ANALYSIS OF
SURGICAL MANAGEMENT OF
A-V PATTERN DEVIATIONS

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CERTIFICATE

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ANALYSIS OF
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A-V PATTERN DEVIATIONS

INTRODUCTION:

Binocular single vision (BSV) is one of the hallmarks of the human race that has bestowed on it the supremacy in the hierarchy of the animal kingdom. BSV is accomplished by a perfect sensorimotor coordination of the two eyes both at rest and during movement. The two dimensional images of an object formed at the fovea of each eye, transmitted to the respective visual cortex are processed and perceived as three dimensional percept. This requires constant and controlled activity of the appropriate muscles to maintain fixation on the object. It also requires the accomodational mechanism to maintain clear view even as the object moves closer or farther.

HISTORICAL REVIEW:

Hippocrates, the father of medicine differentiated between concomitant and paralytic squint and stressed the hereditary aspects.

1743-George.L.deBuffon recommended occlusion of the normal eye to force the squinting eye to use.

1900	Worth and Black invented the amblyoscope
1914	Ettles introduced synoptophore
1978	Campbell introduced CAM treatment for stimulating the macula of the eye with eccentric fixation.

HISTORY OF STRABISMUS SURGERY:

In 1752, Eschenbach divided a muscle to correct squint. In 1818, Gibson experimented with extraocular muscle transection for treatment of esotropia.

In 1839, D.F.Dieffenbach was the first to successfully perform a myotomy.

HISTORICAL REVIEW OF A-V PATTERNS:

In 1948, Urrets-Zavalia described the importance of performing measurements of deviation in upward, downward and primary positions of gaze. He also said that oblique overactions and underactions are associated with increased or decreased convergence or divergence in these positions.

In 1950, Urist introduced this concept in American literature.

In 1951, Albert suggested the descriptive terms A&V pattern.

In 1951, Urist published papers about horizontal theory of A-V patterns.

ANATOMY

A clear understanding not only of the extraocular muscles but of the fascial structures and fat associated with the globe and orbit is a pre-requisite to successful surgery. The conjunctiva, anterior tenon's capsule, posterior tenon's capsule (intermuscular membrane) and muscle sheath play an important role in the movement of the globe.

CONJUNCTIVA

The bulbar conjunctiva fused with the underlying anterior tenon's capsule is firmly attached to the sclera at the limbus. It has multiple fine embedded arterioles and veins, which are branches of the anterior ciliary vessels and the marginal vascular arcade of the lid. This circulation provides a small but significant blood supply to the anterior segment.

TENON'S CAPSULE

Tenon's capsule is a condensation of fibrous tissue extending from limbus to optic nerve entrance. The anterior orifice of tenon's capsule is attached to the sclera 2mm from limbus. The posterior orifice is fused with the optic nerve sheath. The muscles enter through slits and vortex veins make small openings.

Each extra ocular muscle has an extra capsular (outside Tenon's) and intracapsular portion. In the extracapsular portion it is encased in a muscle sheath: a reflection of Tenon's capsule running backwards for a distance of 10-12mm. The muscle sheaths of the four recti are connected by a fascial formation called the intermuscular septum. The intracapsular portion has no muscle sheath.

It is divided in to anterior and posterior parts. The anterior tenon's capsule is fused with the conjunctiva and overlies the anterior half to two thirds of the rectus muscles and the intermuscular membrane. The posterior tenon's capsule is composed of the fibrous sheath of the rectus muscles with the intermuscular membrane.

The extent to which the intermuscular membrane is dissected will determine how far the recti, especially the medial and lateral recti will retract during surgery.

EXTRAOCULAR MUSCLES

There are three pairs of extra ocular muscles in each eye ball. A pair horizontal rectus (medial &lateral recti) a pair of vertical rectus muscle (superior and inferior rectus) and a pair of oblique muscle (superior and inferior oblique muscles)

RECTUS MUSCLES

All the recti take origin from the annulus of Zinn which surrounds the optic canal and in part superior orbital fissure while the medial rectus runs almost straight, parallel to the saggital plane, the lateral rectus run anterolateralllly, makes an angle of about 40-45 degree with the sagittal plane.

The two vertical recti make an angle of about 23degree with the sagittal plane. The recti then curve around the globe strapping it, the lateral rectus the most, and the medial rectus there least. They finally get inserted anterior to the equator, at a varying distance from the limbus. These insertions form the spiral of Tillaux.

SUPERIOR OBLIQUE

The superior oblique arises from the superomedial part of the optic foramen, runs parallel and close to upper part of medial wall upto trochlea, where it turns around and runs posterolaterally making an angle of 54 degree with the sagittal plane. The post- trochlear part becomes fan-shaped, passes beneath the superior rectus and gets attached posterior to equator. It is the longest extra ocular muscle length being 60mm, 40mm pre-trochlear and 20mm post-trochlear.

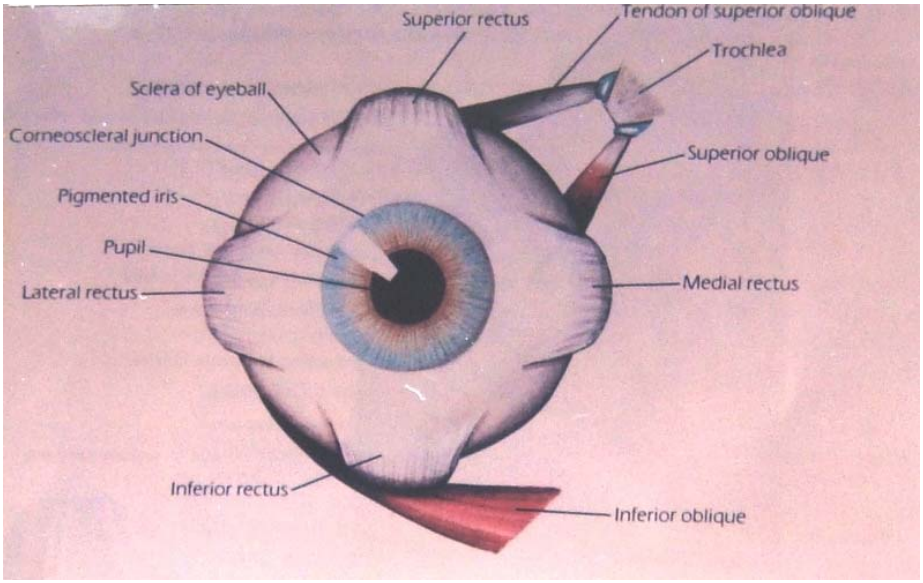
The posterior fibres of the fan are responsible for depression and the anterior fibres are responsible for intorsion. For practical purposes, the trochlea acts as a functional origin of superior oblique.

INFERIOR OBLIQUE

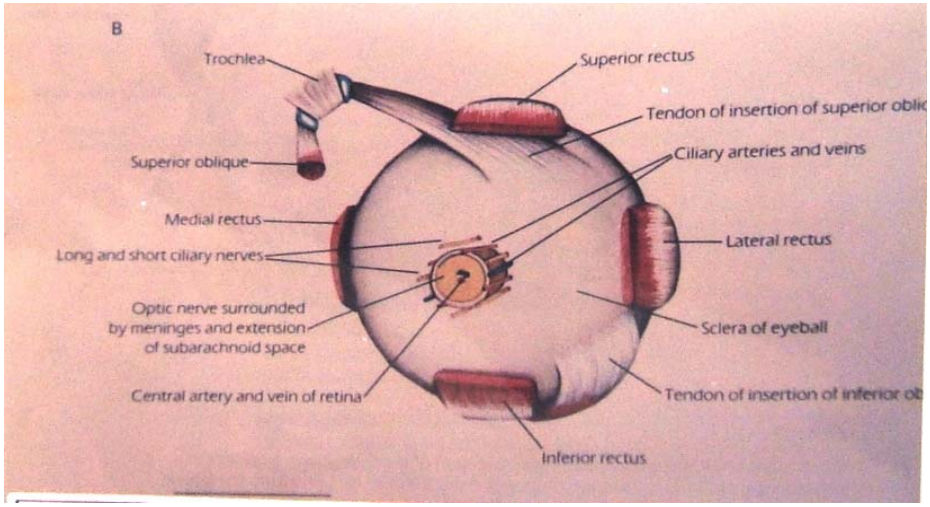
It is the shortest of all, 37 mm, originates in the anteroinferior angle of the bony orbit in a shallow depression in the orbital plate of the maxilla. It runs posterolaterally 51degree to the sagittalplane, passing below inferior rectus inserting in a fan shaped manner. The insertion is about 9mm wide.

