Strabismus & Eye movement

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Extraocular muscles of orbit

Muscle	Origin	Insertion	N. supply	action: 1st	2nd	3rd	Clinical testing Direction to move eye when testing muscle
Superior rectus	common tendinous ring	Superior surface of eyeball	Oculomotor 3rd	Elevation	Intorsion	Adduction	 **Look laterally and upward**
Inferior rectus	common tendinous ring	Inferior surface of eyeball	Oculomotor 3rd	Depression	Extorsion	Adduction	 **Look laterally and downward**
Medial rectus	common tendinous ring	Medial surface of eyeball	Oculomotor 3rd	Adduction	_____	_____	 **Look medially**
Lateral rectus	common tendinous ring	Lateral surface of eyeball	Abducent 6th	Abduction	_____	_____	 **Look laterally**
Superior oblique	Posterior wall of orbital cavity	attached to superior surface beneath **SR**	Trochlear 4th	Intorsion	Depression	Abduction	 **Look medially and downward**
Inferior oblique 👎	Floor of orbital cavity	Lateral surface of eyeball deep to **LR**	Oculomotor 3rd	**Ex**torsion ✕	Elevation	Abduction	 **Look medially and upward**
Levator palpebrae superioris	Back of orbital cavity	Anterior surface and upper margin of superior tarsal plate	Striated muscle oculomotor nerve, smooth muscle sympathetic	Elevation of upper eyelid	_____	_____	

Agonist muscles

The primary muscle that moves an eye in a given direction

Antagonist muscles

Muscle in the same eye that moves the eye in the opposite direction of the agonist

Synergists muscles

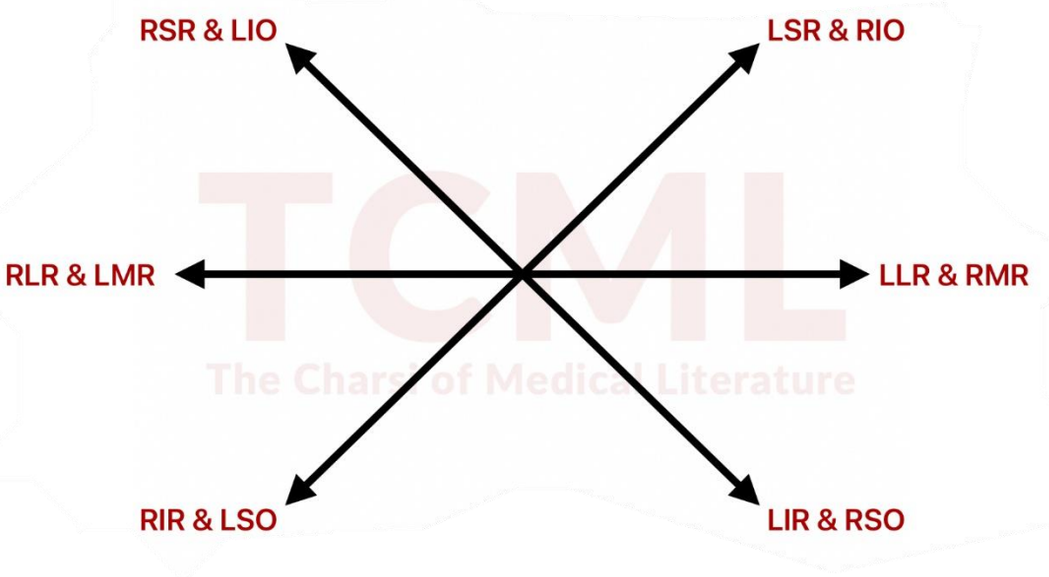
A muscle in the same eye that moves the eye in the same direction as the agonist

Yoke muscles

muscles in each eye that accomplish a given version

(contralateral synergists)

Muscle	Synergist	Antagonist
Medial rectus	S\I. rectus	L.rectus + S\I. oblique
Lateral rectus	S\I. oblique	M\S\I. rectus
Superior rectus	I.oblique\M.rectus	I.rectus + S.oblique
Inferior rectus	S.oblique\M.rectus	I.Oblique + S.rectus
Superior oblique	I\L. rectus	I.Oblique + S.rectus
Inferior oblique	S\L. rectus	I.rectus + S.oblique



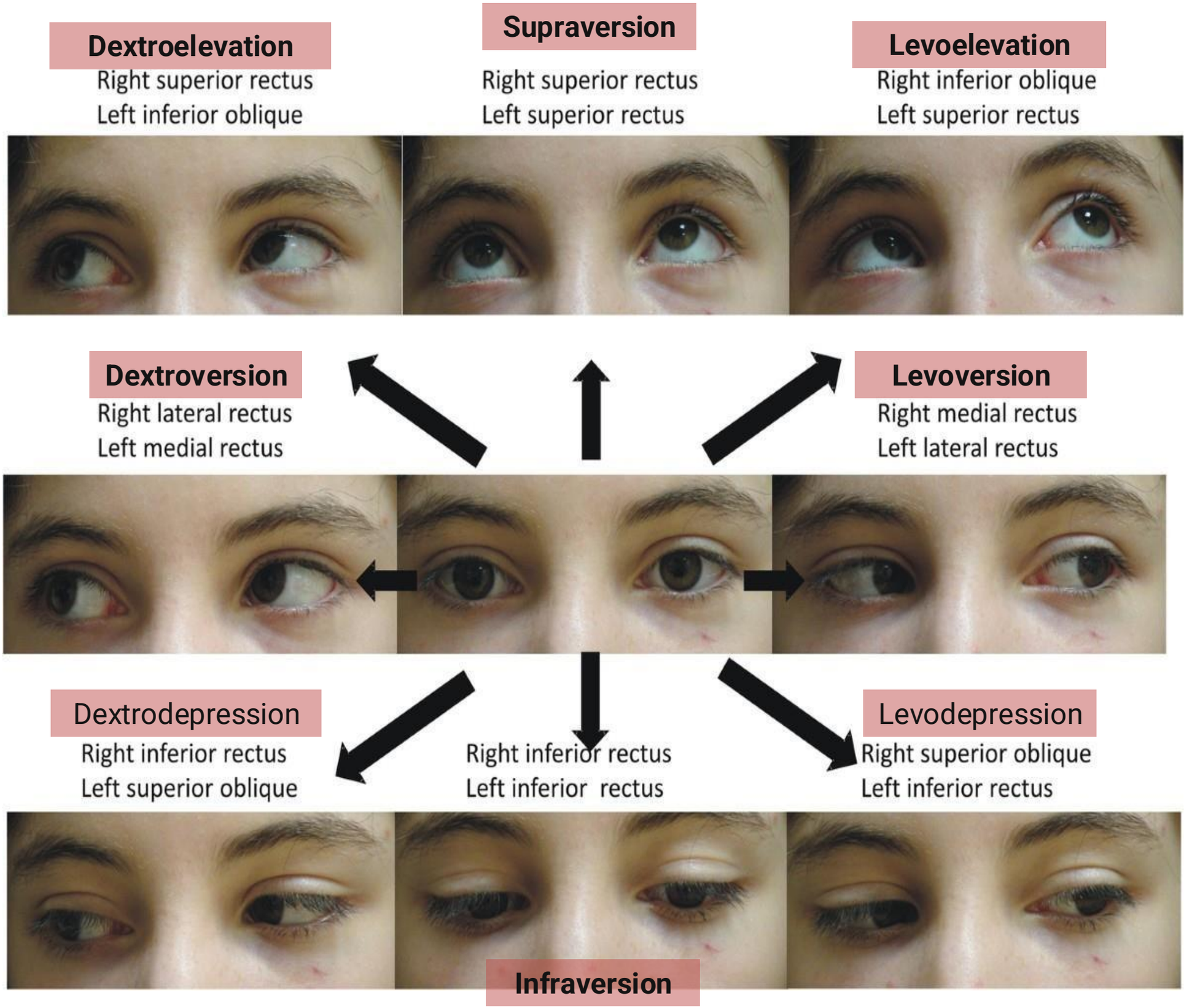
HERING'S LAW

an equal and simultaneous innervation flows from the brain to a pair of muscles which contract simultaneously (yoke muscles) in different binocular movements.

e.g:

i. During convergence, both medial recti get equal innervation.

ii. During dextroelevation, right superior rectus and left inferior oblique receive equal and simultaneous innervation.


Dextroelevation
Right superior rectus
Left inferior oblique
Supraversion
Right superior rectus
Left superior rectus
Levoelevation
Right inferior oblique
Left superior rectus
Dextroversion
Right lateral rectus
Left medial rectus
Levoversion
Right medial rectus
Left lateral rectus
Dextrodepression
Right inferior rectus
Left superior oblique
Right inferior rectus
Left inferior rectus
Levodepression
Right superior oblique
Left inferior rectus
Infraversion

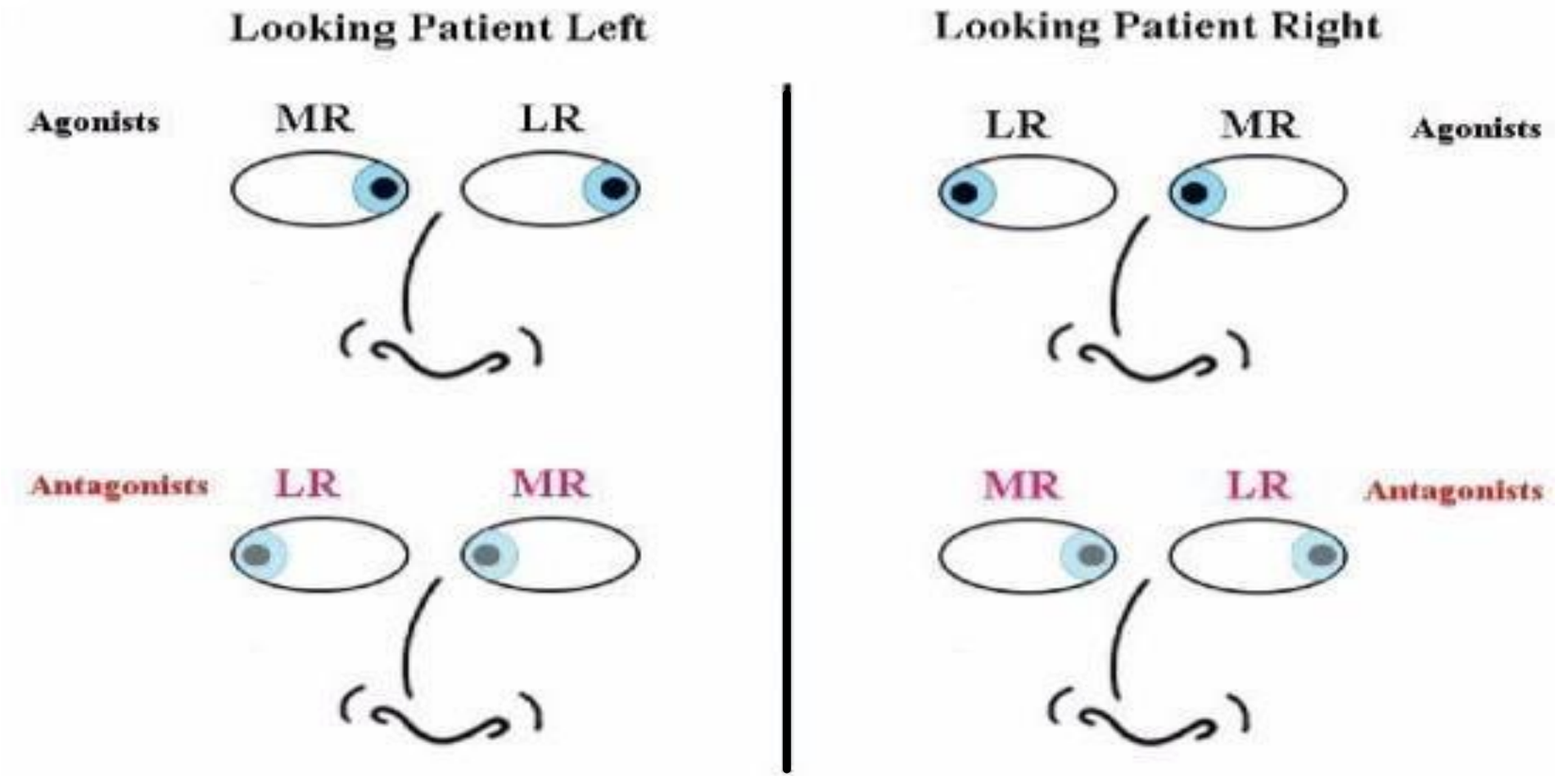
Sherrington's law of reciprocal innervation

- This law states that during ocular motility an increased flow of innervation to the contracting agonist muscle is accompanied by a decreased flow of innervation to the relaxing antagonist muscle.

