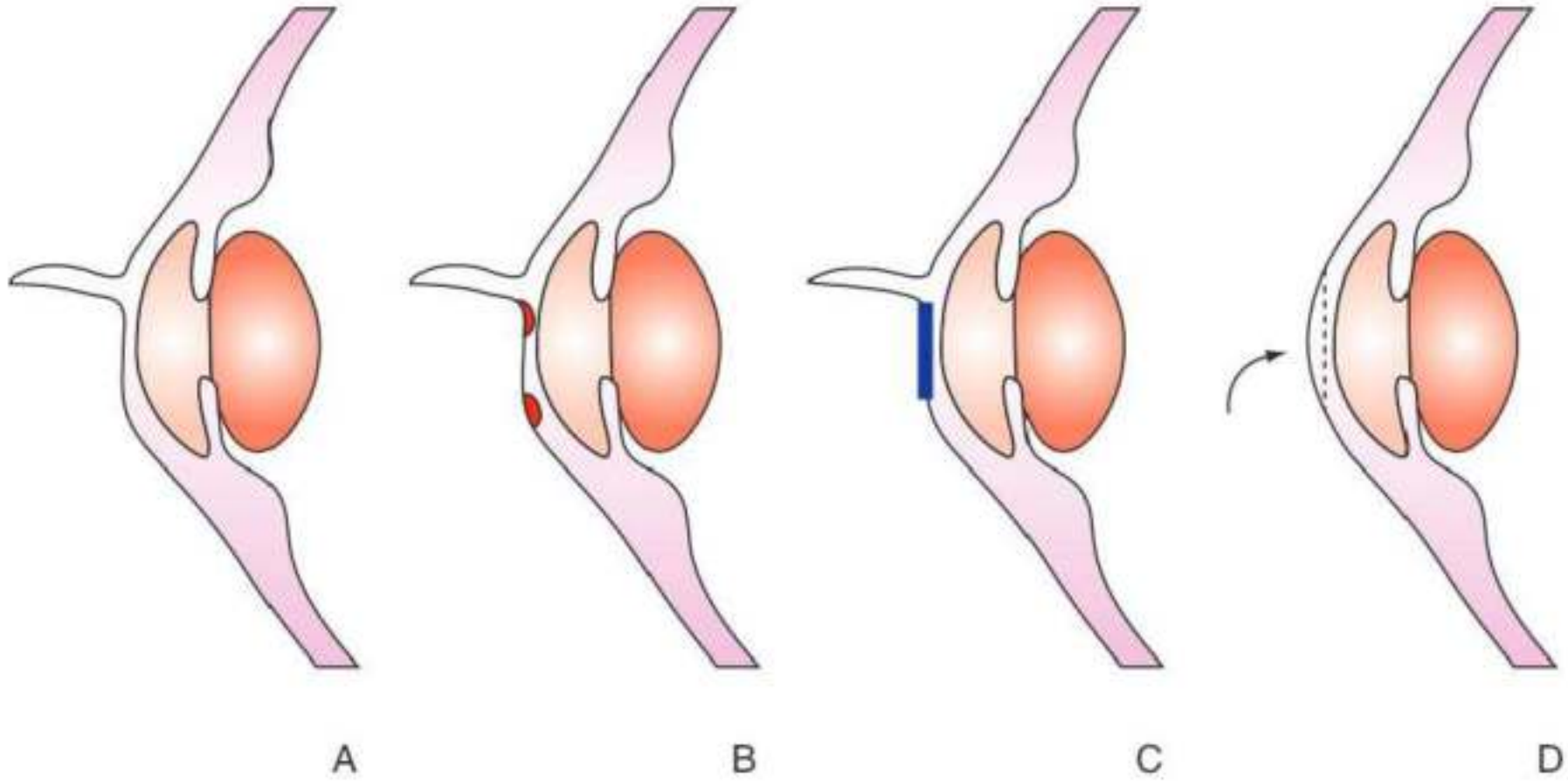


Fig. 11.29 *Procedure of presbyopic bifocal LASIK: A, creation of corneal flap; B, hyperopic ablation; C, myopic ablation; D, reposition of corneal flap.*

Pathological Accommodation

- Insufficiency of Accommodation:- when the accommodative power is significantly and persistently below the normal physiological limits for the patient's age.

Causes:- Premature sclerosis of lens .

Weakness of ciliary muscle due to systemic causes such as anemia, malnutrition, diabetes , pregnancy etc.

Weakness of ciliary muscle due to local causes such as POAG , mild cyclitis.

- Clinical Features :- Headache

  Fatigue

  Irritability of the eye.

  Intermittent diplopia due to associated disturbances of convergence is also reported. often accommodative failure is associated with convergence insufficiency, but sometimes the attempt to accommodate brings excessive amount of convergence.

Treatment :-1.Treat the cause

2. Near vision spectacles in the form of weakest convex lens which allows adequate vision should be given till the power of accommodation improves and also to stimulate accommodation.

3. Accommodation Exercise :-

Accommodation test-card exercise is the most simple and commonly advised exercise. The accommodation test card consist of a black vertical line drawn on a white card. The patient is instructed to hold the card at a considerable distance from the eyes and then bring it closer until the line appears blurred and indistinct. By repeating this, the patient should b encouraged to attempt to bring his or her near point as close as possible. The patient should be encouraged to maintain the accommodative effect as large as it can be done with comfort. Patient should be advised to practice at short period throughout the day.

- ILL- Sustained Accommodation:- It refers to a situation in which although the range of accommodation is normal, it cannot be sustained for a sufficient time period.
- Seen in – Pt. recovering from debilitating illness.

  Person in a state of general tiredness.

  Person reading in a dim light.

Inertia of Accommodation

- Rare condition
- Difficulty in altering the range of accommodation
- Requires time and effort to focus a near object after looking into distance

- Treatment:
  - Correction of refractive error
  - Accommodative Exercises

- Paralysis of Accommodation :- Refers to complete absence of accommodation.

- Causes:
  - Drug induced cycloplegia –atropine ,homatropine
  - Internal opthalmoplegia [paralysis of cilliary muscle & sphincter pupillae]
  - Neuritis associated with chronic alcoholism, diabetes
  - CNS infections
  - Head Injury

Clinical Features

- Blurring of near vision.
- Photophobia .
- Micropsia As a more accommodative effort is required to see near object which is then perceived to be nearer than it actually is and therefore smaller.

Treatment :- Self-recovery occurs in drug-induced paralysis.

Dark glasses are effective in reducing the glare.

Convex lenses for near vision may be prescribed if the paralysis is permanent.

Hyperaccommodation

- Excessive accommodation:- situation in which an individual exerts more than the normal required accommodation for performing a certain near work. It is within the voluntary control of the individual and is an intermittent .

- Causes :- Refractive error.

  Presbyopia

  Use of wrong spectacle.

  Prolonged near work.

Clinical Features

- Dimintion of vision -pseudomyopia develops.
- Asthenopia.

Treatment :- Correction of Refractive error

Full cycloplegic refraction should be done.

Use of atropine in uncooperative cases for one or two weeks to allow the overexcited ciliary muscle to relax.

Spasm of Accommodation

- Abnormally excessive accommodation which is out of voluntary control of the individual
- Causes:
  - Drug induced spasm after use of strong miotics
  - Spasm of near reflex

Clinical Features

- Blurred vision for distant objects.
- Asthenopic symptoms.
- Macropsia.

Treatment :- Relaxation of ciliary muscle by giving atropine

Optical treatment by correcting spectacle should be worn immediately when eyes are used again.

THANK
YOU