Its anterior end of insertion is located about 10mm behind and 1-2mm above the lower edge of lateral rectus. The posterior end is located 1mm below and 1-2mm lateral to the macula. Its posterior fibres are responsible for elevation and anterior fibres for extorsion.

Anterior view of extra ocular muscle



Posterior view of extra ocular muscle



ANATOMIC FEATURES OF THE RECTI AND OBLIQUES

Muscles	Length (mm)	Length of Tendon (mm)	Width of Tendon (mm)
Medial rectus	40	3.7	10.3
Inferior rectus	40	5.5	9.8
Lateral rectus	40	8.8	9.2
Superior rectus	40	5.8	10.8
Inferior oblique	37	1	9.4
Superior oblique	60	30	10.7

LIGAMENT OF LOCK WOOD

The fascia of the inferior oblique and inferior rectus gets meshed to form the suspensory ligament of Lockwood. Some of the fibres of the lower lid are also attached to this and a large recession of inferior rectus without separating these fibres causes drooping of the lower lid. Similarly a large resection there is a narrowing the palpebral fissure.

A similar effect is seen in the position of the upper lid on large recession and resections of the superior rectus, without separating the fibrous attachment between the upper lid and the superior rectus. A recession causing a retraction and a resection causing a ptosis.

BLOOD SUPPLY

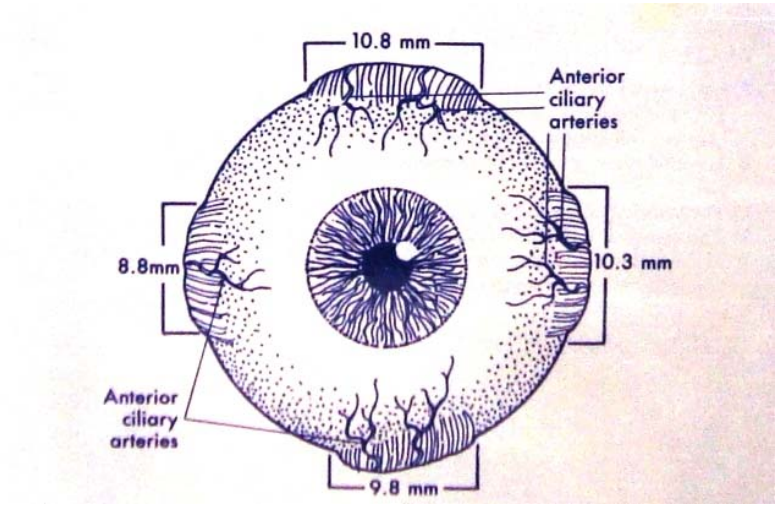
All the recti and superior oblique get their vascular supply and innervation on its inner aspect at the junction of the middle and distal third. The inferior oblique gets its innervation and blood supply as it crosses the nasal border of the inferior rectus. The obliques do not contribute to the anterior ciliary circulation. Each of the recti, except the lateral rectus, contributes two anterior ciliary arteries, the lateral rectus gives one all of

which provides 70-80% of the blood supply to anterior segment. The remaining is provided by long posterior ciliary arteries that come forward intra sclerally at 3'o and 9'o clock position. Thus a surgery on the two vertical recti along with the lateral rectus can cause anterior segment ischemia.

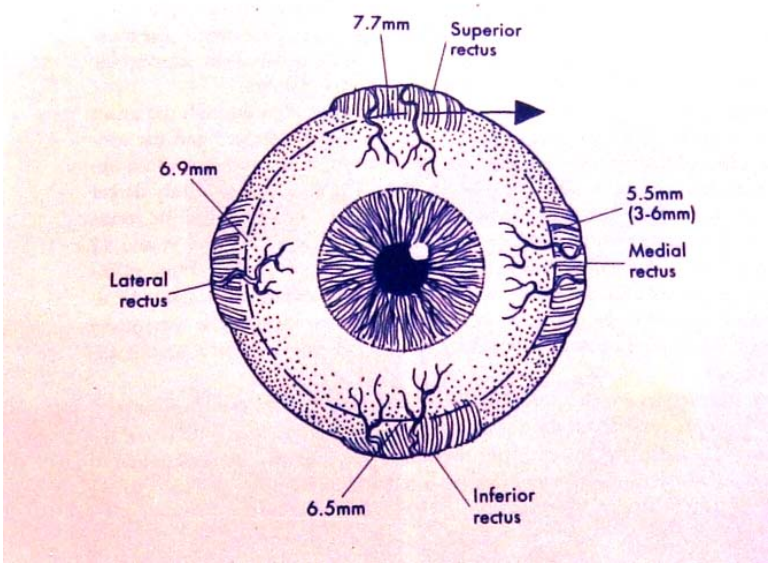
NERVE SUPPLY

The oculomotor nerve supplies to superior rectus, medial rectus, inferior rectus, inferior oblique and also to levator palpebrae superioris and intraocular muscles: sphincter pupillae, and ciliary muscles. The abducent nerve supplies the lateral rectus. The trochlear nerve supplies the superior oblique.

Width of Tendon insertion of recti muscles



Spiral of Tillaux



PHYSIOLOGY OF OCULAR MOVEMENTS

DUCTION MOVEMENTS

Ductions are monocular eye movement around “axes of fick”. The eye ball rotates around one of three axes. Perpendicular to these axes three planes of eye movement called Listing planes, which is listed below;

Horizontal plane: Horizontal eye movements around vertical Z-axis (abduction &adduction)

Vertical plane : vertical eye movements around horizontal X-axis. (elevation & depression)

Torsional plane: Torsional eye movements around anteroposterior Y-axis. (intorsion &extorsion)

VERSIONS MOVEMENTS

“Versions” are binocular eye movements that are in the same direction (conjugate eye movements). Binocular eye movements in the opposite direction (disconjugate eye movements) are called “vergences”.

Dextroversion: right sided binocular horizontal eye movement.

Levoversion: left sided binocular horizontal eye movement.

Sursumversion: straight up binocular vertical eye movement.

Deorsumversion: straight down binocular vertical eye movement.

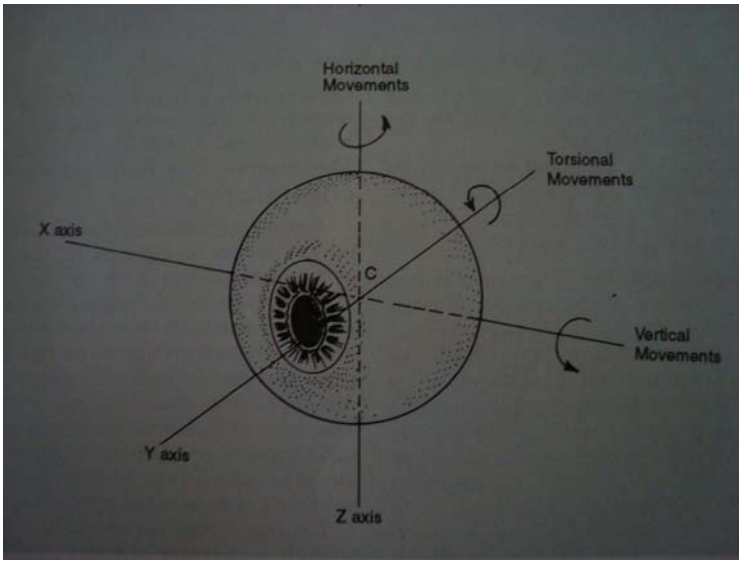
Dextroelevation: right and upward binocular oblique eye movement.

Levoelevation: left and upward binocular oblique eye movement.