> During levoversion, an increased innervational flow to the right medial rectus and left lateral rectus, accompanied by decreased flow of innervation to right lateral rectus and left medial rectus

> But in certain pathological condition ,co-contraction of antagonistic muscles instead of relaxation antagonist muscle occurs. For e.g Duane's retraction syndrome, limits the amount of movement achievable

Clinical application of Sherrington's law



Squint is misalignment of the visual axes.

It is a failure of the co-ordination of binocular alignment. It leads inevitably loss of binocular single vision. Fusion of the two images is replaced either by diplopia or suppression of one image. Strabismus may be caused by orbit, muscle, motor nerve, or brainstem pathology.

Binocular single vision (BSV):
Normally both eyes are directed towards the same object. Eye movement is coordinated so the retinal image falls always on a corresponding points of each retina. These corresponding points are fused centrally as one.

Stereopsis:
the perception of depth produced by the reception in the brain of visual stimuli from both eyes in combination; binocular vision. (3D image)

If both eyes are not aligned BSV is not possible this will result in:
Diplopia: single object is seen in two different places.
Confusion: two separate and different objects appear to be at the same point.

-Constant non-alignment will lead to a defense to avoid diplopia and confusion
-Suppression of the deviating eye will lead to AMBLYOPIA
-Intermittent deviation will not lead to amblyopia but stereopsis may not developed

Investigating a squint

The following steps are taken in investigating a squinting child:

- History
- Determination of acuity
- Check for pseudostrabismus
- Detection of any abnormality in eye movement
- Measurement of stereopsis
- Detection and measurement of the squint
- Determination of any refractive error
- Careful examination of the eyes, including a dilated fundus view
- Head postures

Motor tests:

1. Corneal reflection test
2. Cover/uncover test
3. Prism cover test
4. Synaptophore
5. Maddox rod
6. Maddox wing
7. Diplopia testing
8. Hess charting

Sensory tests:

1. Worth's four dot test
2. Bagolini's test
3. Test for stereopsis
4. After images test

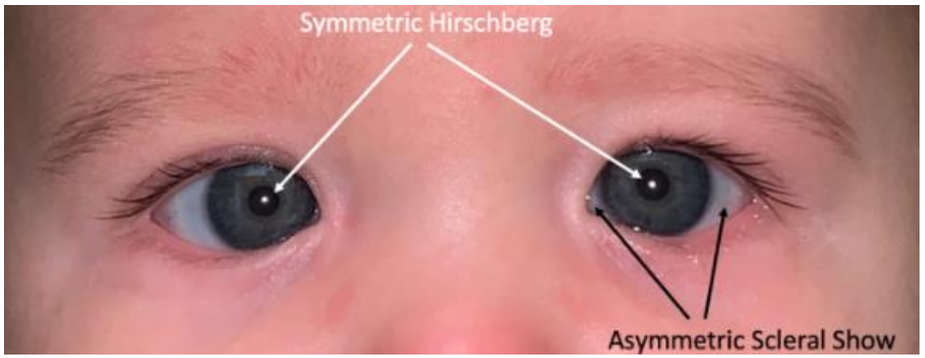
History

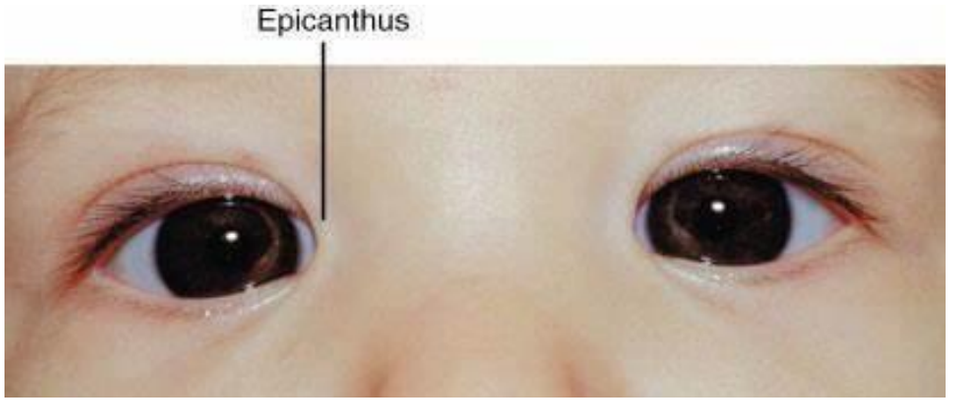
A careful history is important in the diagnosis
Age of onset of deviation
Is the deviation constant or intermittent?
Is the deviation present for distance, near or both?
Is it unilateral or alternating?
Is it present only when the patient is inattentive or fatigued?
Is it associated with trauma or physical stress?
History of patching
Refractive errors history
Old photographs
Birth history
Is there a family history of strabismus?
Are there any other medical problems?
Headaches, diplopia, vertigo

Pseudosquint

The patient is examined for external features that may simulate a squint (pseudo-squint) such as:

- Epicanthus (a crescentic fold of skin on the side of the nose that incompletely covers the inner canthus) or telecanthus (increased distance between the inner canthi) which simulate a convergent squint.
- Facial asymmetry





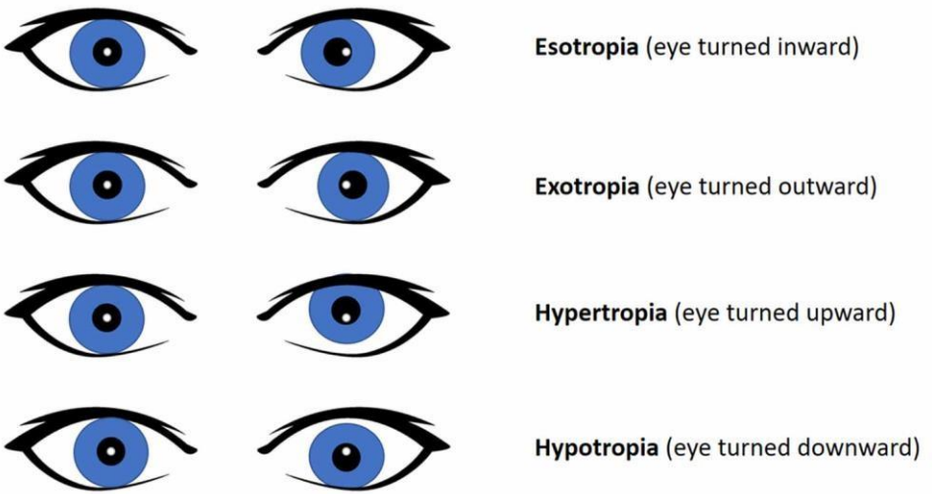
Corneal reflection test

(Hirschberg test)

The alignment of the eyes is tested using a pen torch. The corneal reflection of a torchlight, held 33 cm in front of the subject, is a guide to eye position. If there is no squint,

the light reflex will be central in both eyes.

If the child is squinting, the reflection will be central in the fixating eyeand deviated in the squinting eye



Strabismus can be:

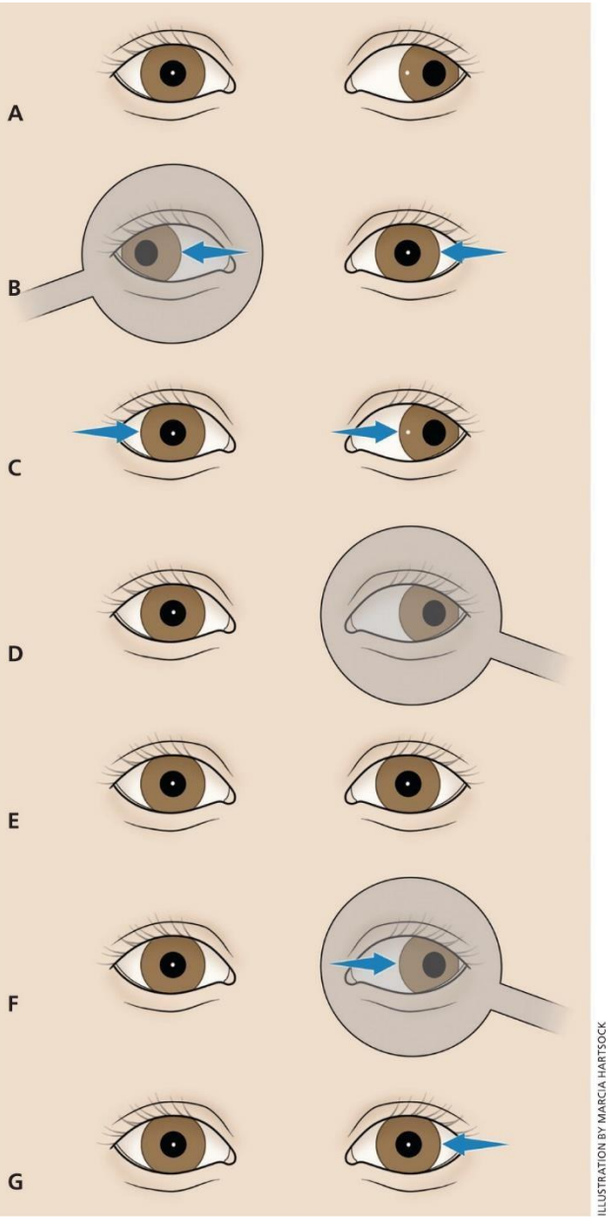
1 Tropia (manifest)
2 Phoria (latent)

Cover/uncover test

Test consists of two parts:

Cover test: to detect heterotropia
the patient is asked to fixate on a point light. Then, the normal looking / fixating eye is covered while observing the movement of the uncovered eye.
In the presence of squint the uncovered eye will move in opposite direction to take fixation, while in apparent squint there will be no movement.
This test should be performed for near fixation (i.e., at 33 cm) distance Fixation (i.e., at 6 metres)

Uncover test: to detect heterophoria
one eye is covered with an occluder and the other is made to fix an object.
In the presence of heterophoria, the eye under cover will deviate.
After a few seconds the cover is quickly removed and the movement of the eye (which was under cover) is observed.
Direction of movement of the eyeball tells the type of heterophoria (e.g., the eye will move outward in the presence of esophoria).



Alternate cover test

It is a dissociation test which reveals the total deviation when fusion is suspended.
Procedure - Suppose Rt eye is covered for several seconds. The occluder is quickly shifted to opposite eye for 2 seconds, then back and forth several times. After the cover is removed, the examiner notes the speed and smoothness of recovery as the return to their pre-dissociated state.