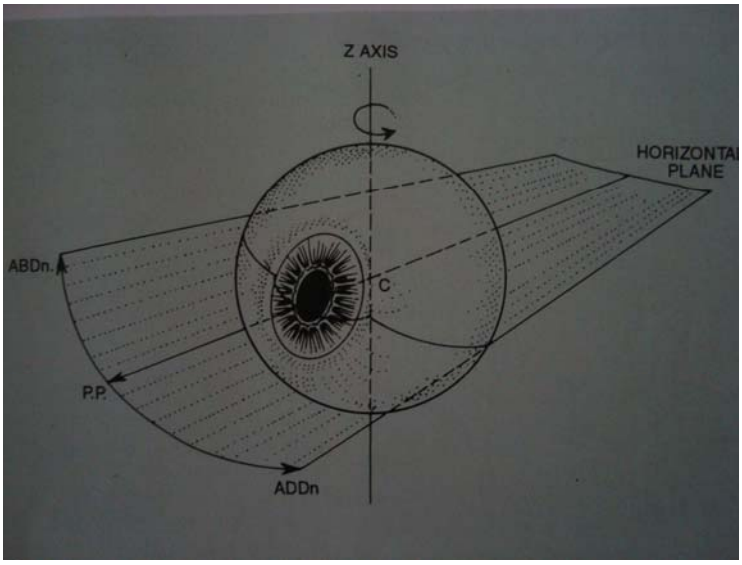
Dextrodepression: right and downward binocular oblique eye movement.

Levodepression: left and downward binocular oblique eye movement.

Planes and axes of eye movements



Planes and axes of eye movements



VERGENCES

Vergences are binocular, simultaneous, disjugate movements (in opposite direction).Convergence is simultaneous adduction. Divergence is outward movement from a convergent position. Convergence may be voluntary or reflex. Reflex convergence has four components;

Tonic convergence: which implies inherent innervational tone of the medial recti when the patient is awake.

Proximal convergence: is induced by psychological awareness of a near object.

Fusional convergence: is the fine adjustment necessary for binocular fixation which maintains BSV by ensuring similar images are projected onto corresponding retinal areas of each eye.

Accomodative convergence: is induced by the act of accommodation as part of synthetic near reflex. Each dioptre of accommodation is accompanied by a constant increment in convergence giving AC/A ratio.

DIAGNOSTIC POSITIONS OF GAZE

The primary position of the globe is assumed when ore is looking straight ahead. Primary action of a muscle is its major effect when the eye is in the primary position. The abducted, adducted, elevated and depressed positions of the globe ore termed as secondary position. The oblique positions of the eye are termed as tertiary position. Subsidiary actions (secondary & tertiary) are the additional actions which depend on the position of the eye.

PRIMARY & SUBSIDIARY ACTIONS OF EOM

HORIZONTAL RECTI

Their axis of rotation coincides in the primary position with Z-axis. As a result lateral rectus abducts the line of gaze and the medial rectus adducts the line of gaze. However in extreme positions of elevation and depression these muscles have a component of elevation and depression (secondary action).

VERTICAL RECTI

Superior rectus muscle primarily acts as an elevator in primary position its secondary action being intorsion when abducted 23 degree if is a pure elevator when adducted it becomes more and more an intorter.

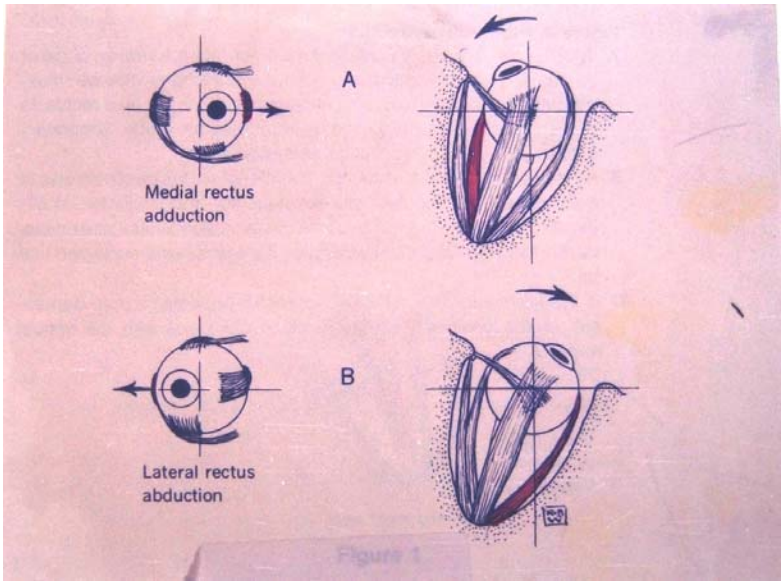
Inferior rectus, a depressor in the primary position becomes or better depressor in abduction and on adduction it becomes a better extorter. The tertiary action of vertical recti is adduction.

OBLIQUE MUSCLES

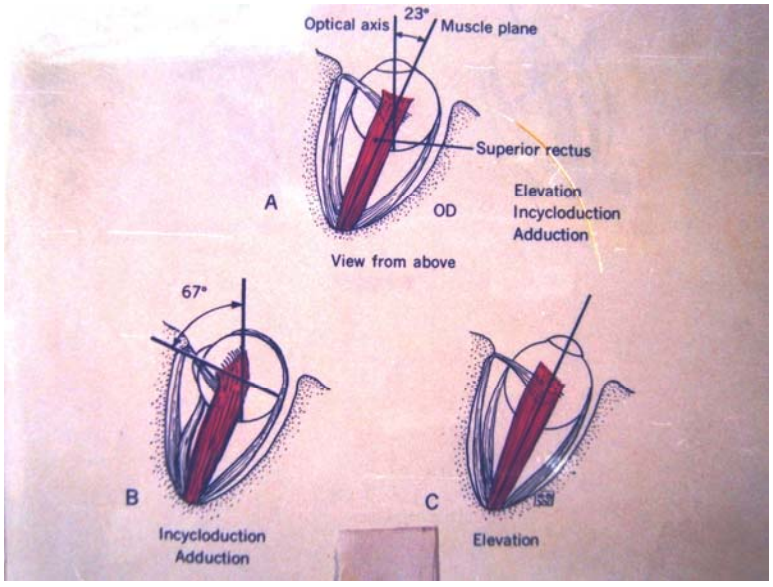
The superior oblique is primarily an 'intorter' in the primary position if adducted it becomes more and more a 'depressor'. When adducted 54 degree it becomes a pure depressor. When abducted progressively it becomes an intorter and it's a pure intortor at 36 degree abduction.

Similarly the inferior oblique primarily an extorter becomes a pure elevator at 51 degree adduction and a pure extorter in 30degree abduction. The tertiary action of oblique is abduction.

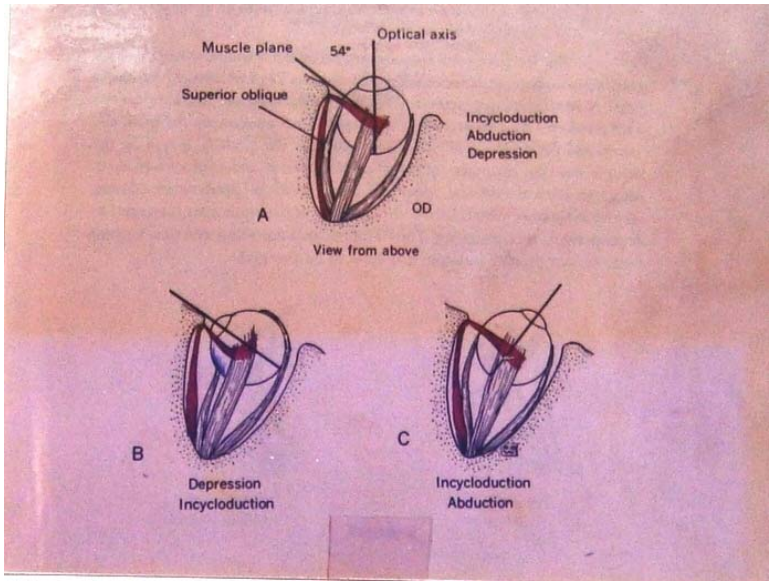
Action of Horizontal recti muscles



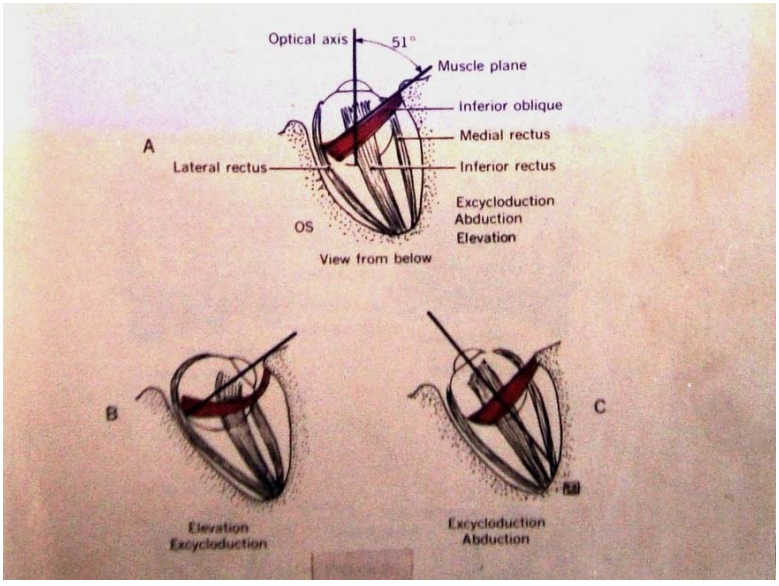
Action of vertical recti muscles



Actin of superior oblique muscle



Action of inderior oblique muscle



LAWS OF OCULAR MOTILITY

AGONIST- ANTAGONIST pairs are muscles of the same eye that move the eye in opposite directions. The agonist is the primary muscle moving the eye in a given direction. The antagonist is the opposite direction to the agonist.

SYNERGISTS: are muscles of the same eye that move the eye in the same direction. For example right superior rectus and right inferior oblique act synergistically in elevation.

YOKE MUSCLE (contralateral synergists) are pairs of muscles one in each eye that produce conjugate ocular movements. For example the yokemuscle of the left superior oblique is the right inferior rectus.

HERING'S LAW states that for any binocular movements the corresponding yoke muscle receives equal and simultaneous innervation.

SHERRINGTON'S LAW states that for any binocular eye movement the direct antagonist receives an equal and simultaneous inhibition of its innervation.

DONDER'S LAW states that to each position of the line of sight belongs a definite orientation of the horizontal and vertical meridians relative to the co-ordinate of space.

LISTING'S LAW states that there is no real torsion or cyclorotation of the eye around anteroposterior axis, when it comes to a tertiary posterior from the primary position.

STRABISMUS

- Visual axis passes from the fovea, through the nodal point of the eye to the point of fixation.
- In normal binocular single vision (BSV) the two visual axis intersert at the point of fixation, the eyes are said to be in alignment i.e. ‘orthophoric’.
- When the two visual axes are not aligned to the point of fixation, that is one eye fixates at the point, but the other eye do not, a ‘strabismus’ or ‘squint’ or ‘heterotropia’ results.
- When this tendency is overcome by the fusional vergences the subject does not manifest squint. This latent squint is called ‘heterophoria’.
- When the squint is present at times and controlled at other times it is called ‘intermittent squint’.
- When the visual axes are parallel but the eyes seem to have a squint is called pseudostrabismus. Eg: hypertelorism
- Strabismus is classified into ‘comittant’ and ‘incomitant’ strabismus when the deviations are equal in all the different gazes it is called ‘comittant’. When the deviations are more in one gaze it is called ‘incomittant’.
- Comittant strabismus is further classified into horizontal, vertical and torsional strabismus.
- In horizontal strabismus when the eyes are convergent it is called as ‘esotropia’. When the eyes are divergent it is called ‘exotropia’. The corresponding latent strabismus are called ‘esophoria’ and ‘exophoria’ and the intermittent heterotropias are called ‘intermittent esotropia’ and ‘intermittent exotropia’.

- Esotropias are further classified into accommodative, non accommodative, and partially accommodative depending on the role of accommodative and refractive elements in its causation.
- Vertical comittant strabismus is classified into 'hypertropia' (upward deviation) and hypotropia (downward deviation).
- Torsional squint or cyclotropia are divided into incyclotropia (12-o-clock meridian intorted or turned in) or excyclotropia (12-oclock meridian extorted or turned out).
- The incomittant strabismus can be subdivided into paralytic, restrictive and spastic depending on the cause of underaction in the first two and over action in third type.

BINOCULAR SINGLE VISION

BSV is characterized by the ability to fuse the images from the two eyes and to perceive binocular depth.

GRADES OF BSV

1. Simultaneous macular perception: is the ability to see two dissimilar objects simultaneously.
2. Fusion: is the ability to superimpose two incomplete but similar image to form one complete image
3. Stereopsis: is the ability to perceive third dimension i.e., depth perception.

All the three grades of BSV can be tested with 'synoptophore'.

CONSEQUENCES OF STRABISMUS

When squint occurs two fovea's view two different objects and send two different images. This leads to 'confusion'. However the cortex immediately settles for one image with its inherent strong cortical or retinal rivalry.

When squint occurs an object in space is perceived by the fovea of one eye and some other extra foveal point of the other eye which has a different projection or localization value in space. Thus an object would be localized twice in space causing 'diplopia'.

ADAPTATIONS TO STRABISMUS

While confusion is immediately controlled by strong foveal rivarlry, some adaptations are required to tackle diplopia. The adaptation can be 'motor' or 'sensory'.

MOTOR ADAPTATIONS

1. fusion: ability of two eyes to keep in check the tendency of squint
2. Changes in headposture like chin elevation or depression face turn or head tilt.
3. Blind spot mechanism: image made to fall on blind spot.

SENSORY ADAPTATIONS

1. Suppression: cortical mechanism of ignoring the image of one eye.
2. Anomalous retinal correspondence is the establishment of an extrafoveal point of the squinting eye with the fovea of normal eye in attempt to regain binocularity.
3. Amblyopia resulting from prolonged uniocular suppression.

A-V PATTERNS

Horizontal deviations (esotropia and exotropia) which may be comitant in horizontal gazes, may not be comitant in vertical gazes on looking up and looking down. They are described by alphabetic terms as A and V patterns, because the changes of horizontal deviation in up and down gaze resembles the alphabets A or V.

CLASSIFICATION

1. A-EXOTROPIA

   An exodeviation more in down gaze, less in upgaze

2. A- ESOTROPIA

   An esodeviation which becomes more convergent in up gaze and less convergent in the down gaze is said to have an A-esotropia.

3. V-ESOTROPIA

   An esodeviation which is more convergent in down gaze and less convergent in upgaze is termed as V-esotropia.

4. V-EXOTROPIA

   An exodeviation which more diverged in up gaze and less divergent in down gaze is termed as V-exotropia.

5. X-EXOTROPIA

   An exodeviation which is more divergent in up and down gaze compared with the angle of deviation in primary position.

6. Y-EXOTROPIA

An exodeviation more in up gaze but no significant change in deviation from the primary position to down gaze.

7. DIAMOND EXOTROPIA

Exotropia only in primary position not in up and down gazes.

ETIOLOGY

Many etiologies like horizontal, vertical and oblique muscle dysfunctions, facial characteristics and abnormal muscle insertions has been suggested but there is no unanimity concerning the pathophysiology of A and V patterns has been established. Several schools of thought have evolved.

HORIZONTAL SCHOOL

Urist suggested that horizontal rectus muscles were responsible for the incomitance of horizontal deviation assuming that lateral recti are more effective in up gaze and medial recti more effective in down gaze. In V-esotropia overaction of medial recti caused the increased convergence in down gaze and overaction of lateral recti caused the increased up gaze in V-exotropia.

Conversely, increased divergence in down gaze in A exotropia was thought to be caused by underacting medial rectus must and in A-exotropia by underacting lateral recti. Urist also advocated horizontal surgery alone to alter A-V pattern. Breinin from his electromyographic data said that the horizontal recti although not solely causative must play a role in the etiology of A&V patterns.

PATTERN	CAUSED BY
V –exotropia	Overaction of lateral recti on up gaze.
V-esotropia	Overaction of medial recti on down gaze.
A-exotropia	Underacion of lateral recti on upgaze.
A-esotropia	Underaction of medial recti on down gaze.

VERTICAL SCHOOL

Brown stressed the role of vertical recti in the etiology of A-V patterns, the principle being dysfunction in the adducting property (tertiary acion) of vertical recti.

If superior rectus is underacting, their adductive effect in upward gaze will diminish, the eyes will diverge in upward gaze because of secondary overaction of inferior obliques.

In downward gaze underaction of the superior oblique will cause decreased abduction and secondary overacion of inferior rectus resulting in increased abduction would produce a 'V pattern'. Conversely, if inferior rectus is understanding with secondary overaction of superior oblique resulting in increased divergence in down gaze and in up gaze secondary underaction of inferior oblique and overaction of superior rectus will result in 'A' pattern.