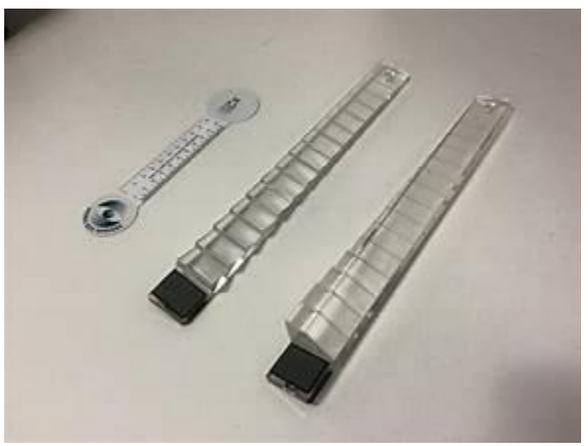
A patient with a well compensated heterophoria will have straight eyes before and ci after the test has been performed whereas a patient with poor control may decompensate to a manifest deviation. It reveals whether the squint is unilateral or alternate and also differentiate non paralytic squint from paralytic squint.

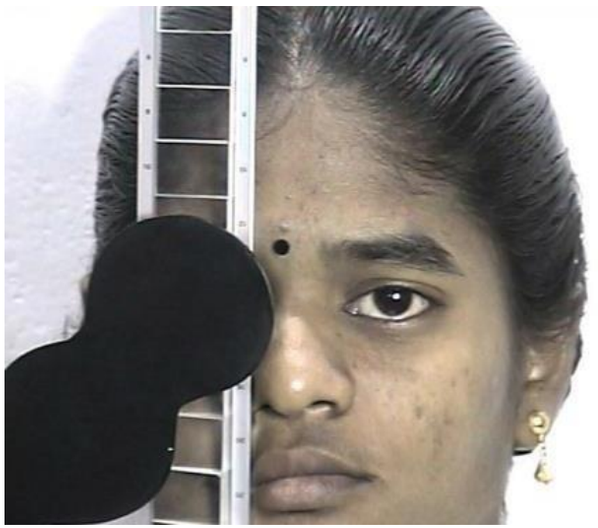
Prism cover test

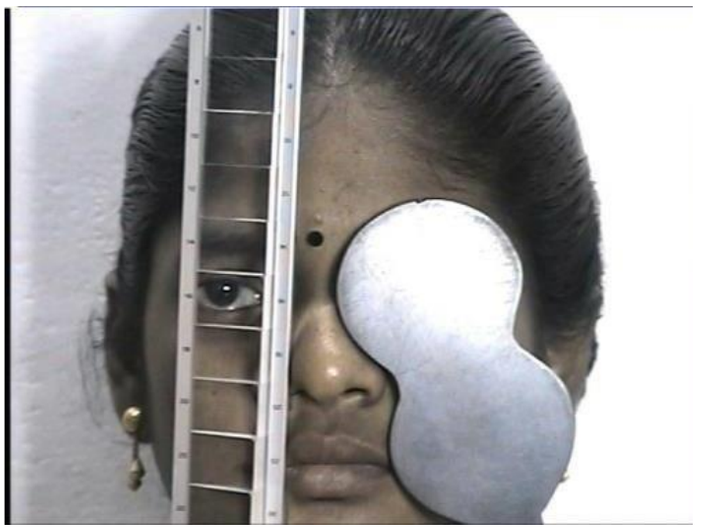
It measures angle of deviation on near or distance fixation and in any gaze position.
It combines alternate cover test with prisms.

Procedure - Prisms of increasing strength with apex towards the deviation are placed in front of one eye and the patient is asked to fixate an object with the other. The cover-uncover test is performed till there is no recovery movement of the eye under cover.

It gives the amount of deviation in prism dioptres.
Both heterophoria as well as heterotropia can be measured by this toct







Infantile esotropia (congenital esotropia)

esotropia of one or both eyes with an onset before the age of six months, with a constant, large angle of strabismus (> 30 PD), no or mild amblyopia, small to moderate hyperopia, latent nystagmus, dissociated vertical deviation

Treatment:

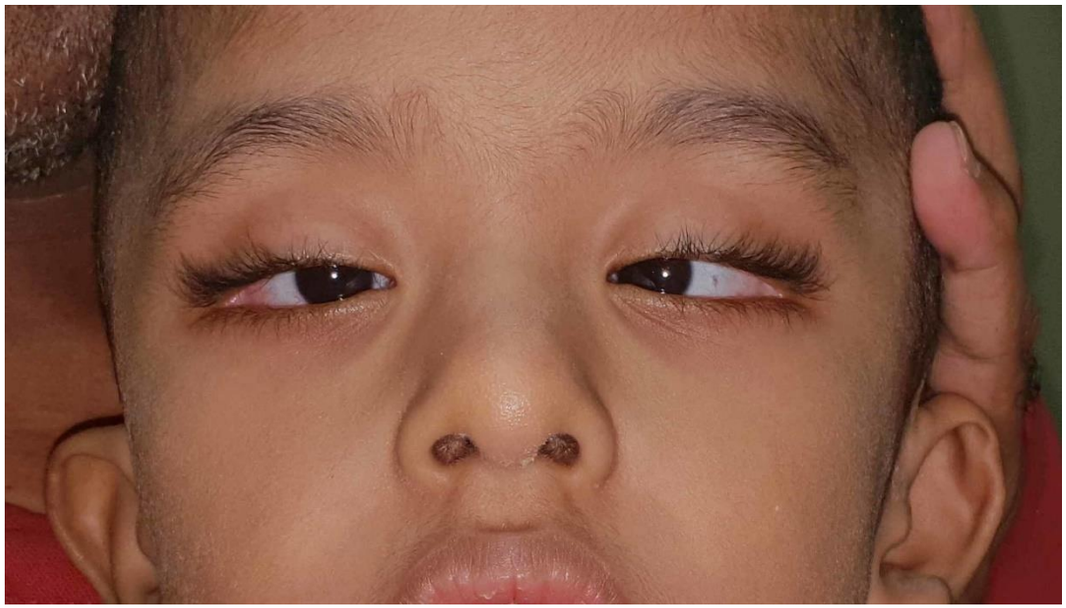
Surgery

Frequently, bilateral medial rectus recession is the initial surgery for infantile esotropia. Alternatively, recession and resection of horizontal eye muscles of the same eye may be preferred if there is amblyopia or an anatomic defect of one eye.

Botulinum toxin

Eye glasses

Eye patching




Infantile esotropia, before surgery

Accomodative esotropia

Accommodative esotropia is an inward turning of one or both eyes that occurs with activation of the accommodative reflex.

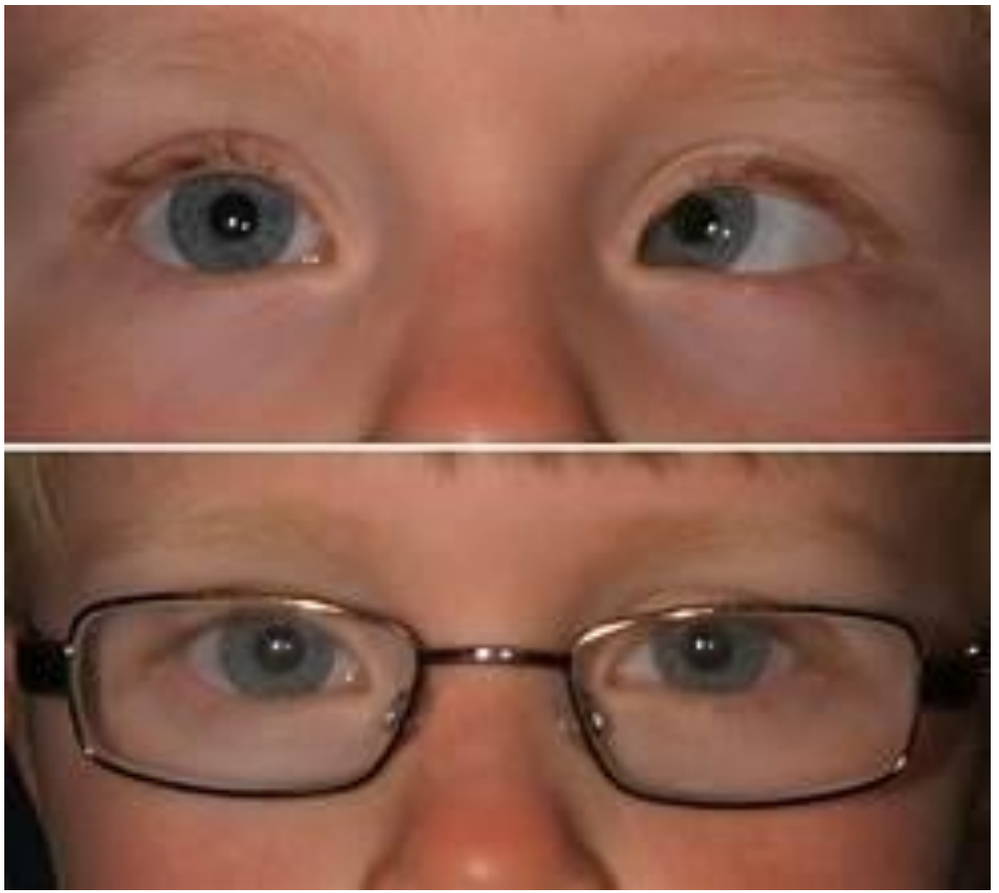
It is also called refractive esotropia and it is one of the most common forms of esotropia (crossed eye) in children. Accommodative esotropia happens when one or both eyes cross while trying to focus. This happens in children who are typically more farsighted (hyperopic) than usual. This means that the eyes must work harder to see clearly, particularly when the object of regard is up close

Onset usually between 6 months and 7 years of age, averaging 2.5 years

averaging between 20 and 40 prism diopters
The average cycloplegic refractive error in refractive accommodative esotropia is +4.75 D,3 but ranges between + 1.5 and +7.0 D.

Treatment:
The mainstay of treatment is spectacle correction in refractive accommodative esotropia.
There is some urgency in initiation of treatment because delay could result in loss of fusion ability, development of amblyopia, and loss of stereopsis

should be worn full time



Accomodative esotropia can be divided into:

(1) refractive
caused by uncorrected or under-corrected hyperopia

(2) non-refractive
caused by excessive convergence of the eyes in response to accommodation for near focus, regardless of refractive error.