PATTERN	CAUSED BY
V-pattern	Overaction of inferior rectus on down gaze or underaction of superior rectus on up gaze.
A-pattern	Overacion of superior rectus on up gaze or underacion of inferior rectus on down gaze.

OBLIQUE SCHOOL

Most current authors believe that dysfunction of the oblique muscles play a major role in A-pattern. Based on the dysfunction of the abducting property (tertiary action) of obliques an A-V pattern would result. If a superior oblique muscle is paretic, the tertiary action i.e, abducting property is weakened which result in consequent increase in convergence in down gaze producing a V pattern. If the inferior oblique is weakened or superior oblique is overacting it would result in A-pattern in a similar position.

PATTERN	CAUSED BY
V-pattern	Overaction of inferior oblique or underaction of superior oblique
A-pattern	Overacion of superior oblique or underaction of inferior oblique

STRUCTURAL (orbital) FACTORS

Variation in skull and orbital bone are known to have underaction or overaction of oblique muscles. This may be due to variations in the site of origins and insertions of the inferior or superior obliques.

Normally the planes of superior or inferior obliques are identical, forms an angle of 51degree with the optical axis of globe. Variations from this pattern would result in an imbalance between the oblique muscles which may produce an overaction of oblique.

Gobin introduced the term ‘desaggitalisation’ where the oblique muscles become more parallel to the coronal axis as seen in plagoicephaly. Here the superior oblique is desagittalised due to retroplacement of trochlea and it becomes a poorer depressor (pseudoparalysis). The inferior oblique becomes a stronger elevator relatively and it also causes abduction in up gaze resulting in ‘V-exotropia’.

Conversely in ‘saggitalisation’ the oblique muscle becomes parallel to the sagital plane. In hydrocephalus, a more frontally placed trochlea, the superior oblique becomes more sagittalised and the superior oblique becomes effective as depressor and increased abduction in downgaze which causes ‘A-exotropia’.

Mein reported high incidence of V and A pattern in Duane’s retraction syndrome. The lateral rectus muscle could slip over the globe to produce an up or down shoot on attemted adduction. An upshoot results in a Vpattern and a down shoot results in Apattern.

Urrets –zavolia stated that

i. Mongoloid fissures favoured the productionof A-pattern esotropia and V-pattern exotropia
ii. Antimongoloid fissures favoured the production of V-pattern esotropia and A-pattern exotropia.

A shallow orbit results in proptosis can alter the relationship between the vertically acting muscles causing V-pattern as in Crouzon’s syndrome.

ANOMALIES OF MUSCLE INSERTION AND CYCLOTORSION

Anomalies of insertion of horizontal, vertical and oblique muscles are known to cause A and V patterns. Because of obliquity horizontal, vertical and torsional vectors are created which create more abduction in up or down gazes causing A and V phenomena.

On patients with V-patterns the insertion of medial rectus were higher than normal and insertions of the lateral rectus were lower than normal, resulting in increased abduction of lateral recti on elevation and increased adduction of the medial recti on

depression. In patients with A patterns the opposite displacements were found. These findings were confirmed by Bielschowsky who reported normalization of unilateral upshoot in adduction after intraplacement and advancement of the medial rectus in an exotropic patient.

Weiss considered cyclotorsion of the globe to be the basic etiologic factor of the A and V patterns. For instance, excyclotorsion of the globe woruld increase the abducting effect of the superior rectus in upgaze and decrease the abducting effect of the inferior rectus in down gaze causing V pattern.

CONCLUSION

It seems reasonable to conclude that no single etiologic factor can explain all A and V patterns. An apparent overaction or underaction of oblique muscles and horizontal recti is the most common clinical finding and surgery on these muscles has been successful in elimination of these patterns on the other hand.

PREVALENCE

- A & V patterns have been commonly seen in atleast one fifth of esotropia and exotropia.
- V patterns are more common than A patterns, in which V- esotropia is the most common anomaly followed in order of frequently A-esotropia, V-exotropia and A-exotropia.
- While esodeviations are more common in west, the exodeviations are more common in the Indian and African race.
- According to American academy of ophthalmology the relative frequency of A and V patterns are as follows:

  V-esotropia- 41%

  A-esotropia- 25%

  V-exotropia- 23%

  A-exotropia- 11%

SIGNS AND SYMPTOMS

- Asthenopia and diplopia are common complaints since fusion have to be maintained for long time in certain positions of gaze.
- Difficulty in reading when there is increased deviation in down gaze as in A-exotropia and V-esotropia is a common complaint.
- While deviation in upward gaze are tolerated well since there is little interference with binocular vision.
- Compensatory posture can be used to place the eyes in the position of least deviation of least deviation in order to maintain BSV.

MANAGEMENT

INVESTIGATIONS

The aims of investigation are

- To detect and measure the V and A pattern.
- To elicit the reason for the pattern if possible.
- To assess its influence on the management of the strabismus.

MEASUREMENT OF A AND V PATTERNS

The horizontal deviations are measured in 25degree upgaze and 35degree downgaze in addition to the primary position at 33cm fixation and 6m distance target with (and without) fully correcting the refractive error.

- V –pattern, measuring a minimum difference of 15Δ from upgaze to down gaze.
- A-pattern, measuring a minimum difference of 10Δ from upgaze to downgaze.

There is a physiologic tendency to relative divergence on upgaze therefore the minimum standard demanded for a V pattern is larger than for and A pattern.

For measurements these positions are quantified with the help of

- Scale and a protractor on the lateral side of head for 6m distant targets.
- Head can be suitably fitted or the target is suitably fixed for 33cm near fixation.
- A cephalodeviometer has been devised using a mirror with markings on it. The patient is made to wear a head band with a vertical marker and head is suitably tilted for regarding wired position.

COVER TEST

It should be performed in the primary position, on upgaze and downgaze for both distance and near fixation.

It helps to detect the type of manifest and latent strabismus, visual dominance and the presence of amblyopia.

MEASUREMENTS OF DEVIATIONS

Deviations can be measured by two methods

I. Objective
II. Subjective

Objective test depend on observations by the examiner of the patient fixation pattern.

Subjective test requires the patient's subjective response for measuring the patients deviation.

OBJECTIVE TESTS

PRISM BAR COVER TEST (PBCT)

It is the simplest and best method where the prism or prism bar with the cover test are used to measure the amount of deviation. In essence it is the cover-uncover test with the addition of neutralization of the deviation by the prism.

Deviations are measured for distance and near fixation targets, with and without correction, in nine different cardinal positions of gaze with right and left eye fixing alternatively (to measure primary and secondary deviation).

CORNEAL REFLECTION TESTS

HIRSCHBERG'S TEST:

Gives a rough estimate of the amount of manifest deviation especially in young or uncooperative patients. Each mm of deviation is approximately equal to 7 degree. If the reflex is situated is temporal border of pupil as in exodeviation. The deviation is about 15 degree, if at the limbus the deviation is 45 degree (1degree=2prism dioptres).

KRIMSKY TEST

By utilizing a prism bar one can quantity the deviation using the corneal reflection. It is preferable to place the prism bar on the fixating eye and to neutralize the amount by observing the corneal reflex in the deviating eye.

SYNOPTOPHORE

It's a complete orthoptic instrument based on haploscopic principle (two physical locations projected to create one physiological localization). It can be used for:

i. Measurement the deviation in different opaque position horizontal, vertical, torsional deviation can be measured.
ii. Can measure the subjective and objective angle of deviation.
iii. Assessment of binocular status (simulataneous macular perception, fusion and stereopsis)

SUBJECTIVE TESTS

These tests utilize the subject's perception of the deviation. When there is misalignment the subject perceives diplopia and the separation between the two images indicates the subjective deviation. Which is measured with the help of two principles diplopia principle and haploscopic principle.

In diplopia principle a single physical location of the target is perceived by the subject as two perceptual localizations.eg:

1. diplopia testing with red-green goggles
2. measurement of deviation on maddox tangent scale with maddox rod.

With haploscopic principle two physical location are used to have on perceptional localization.

Eg: 1. synoptophore

2. hess screen

OCULAR MOVEMENTS

In addition to measuring the ocular deviations it is important to the underaction and overaction of extra ocular muscles.

Extra ocular movements are measured by a simple method called 'Limbus test of motility of Kestenbaum'. Where a transparent millimeter scale is placed horizontally in front of cornea for measuring horizontal muscles undeactions and overaction and placing vertically for measuring vertical muscles underaction and overactions.

For example for measuring abduction, the location of nasal limbus point is noted on the ruler in primary position and in maximum abduction. The difference gives the measure of abduction. Similarly other movements can be measured with limbus as reference point. Normal values are 10mm for adduction, abduction and depression and 5 to 7mm for elevation.

GRADING OBLIQUE OVERACTIONS

To grade inferior oblique overactions is by observing the angle the adducting eye makes with the horizontal line as it elevates and abducts (if overacting) on lateral version to the opposite side.

Grade 1+: upto 15degree angle with the horizontal line.

Grade 2+: upto 30degree angle with the horizontal line.

Grade 3+: upto 60degree angle with the horizontal line.

Grade 4+: upto 90degree angle with the horizontal line.

Analogous to this grading the superior oblique also can be graded. The angle the adducting eye makes with the horizontal line as it depresses and abducts or lateral version.

MEASUREMENT OF CYCLODEVIATIONS

1. Diplopia charting with slit target.
2. Double Maddox rod test.
3. Synoptophore.
4. Fundus examination.

TESTS FOR SUPPRESSION AND BSV

1. Bagolini striated glasses
2. Worth-four dot test.
3. Synoptophore.
4. After image testing.

MANAGEMENT OF A &V PATTERNS

V and A patterns are treated surgically depending on whether a functional result or cosmetic result or both is needed.

FUNCTIONAL RESULTS

Surgery is indicated to restore a useful field of binocular single vision, particularly on down gaze without the need for compensatory head posture.

COSMETIC RESULTS

Surgery is usually performed if the pattern is cosmetically unacceptable.

FACTORS DECIDING THE SURGERY IN A-V PATTERNS

- The deviation in the primary position determines the amount of surgery for the horizontal recti.
- A and V pattern should be checked for all cases of exo and esotropias.
- Oblique muscle overaction has to be checked and if present appropriate weakening procedure has to be done.
- In the absence of oblique muscle overaction vertical transpositioning of horizontal recti is done.
- Another surgical option in the absence of oblique muscle overaction is differential or slanting recession and resection can be done or can be added to transposition surgeries.

SURGERY ON HORIZONTAL RECTUS MUSCLE

Surgery on the horizontal rectus muscle alone is effective in A and V pattern when the dysfunction of the oblique muscles is minor. But when oblique muscle overaction is severe horizontal surgery should be combined with procedures on the oblique muscle.

TRANSPOSITION OF HORIZONTAL RECTUS MUSCLE

This techniques was described by Knapp and is based on the principle that with the eyes in elevation or depression, the muscle plane of the horizontal rectus muscle is determined by the centre of rotation of the globe and centre of origin and insertion.

Thus a horizontal rectus muscle aids elevation in upward gaze and depression in downward gaze and the horizontal action of these muscle decreases in these position. This physiologic action is enhanced by raising or lowering the muscle insertion.

For instance, when the insertion of the medial rectus is lowered, its horizontal action further decreases in down gaze in favor of its action as a depressor. On the other hand when insertion of lateral rectus is raised its horizontal action will be decreased in elevation in favor of its action as an elevator. The shifting is done such that the muscle insertion remains concentric to limbus. A 5-8mm displacement is usual sufficient. The following guide is helpful:

I. A PATTERN:

a) Medial recti shifted up or in both eyes.

b) Lateral recti shifted down or in both eyes.

c) Medial rectus up, lateral rectus down in a monocular recession on resection.

II. V-PATTERN:

a) Medial recti shifted down in both eyes or

b) Lateral recti shifted up in both eyes or

c) Medial rectus down and lateral rectus up in a monocular recession-resection.

Above transposition surgeries are combined with recession – resection surgeries.

SLANTING RECESSION-RESECTIONS

A-V patterns can also be treated by differential recessions of upper and lower ends of the horizontal recti (3-5mm difference).

1) A-esotropia: both medial recti recessed with the upper ends more than the lower ends.
2) A-exotropia: both the lateral recti are recessed with the lower ends more than the upper ends.
3) V-esotropia: both the medial recti are recessed, lower ends more.
4) V-exotropia: both the lateral recti are recessed, with upper ends more.

A similar slanting resection is made such that the sutures are placed in oblique fashion. For example, in V-exotropia, medial rectus is resected more at the upper end and lateral rectus is recessed more at upper ends.

SURGERY ON OBLIQUE MUSCLES

Surgery on the oblique muscles is greatly effective in reducing or eliminating vertical incomittance when there is an obvious oblique dysfunction is present.

A weakening or strengthening procedure is usually combined with horizontal recession or resection for better result.

WEAKENING PROCEDURES ON INFERIOR OBLIQUE

1) Recession-commonly done
2) Myomectomy
3) Disinsertion
4) Denervation

WEAKENING PROCEDURES ON SUPERIOR OBLIQUE

1) Tenotomy
2) Tenectomy
3) Silicon expander lengthening

STRENGTHENING PROCEDUDRES ON INFERIOR OBLIQUE

1) Advancement
2) Resection
3) Double breasting

STRENGTHENING PROCEDURES ON SUPERIOR OBLIQUE

1) Tucking (ten application)
2) Tenting

V-ESOTROPIA WITH INFERIOR OBLIQUE OVERACTION

Bi-Medial rectus recession or Bi-Medial rectus Recession – Bi-Lateral rectus resection surgery combined with inferior oblique weakening

V-EXOTROPIA WITH INFERIOR OBLIQUE OVERACTION

Bi-Lateral rectus Recession or Bi-Lateral rectus Recession – Bi-Medial rectus resection combined with inferor oblique weakening.

A-ESOTROPIA WITH SUPERIOR OBLIQUE OVERACTION

Bi-Medial rectus recession or Bi-Medial rectus recession – Bi-Lateral rectus resection surgery combined with superior oblique weakening

A-EXOTROPIA WITH SUPERIOR OBLIQUE OVERACTION

Bi-Lateral rectus recession or Bi-Lateral rectus Recession – Bi-Medial rectus resection combined with superior oblique weakening

V-ESOTROPIA WITHOUT OVERACTION

Bi-medial recession with Medial rectus down-shifted by 5mm or Bi-medial recession with Medial rectus down-shifted by 5mm – Bilateral resection with Lateral rectus up-shifted by 5 mm

V-EXOTROPIA (NO OVERACTION)

Bi-lateral recession with Lateral rectus up-shifted by 5mm or Bi-lateral recession with Lateral rectus up-shifted by 5mm – Bi medial rectus resection with medial rectus down shifted by 5 mm

A-ESOTROPIA (NO OVERACTION)

Bi-medial recession with Medial rectus shifted up by 5mm or Bi-medial recession with Medial rectus shifted up by 5mm – Bi lateral rectus resection with lateral rectus shifted down by 5 mm

A-EXOTROPIA (NO OVERACTION)

Bi-lateral recession with Lateral rectus shifted down by 5mm or Bi-lateral recession with Lateral rectus shifted down by 5mm – Bi medial rectus resection with medial rectus shifted up by 5 mm.

Surgical options for AV patterns

s.no	Pattern	Surgery
1	V-esotropia with inferior overaction	Medial rectus recession or Recession-resection surgery combined with inferior oblique weakening
2.	V-exotropia with inferior oblique overaction	Lateral rectus recession or R-Rsurgery combined with inferor oblique weakening.
3.	A-esotropia with superior oblique overaction	Medial rectus recession or R-R surgery combined with superior oblique weakening
4.	A-exotropia with superior oblique overaction	Lateral rectus recession or R-R surgery combined superior oblique weakening
5.	V-esotropia without overaction	Bi-medial recession with MR down-shifted 5mm
6.	V-exotropia (no overaction)	Bi-lateral recession with LR up-shifted 5mm
7.	A-esotropia (no overaction)	Bi-medial recession with MR shifted up 5mm
8.	A-exotropia (no overaction)	Bi-lateral recession with LR shifted down 5mm

PART - II

SECTION – II

AIM OF THE STUDY

To study the efficiency of transposition of the horizontal and the oblique muscle surgeries in correction A-V pattern.