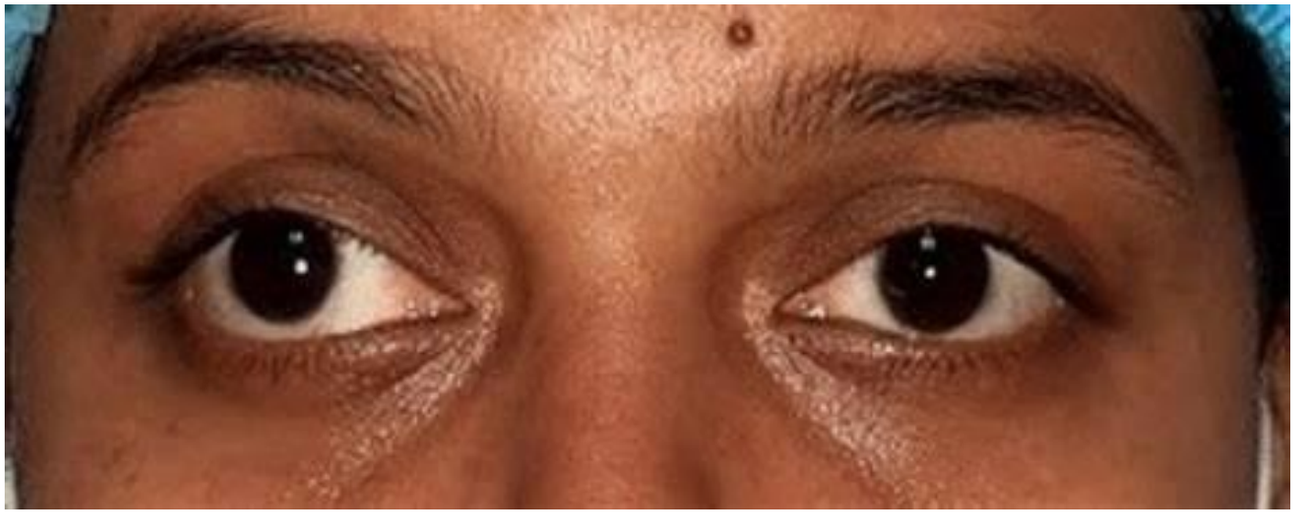
(3) partially accommodative or decompensated
No improvement with glasses
Needs surgery

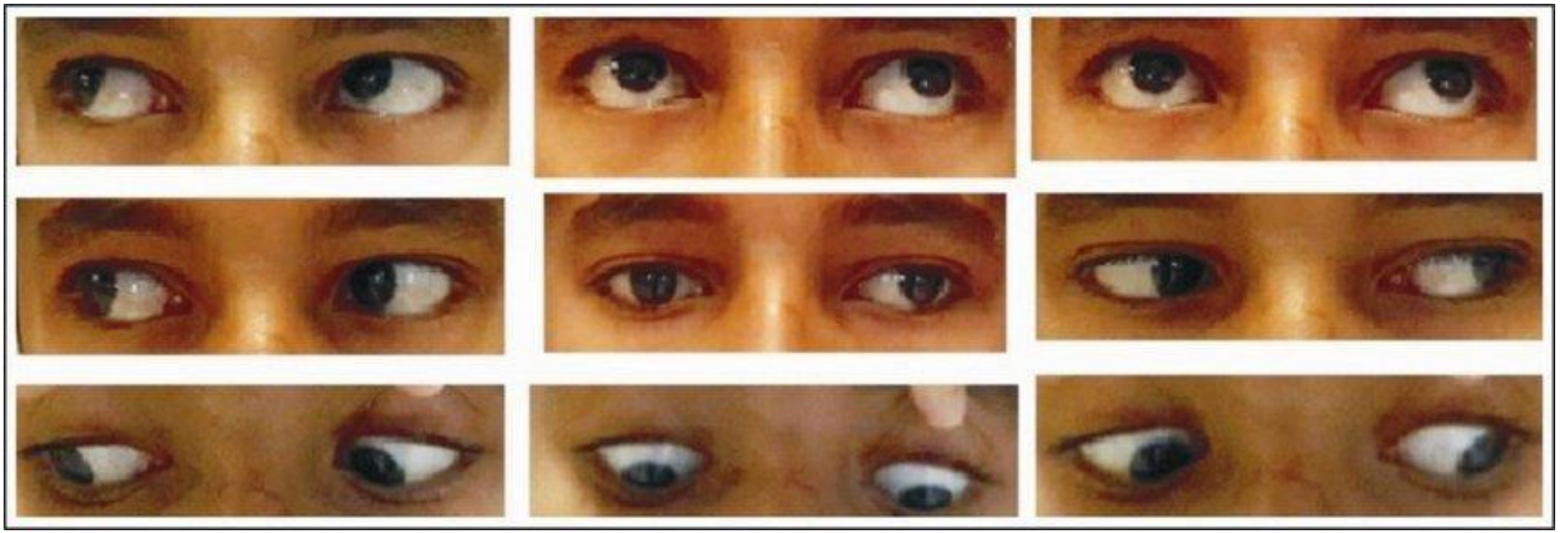
Alternating exotropia (intermittent exotropia)

Intermittent exotropia is the most common form of strabismus, characterized by an intermittent outward deviation of the eyes, affecting as much as 1% of the population. This condition most often presents in childhood and affects females more than males. Control of the intermittent deviation can vary throughout the day.

Treatment:

Surgery: lateral rectus resection / medial rectus resection / Recession-Resection Procedure
Botulinum toxin
Patching
Over-minus glasses





Paralytic (paralysis of one or more EOM)	Non-paralytic
Incomitant	Concomitant
Occurs in childhood and adulthood	Typically in childhood (2-4 years old)
Squinting eye has restricted movement	Eye movement full and equal bilaterally
Angle of deviation varies through different gazes	Angle of deviation constant, regardless of gaze direction
Present with diplopia (usually not associated with amblyopia)	Present with visible squint and amblyopia
Secondary deviation more than primary	Secondary deviation equal to primary
Causes: Trauma, Vascular, Neoplasia, Inflammation, raised intracranial pressure	Causes: High refractive error, cataract, retonoblastoma

Treatment

- The aim of treatment:

1) To restore the binocular single vision.

2) Anatomical alignment or improvement of cosmetic appearance.

* Time of treatment:

- Must be as soon as possible.
- Most cases of squint start between 2 - 5 years.
- After age of 10 years, treatment is difficult. Only cosmetic correction is possible

Lines of treatments

1. Glasses:

- It improves the visual acuity.
- It treats the squint by adjusting the relation between accommodation and convergence.

2. Surgery:

- Indications: |

a) Non-accommodative concomitant squint.

b) Residual angle of squint after correction of errors.

- The aim of surgical treatment:

- to get anatomical alignment and balance,
- so the rules of surgical treatment in concomitant squint is to:

a) strengthen (shortening) the weak muscle and / or

b) weaken (lengthening) the strong muscle.

- Operations to strengthen the muscles:

a) Resection: This shortens the muscle and makes it stronger.

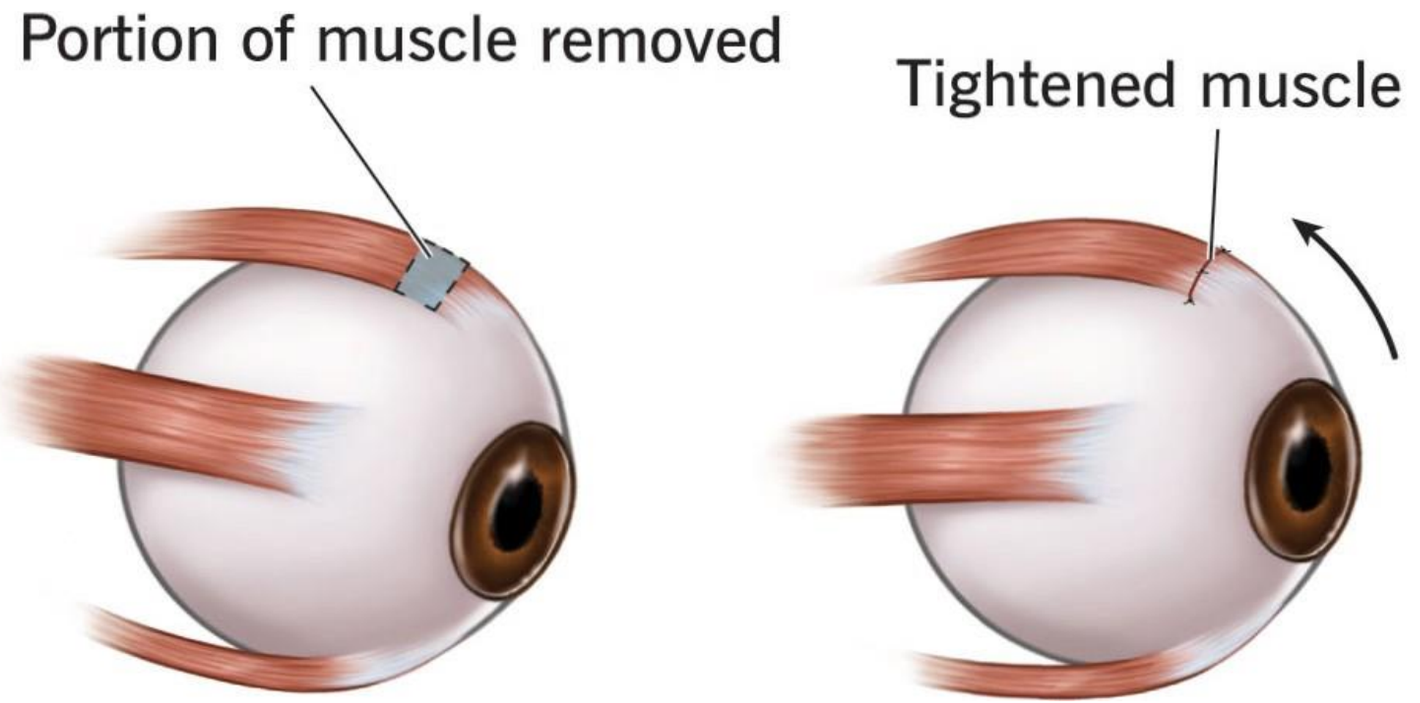
b) Recession: It means receding the insertion backwards to weaken the muscle.

- Rules for surgery:

c) 1 mm. recession or resection of M.R. corrects 3 degrees of deviation.

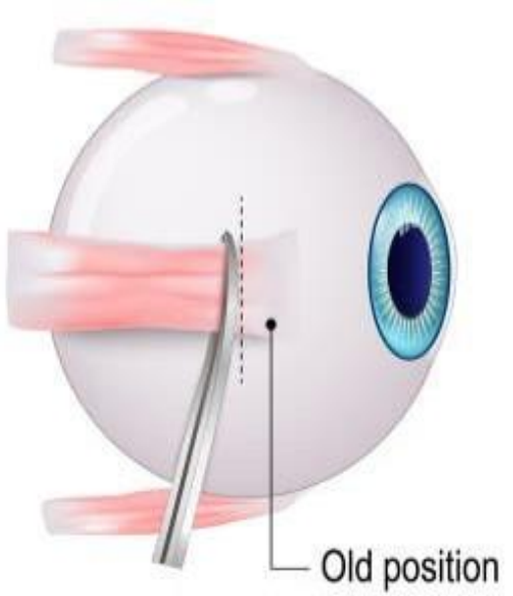
d) 1 mm. recession or resection of L.R. corrects 1 degrees of deviation.

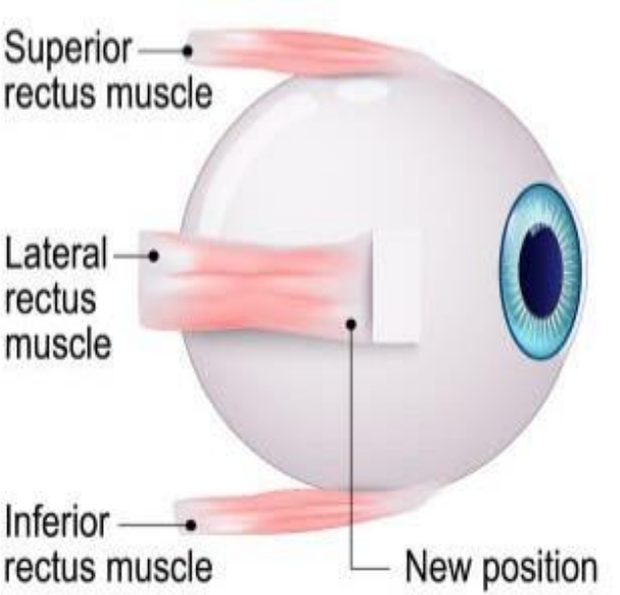
Resection



Following exposure of the muscle, the anterior tendon and muscle are resected, thus shortening them; the muscle is then reattached to its original position.