MATERIALS AND METHODS

In this prospective study, 25 cases A-V patterns that underwent surgery at the regional institute of ophthalmology, Chennai were studied.

INCLUSION CRITERIA

1. Primary non paralytic heterotropia with A&V pattern.
2. 2-25yrs age group with A&V pattern.

EXCLUSION CRITERIA

1. Paralytic exotropia
2. Severe Amblyopic cases
3. Restrictive syndrome
4. Cases that had undergone previous surgery
5. Cases associated with congenital anomalies.

A routine ophthalmic examination and a thorough orthoptic evaluation were carried out in all the patients. The deviation at different distances and different gazes was quantitated using the prism bar cover test. The status of binocular single vision was assessed using the synoptophore, Worth four-dot. The type of fixation as to whether it was central or eccentric was assessed. Refraction was done using atropine 1% or cyclopentolate 0.5% drops. Pre-operative orthoptic treatment was given when considered necessary.

OBSERVATIONS

SEX INCIDENCE AND AGE AT SURGERY

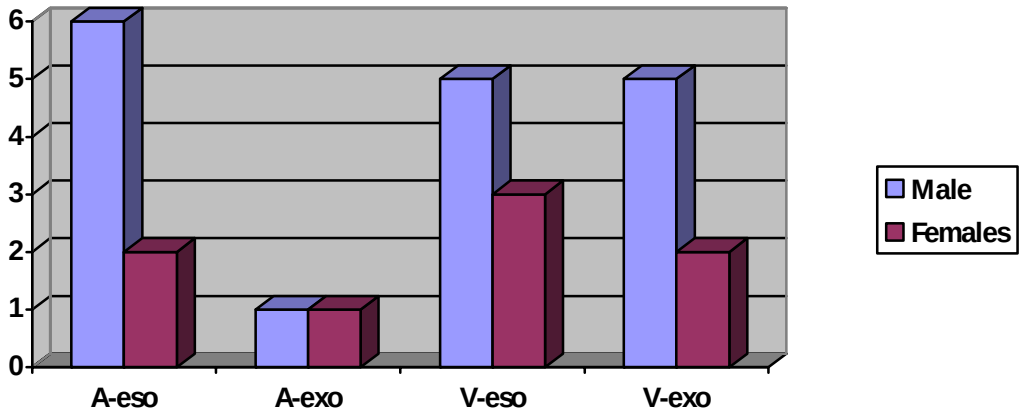
Of the 25 patients (50 eyes) included in the study, 17 were males and 8 were females. Among 17 male patients, 6 had A-eso, 1 patient had A-exo, 5 patients had V-eso and 5 patients had V-exo. Of the 8 female patients, 2 had A-eso, 1 had A-exo, 3 had V-eso and 2 had V-exo.

The age group of patients taken up for surgery ranged from 2-25 yrs.

Sex incidence of AV patterns

Sex	Number of cases				
	A –eso	A –exo	V –eso	V –exo	Total
Males	6	1	5	5	17
Females	2	1	3	2	8
Total	10		15		25

Sex incidence of AV patterns



PREOPERATIVE VISUAL ACTIVITY

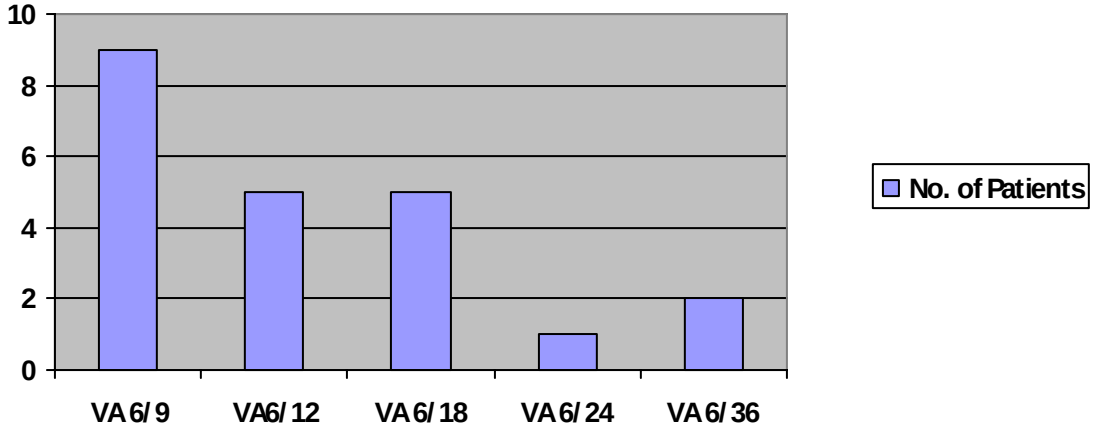
Of 25pts (50 eyes) who were studied, 6 patients who were less than 4 years of age, the visual acuity could not be assessed perfectly, so they were excluded from visual acuity assessment.

Among the 38 eyes, 16 eyes had corrected visual acuity of 6/6 so the remaining 22 eyes were assessed for visual acuity improvement postoperatively. Of the 22 eyes, 10 eyes had preoperative visual acuity 6/9, 5 eyes had 6/12, 5 had of 6/18, 1 eyes had 6/24 and 2 had 6/36.

Preoperative visual acuity

Visual acuity	Number of patients
6/9	9
6/12	5
6/18	5
6/24	1
6/36	2
Total	22

Preoperative visual acuity



PREOPERATIVE DEVIATION

Based on the preoperative deviations, the patients were divided in two groups. Group –I constitutes 14 patients with preoperative deviation of 30-60Δ. Group-II constitutes 11 patients with preoperative deviation of 60-90Δ.

Preoperative deviation

Preoperative Deviation in Δ	Number of cases
30-60Δ	14
60-90Δ	11

REFRACTIVE ERROR

With regard to the refractive error of the 25 cases, 3 cases were emmetropic, 9 cases were myopic, and 13 cases were hypermetropic. Of 31 patients with hypermetropia, 7 patients had A-eso, 4 patients had V-eso. Of 9 myopic patients, 7 had V-exo, 1 had A-exo and 1 had A-eso. All 3 emmetropes had V-eso.

Refractive error

Refractive error	Number of cases
Emmetropia	3
Myopia	9
Hypermetropia	13
Total	25

PREOPERATIVE AMBLYOPIA

The criteria for defining the amblyopia was visual acuity less than lines (6/12) or above. Among 25 patients, 8 patients had strabismic amblyopia none of them had anisometric amblyopia and visual deprivation amblyopia.

PREOPERATIVE BSV

Of the 25 cases, none of the patients had BSV. All of them had suppression in one eye to a significant degree.

A-V PATTERNS

25 patients of A-V pattern were evaluated and taken up for surgery. 8 patients had A-esotropia, 2 patients had A-exotropia,. 8 patients had V-esotropia, 7 patients had V-exotropia. Of the 25 patients, 10 had A pattern and 15 had V pattern.

AV patterns

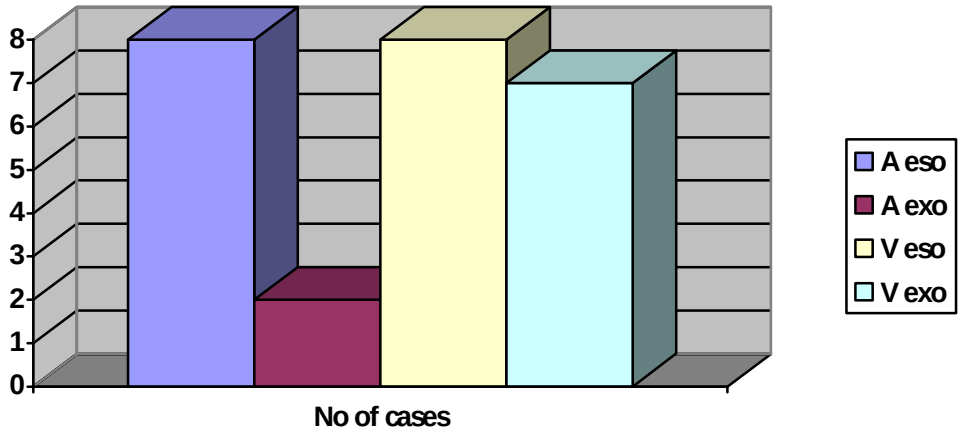
Pattern	Number	Percentage
A pattern	10	40%
V pattern	15	60%

Of the 25 patients, 8 patients had A-eso, 2 had A-exo, 8 had V-eso and 7 had V-exo.