Recession





The conjunctiva has been incised to expose the medial rectus muscle. The muscle is then disinserted and moved backwards on the globe.

Paralytic squint

It is a true manifest deviation of the eye due to paralysis of one or more of the
extraocular muscles in which the deviation differs in different directions of the gaze.

- .... in which the deviation differs in different directions of the gaze (Angle of deviation is not constant).

Causes

- Paralysis of extraocular muscles results from lesions in:

{ the nucleus - the nerve - the myoneural junction - the muscle itself

1) Nuclear lesions:

1. Congenital: Aplasia.
2. Inflammatory: Encephalitis or neuro-syphilis.
3. Degenerative: Disseminated sclerosis.
4. Vascular: Aneurysm - thrombosis - hemorrhage or embolism.
5. Neoplastic: Brain stem tumors.

2) Nerve lesions:

1. Congenital: Rare.
2. Traumatic: Fracture skull base.
3. Inflammatory: Peripheral neuritis due to diabetes or herpes zoster.

3) Vascular:

1. Subarachnoid hemorrhage.
2. Cavernous sinus thrombosis.
3. Aneurysm.

4) Neoplastic: Meningioma - Orbital tumors.

5) Muscle & myoneural junction lesions:

1. Traumatic: contusion & hemorrhage in the muscle sheath.
2. Myasthenia gravis (lesion in the myo-neural junction)

Sign &symptoms

1. Deviation of the eye (Squint):

- In opposite direction to the action of paralyzed muscle.

* The angle of squint: is not constant .

> maximum on looking in the direction of action of the affected muscle

> minimum or even nil on looking to the opposite direction

• cover & uncover Test:

• interpretation:

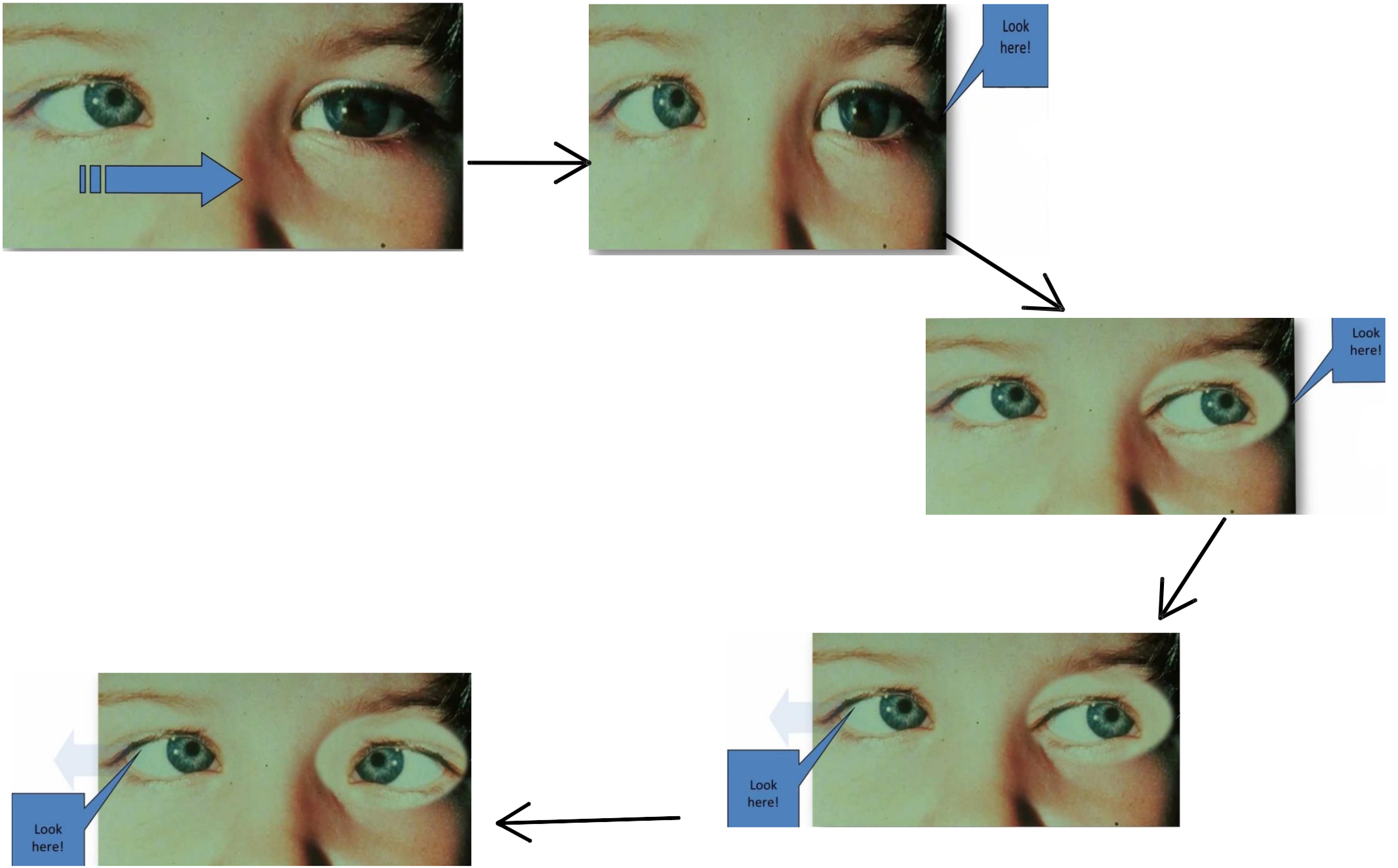
> Secondary deviation is much greater than angle of primary deviation.

> 1ry angle of deviation: Angle of squint when the normal eye is fixing.

> 2ry angle of deviation: Angle of squint when the paralyzed eye is fixing.

• Mechanism:

> Excessive impulses reach the paralyzed muscle to contract and according to Hering law, equal impulses reach the contralateral synergist (synergistic muscle in the sound eye) → more deviation. … { So, 2ry angle is > 1ry angle }


Look here!
Look here!
Look here!
Look here!

2. Binocular diplopia:

- It occurs in the direction of action of the paralyzed muscle and disappears when one eye is covered.
- Images fall on non-corresponding points of the retina resulting in 2 images:

1) True image: It falls on the fovea of the sound eye

2) False image: It falls on non-corresponding point (outside fovea) in paralyzed eye

* Diplopia may be:

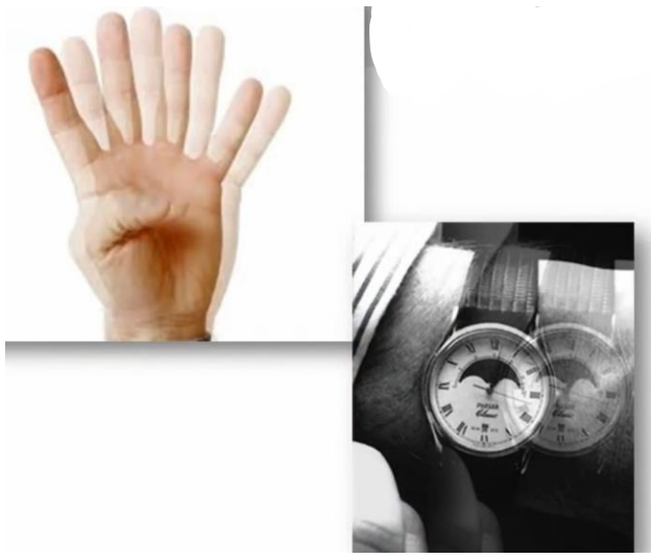
1) Homonymous (uncrossed) diplopia:

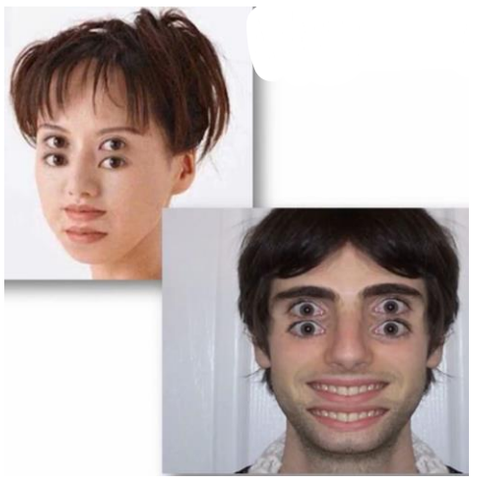
- when the false image is seen on the side of the paralyzed eye.
- It occurs in lateral rectus (abductor) paralysis.

2) Heteronymous (crossed) diplopia:

- When the false image is seen on the opposite side of the paralyzed eye.
- It occurs in medial rectus (adductor) paralysis.

* Horizontal, vertical or torsional diplopia





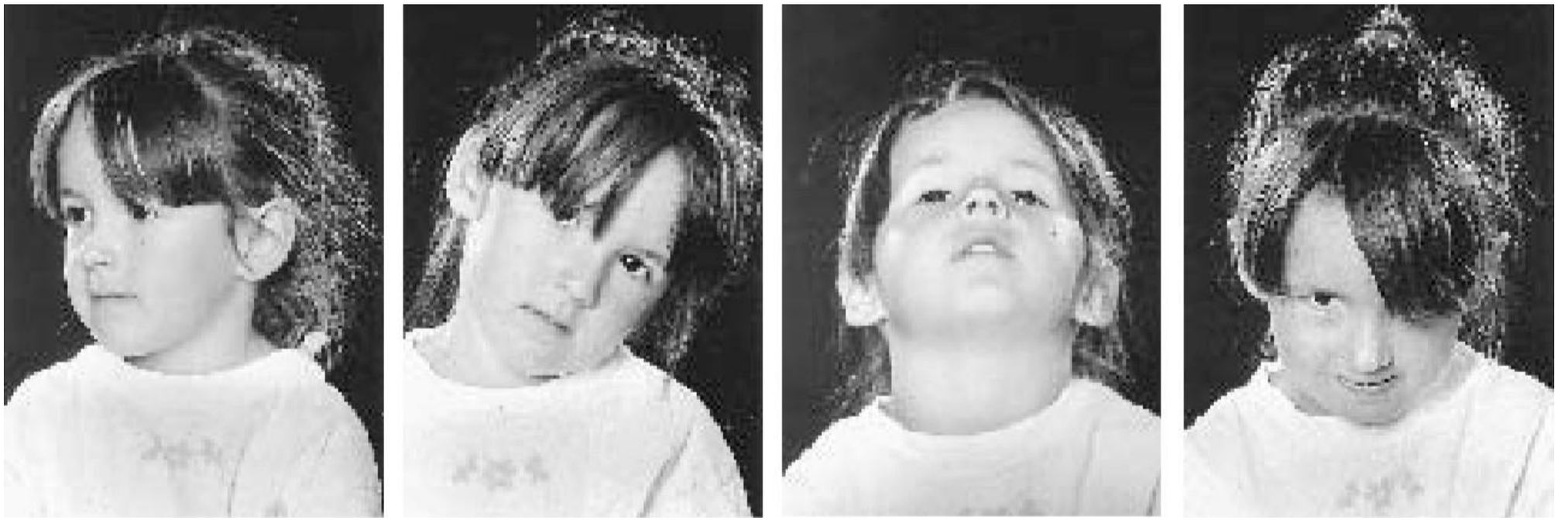
3. Limitation of the ocular motility:

- It occurs in the direction of action of the affected muscle.

4. Compensatory head posture (ocular torticollis):

- The patient tries to compensate his head posture to avoid diplopia.
- The head deviates in the direction of action of paralyzed muscle.

- MR & LR paralysis → Face turn.
- SR & IR paralysis → Chin elevation or depression.
- SO & IO paralysis → Head tilt.



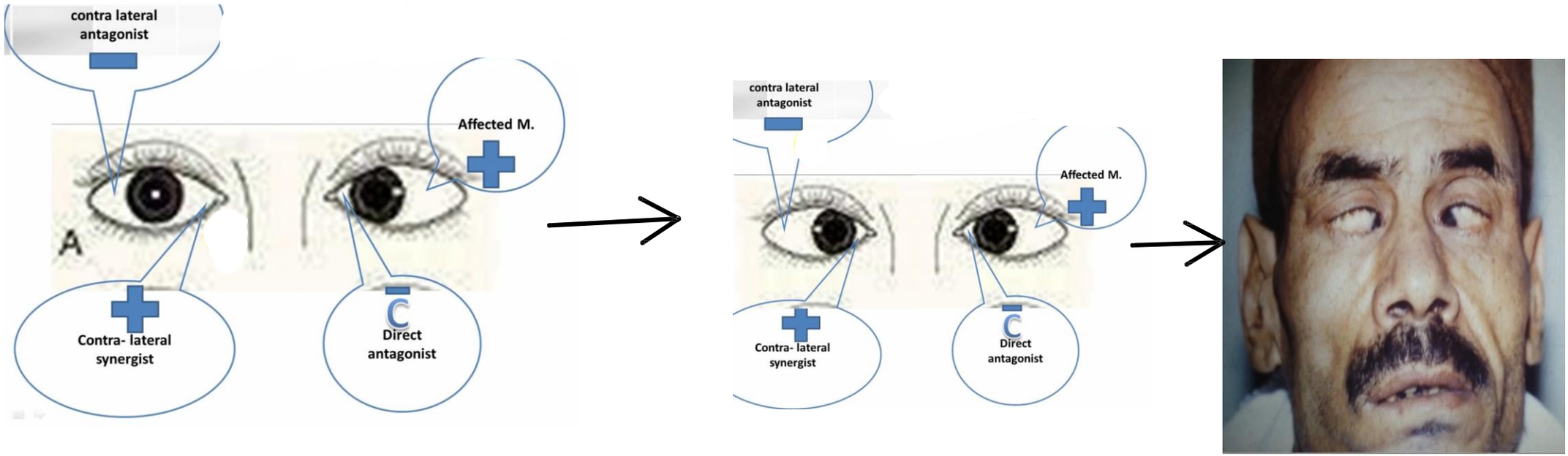
5. False projection:

- If we cover the normal eye of the patient and instruct him to point to an object, his finger will be directed away from the object in the direction of action of the paralyzed muscle.
- False projection is due to excessive nervous impulses needed to move the paralyzed muscle.

6. Headache - vertigo - dizziness - uncertain gait - Nausea & Vomiting

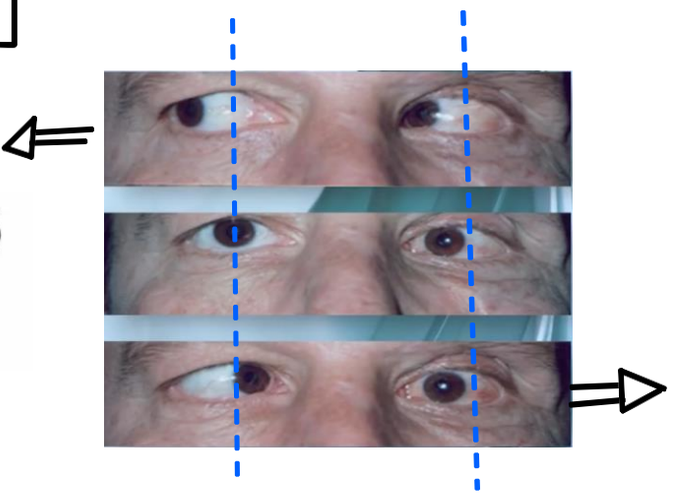
❖Muscle changes*:

- ➢Contracture of the direct antagonist.
- ➢Over action of the contra lateral synergist due to excessive impulses it receives.
- ➢Under action (secondary palsy) of contra lateral antagonist.



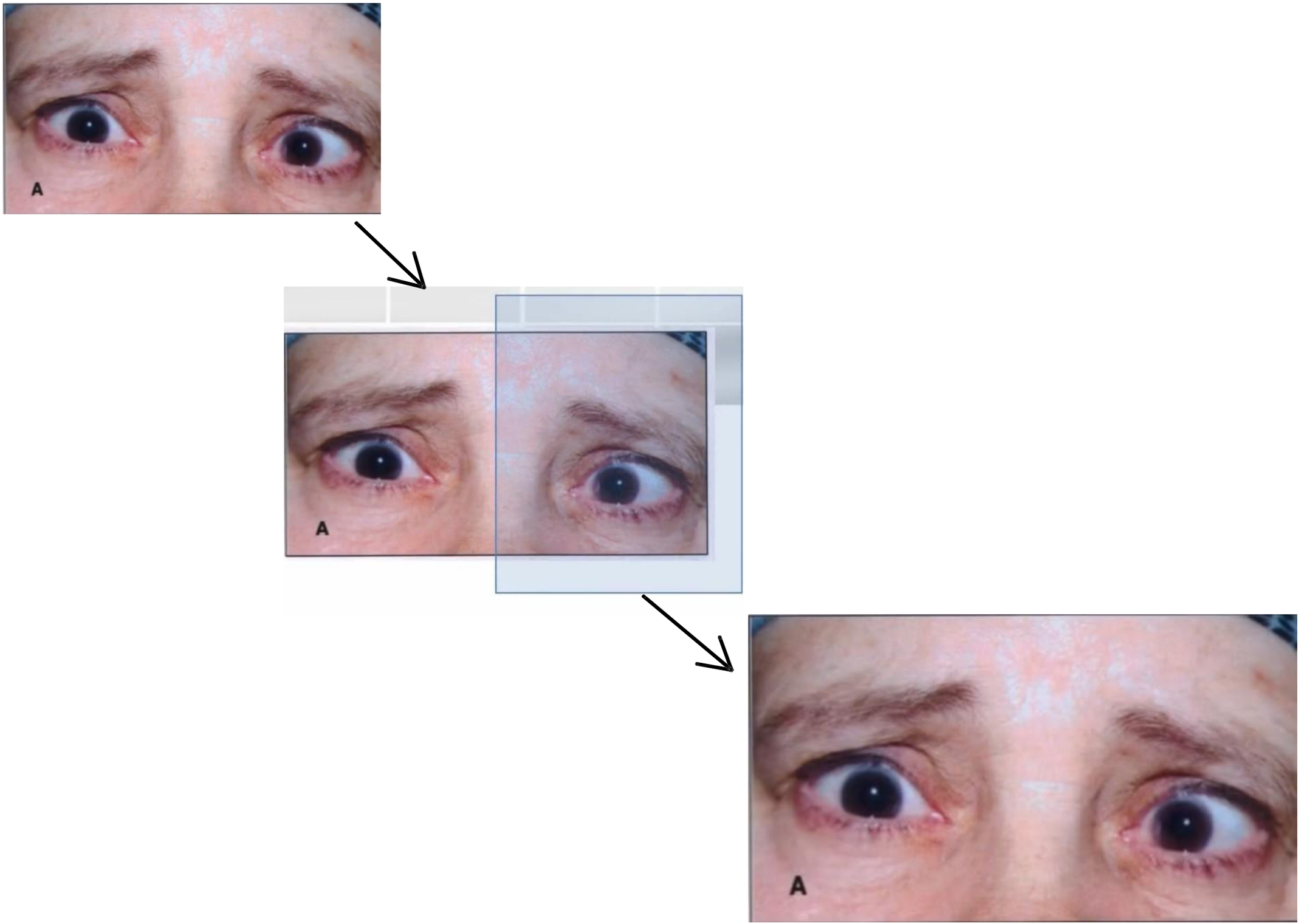
Diagnosis

- Diagnosis of the muscle paralyzed.
- Diagnosis of the cause refer for neurologist



- Examination of the ocular motility: 6 cardinal directions

- Cover-uncover;
  - If the squinting eye (paralyzed) is covered or uncovered nothing happens.
  - If the fixing eye is covered the paralyzed eye moves to fix the object and the fixing eye (under the screen) squints to bigger angle i.e. secondary deviation is greater than primary deviation.
  - When the cover is removed, the good eye resumes fixation.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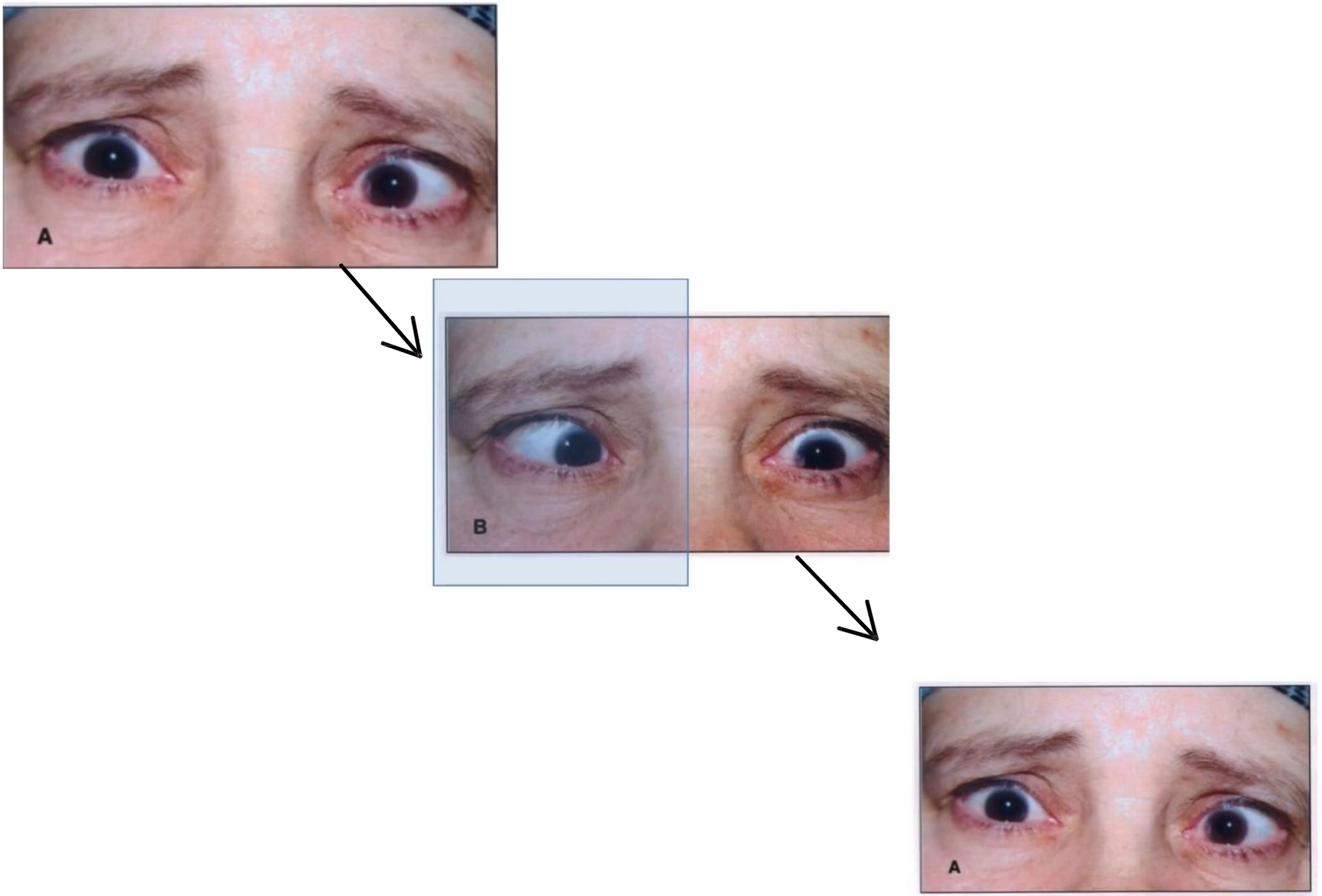
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I Treatment

1) Treatment of the cause.

2) Surgical treatment: If no recovery occurs within 6 months surgery will be recommended

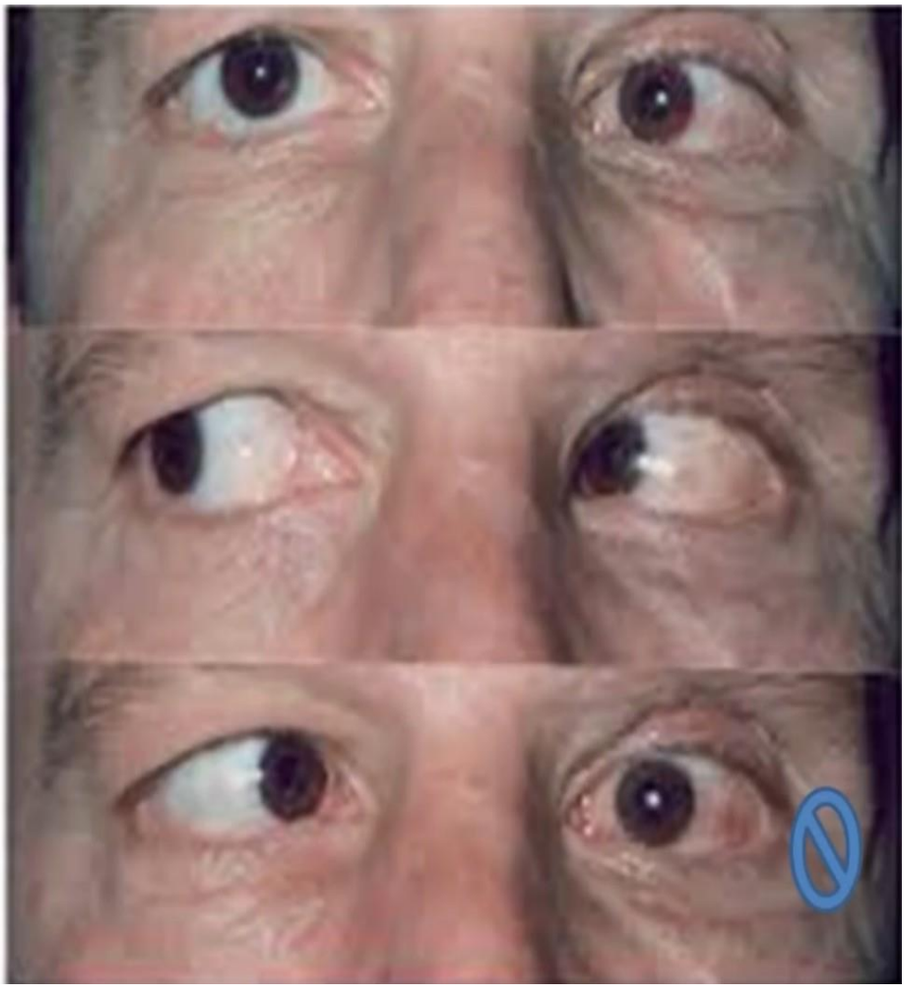
Sixth nerve palsy

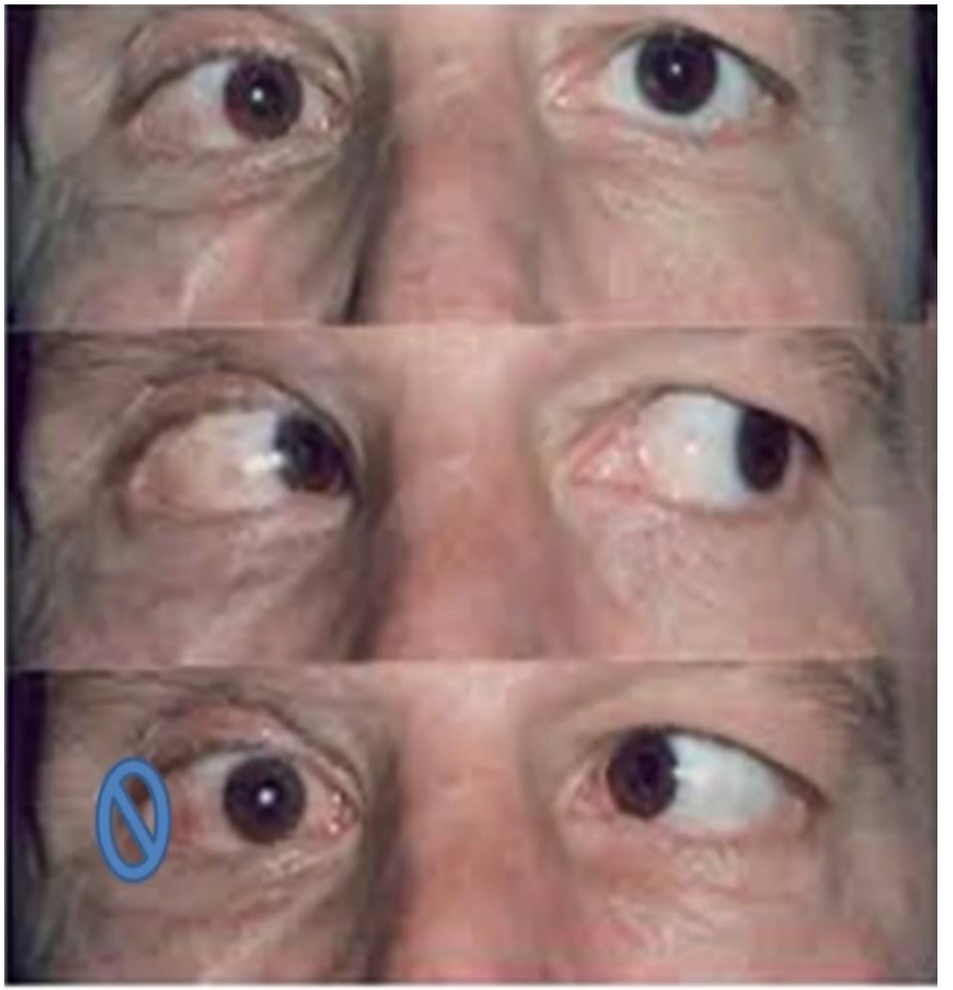
- Here the lateral rectus becomes paralyzed.
- If the right side is affected the clinical picture will be:

1) Convergent squint in right eye.
2) Limitation of abduction of the right eye.
3) The angle of squint is large when the patient looks to the right.
4) The angle of squint is larger when the right eye attempts fixation

{ angle of secondary deviation is greater }

5) Diplopia is most marked when the patient looks to the right. Diplopia is uncrossed.
6) False projection occurs to the right side.
7) The patient turns his face to the right to avoid diplopia



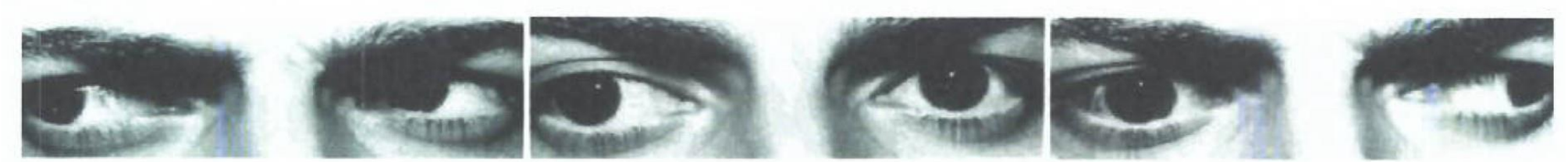


Third nerve palsy

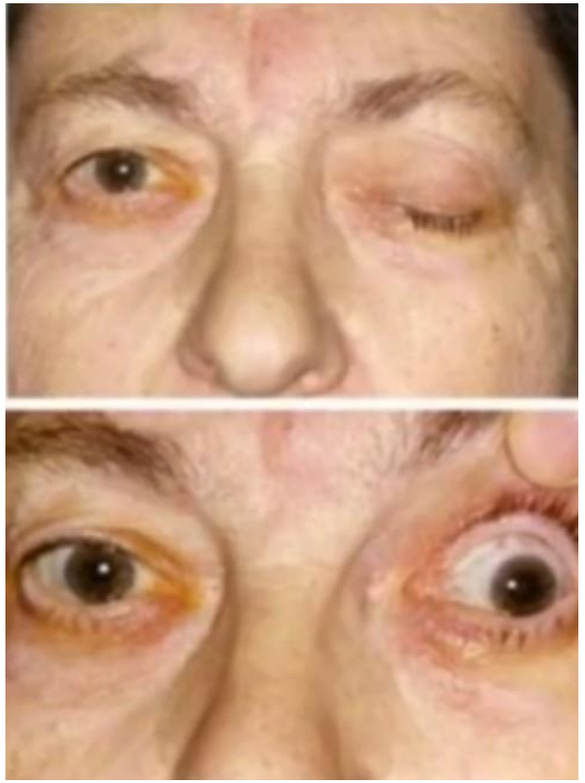
1) Ptosis (levator paralysis)
2) Deviation of eye out (lateral rectus).
3) Superior oblique is a depressor in adduction and the eye cannot be adducted but it

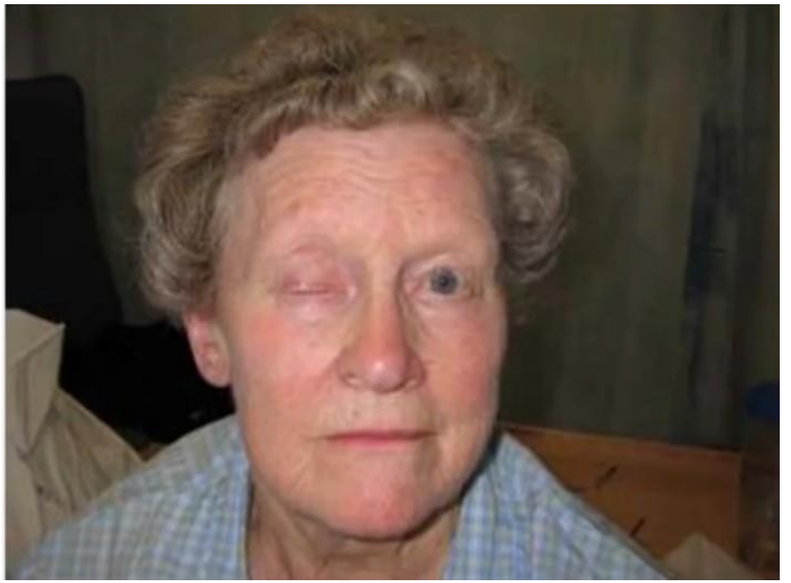
can only intort the eye on attempt downgaze.

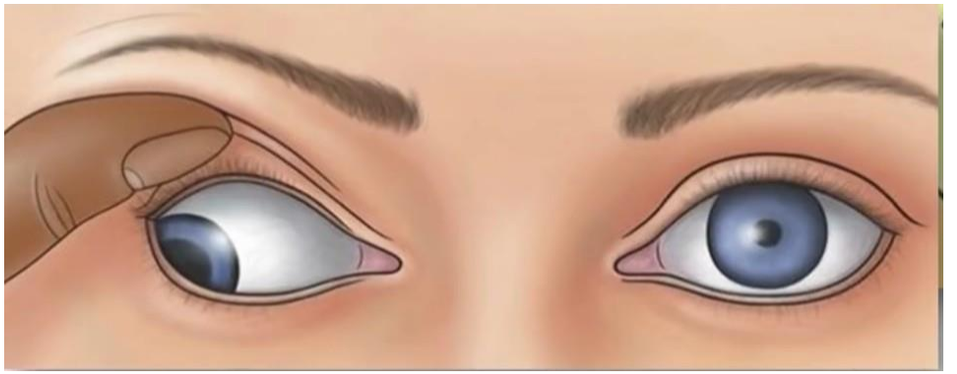
4) Limitation of movement in the direction of involved muscles.
5) Diplopia does not occur due to Ptosis.
6) Dilatation of pupil and paralysis of accommodation.
7) Proptosis is mild due to loss of the tone of the paralyzed muscles.



Rt. MR paralysis

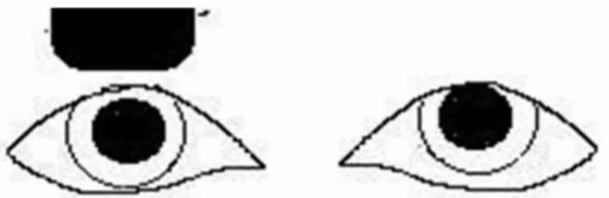






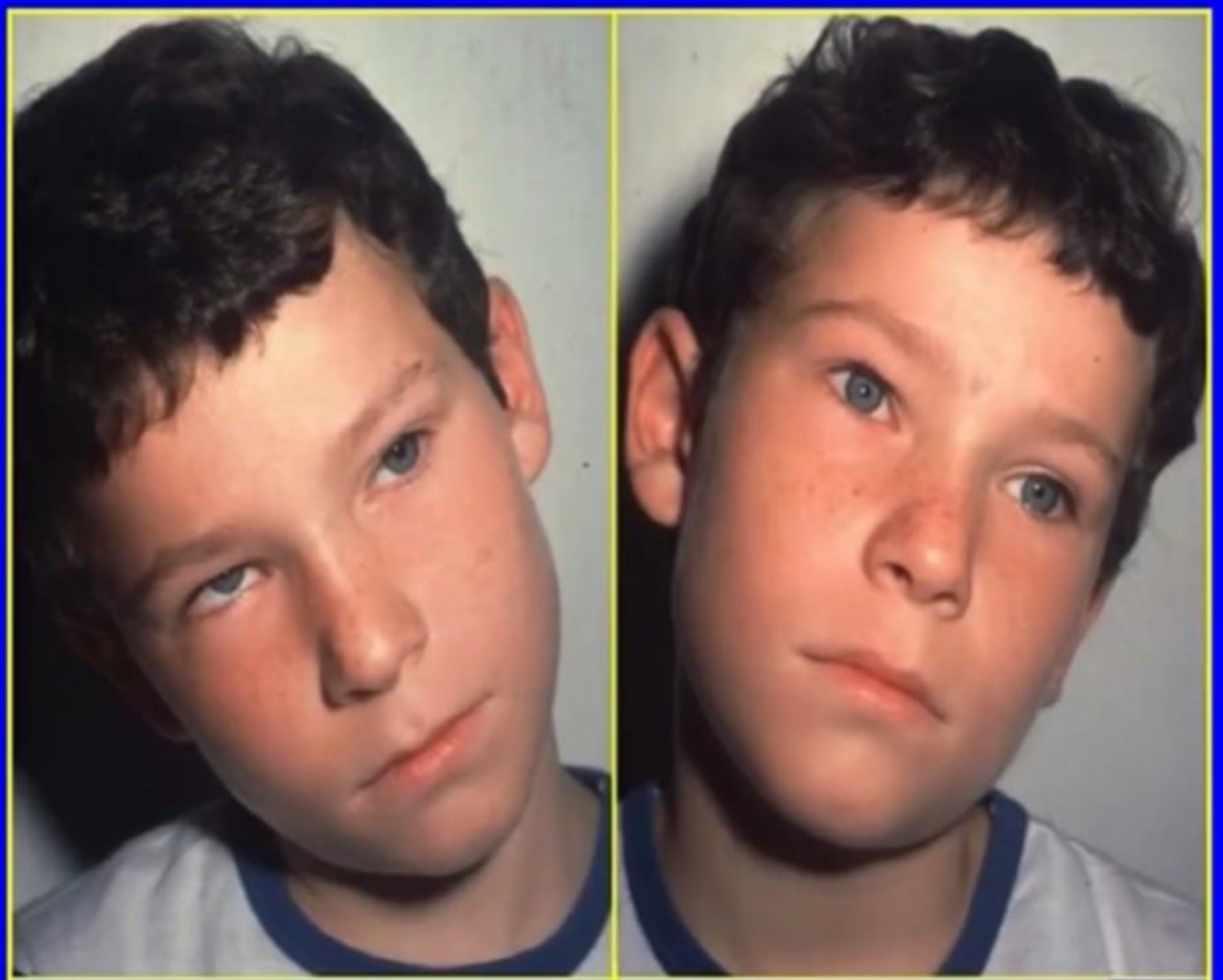
Forth nerve palsy

- The is deviated up (hypertropia).



- Uncrossed binocular diplopia is marked when the eyes looks down

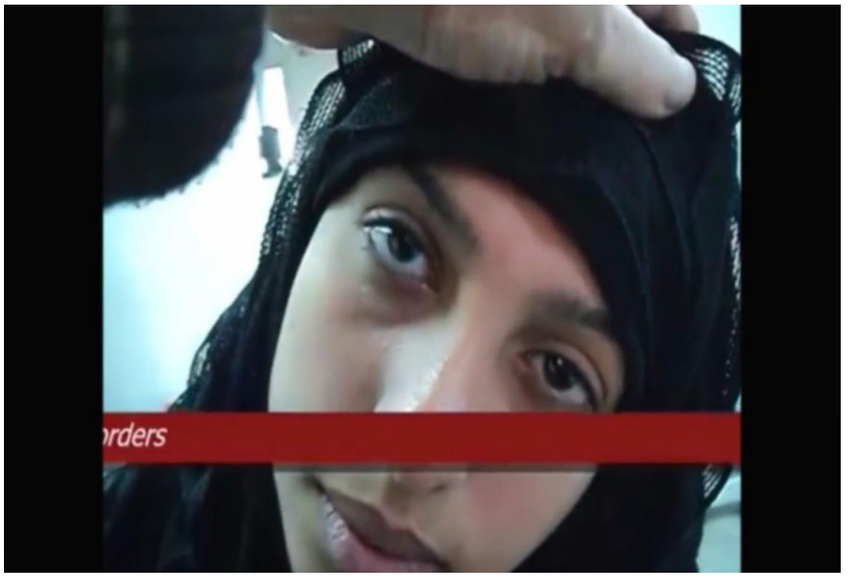
Positive Bielschowsky test in right fourth nerve pal



Increase in right hyperdeviation on ipsilateral head tilt

Absence of right hyperdeviation on contralateral head tilt


culomotor Disorders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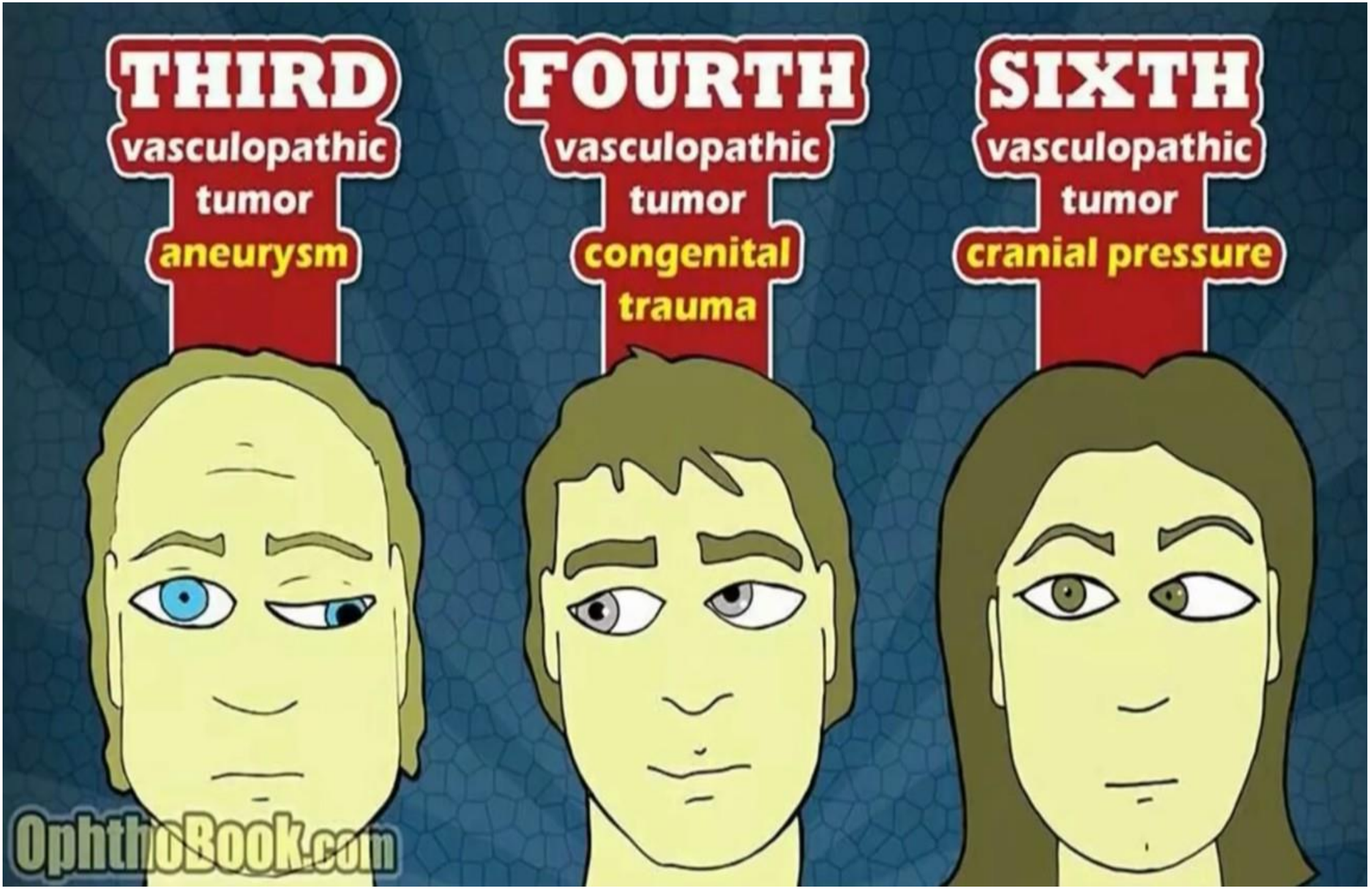
THIRD
vasculopathic
tumor
aneurysm
FOURTH
vasculopathic
tumor
congenital
trauma
SIXTH
vasculopathic
tumor
cranial pressure
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