AV patterns

Pattern	Cases	Percentage
A eso	8	32%
A exo	2	8%
V eso	8	32%
V exo	7	28%

AV patterns



CHOICE OF SURGERY

V-ESOTROPIA

V esotropia with no inferior oblique over action

Bi-medial rectus recession with down shifting of 5mm (or) bimedial rectus recession along with lateral rectus resection and up shifting can be done. Out of 8 cases of V-esotropia, 2 patients with V-esotropia who had no inferior oblique over action underwent bimedial rectus recession with downshift was done.

V esotropia with minimal inferior oblique overaction

The above procedure was also done for V-esotropia with grade I & II Inferior oblique overaction (i.e. up to 30°). 2 patients who had V-esotropia with minimal inferior oblique overaction underwent bi-medial rectus recession with downshifting.

V esotropia with severe inferior oblique overaction

Bimedial rectus recession with inferior oblique recession or bimedial rectus recession plus bilateral rectus resection with inferior oblique recession can be done for grade III & IV inferior oblique over action (more than 30°). Out of 8 cases of V esotropia, 3 patients who had V-esotropia with severe inferior oblique over action underwent bimedial rectus recession with inferior oblique recession.

Pattern	Number
V esotropia with no inferior oblique over action	2
V esotropia with minimal inferior oblique over action	2
V esotropia with severe inferior oblique over action	3
Total	8

V –EXOTROPIA

V – exotropia with no inferior oblique over action

Bilateral lateral rectus recession with up shifting with or without bimedial rectus resection with down shifting (5mm) can be done. Among 7 patients, 3 patients who had V-exotropia with no inferior oblique over action underwent bilateral lateral rectus recession with upshifting along with bilateral medial rectus resection with down shifting.

V –exotropia with minimal inferior oblique overaction

The above procedure was also done for V-exotropia with grade I & II Inferior oblique overaction (i.e. up to 30°). 2 of the 7 patients who had V-exotropia with minimal inferior oblique over action underwent bilateral lateral rectus recession with upshifting along with bilateral medial rectus resection with down shifting.

V – exotropia with severe inferior oblique overaction.

Bilateral lateral rectus recession with inferior oblique recession or bilateral lateral rectus recession plus bimedial rectus resection with inferior oblique recession can be done for grade III & IV inferior oblique over action (more than 30°). Out of 7 patients with V exotropia, 2 patients with severe inferior oblique over action underwent bilateral lateral rectus recession along with bimedial rectus resection with inferior oblique recession.

Pattern	Number
V-exotropia with no inferior oblique over action	3
V-exotropia with minimal inferior oblique over action	2
V-exotropia with severe inferior oblique over action	2
Total	7

A – ESOTROPIA

A –esotropia with no superior oblique over action

Bi-medial rectus recession with up shifting of 5mm (or) bimedial rectus recession along with lateral rectus resection and down shifting can be done. Out of 8 cases of A-esotropia, 6 patients with A-esotropia with no superior oblique overaction underwent bilateral medial rectus recession with upshifting was done.

A –esotropia with minimal superior oblique overaction

The above procedure was also done for A-esotropia with grade I & II superior oblique over action (i.e. up to 30°). 2 patients who had A-esotropia with minimal superior oblique over action underwent bi-medial rectus recession with upshifting.

A –esotropia with severe superior oblique overaction

Bimedial rectus recession with superior oblique recession or bimedial rectus recession plus bilateral rectus resection with superior oblique recession can be done for grade III & IV inferior oblique over action (more than 30°). No cases of A-esotropia with severe superior oblique over action were present in this study.

Pattern	Number
A esotropia with no superior oblique overaction	6
A esotropia with minimal superior oblique overaction	2
A esotropia with severe superior oblique overaction	Nil
Total	8

A –EXOTROPIA

A – EXOTROPIA WITH NO SUPERIOR OBLIQUE OVERACTION

Bilateral lateral rectus recession with upshifting 5mm (or) RR surgery with transposition is done for cases of A-exotropia for no superior oblique overaction. 1 patient had A-exotropia with no superior oblique overaction for who bilateral medial rectus recession with up shift and bimedial lateral rectus resection with up shift was done.

A –EXOTROPIA WITH MINIMAL SUPERIOR OBLIQUE OVERACTION

Bilateral medial rectus with upshifting (or) RR surgery with transposition is done for cases of A-exotrpia with minimal superior oblique overaction upto gradeII , 30°. 1 patient had A-exotropia with minimal superior oblique overaction for who bilateral medial rectus recession with up shift and bimedial lateral rectus resection with up shift was done.

A –EXOTROPIA WITH SEVERE SUPERIOR OBLIQUE OVERACTION

Bilateral medial rectus recession with superior oblique weakening procedure (or) RR surgery with superior oblique weakening procedure is done for cases of A-exotropia with severe superior oblique overaction more than 30°. No patient had A-exotropia with severe superior oblique overaction were present for the study.

Pattern	Number
A exotropia with no superior oblique overaction	Nil
A exotropia with minimal superior oblique overacion	2
A exotropia with severe superior oblique overaction	Nil
Total	2

PREOPERATIVE ANALYSIS

Preoperative analysis	Number of cases
Preoperative V/A	
6/9	9
6/12	5
6/18	5
6/24	1
6/36	2
Preoperative deviation	
30-60Δ	14
60-90Δ	11
Preoperative amblyopia	8
Preoperative BSV	0
A-V PATTERN	
V–esotropia	8
V–exotropia	7
A-esotropia	8
A–exotropia	2

OUT COME

Improvement in visual acuity

Among 22 eyes which were assessed for visual acuity improvement,of 10 eyes which presented with the visual acuity of 6/9, 3 eyes improved to 6/6 after first week, and 6 eyes improved to 6/6 at the end of 8 th week. The improvement was 90% at the end of 8 weeks.

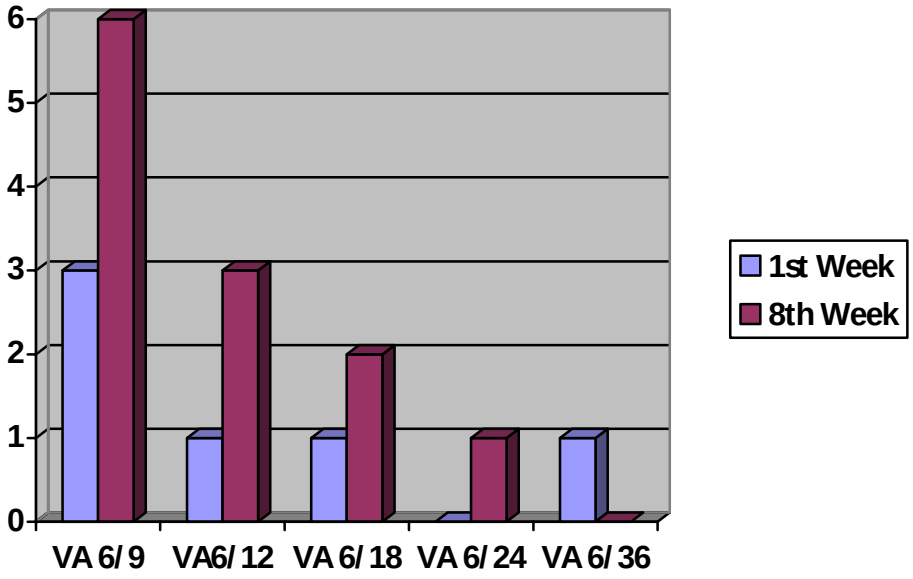
5 eyes which had a visual acuity 6/12 at presentation, 1 eye improved to 6/9 at the end of first week, and 3 eyes improved to 6/9 at the end of 8 th week. The improvement was 80% at the end of 8 weeks.

4 eyes presented with 6/18, 1 eye improved to 6/12 at the end of first week, 2 eyes improved to 6/12 at the end of 8th week. The improvement was 75%. 1 eye had 6/24 at the time of presentation, improved to 6/18 at the end of 8 th week. The improvement was 100%. 2 eyes presented with 6/36 of which 1 eye improved to 6/24 at the end of 1 st week. The improvement was 50%. The overall improvement of visual acuity in the above studied eyes was 80%.

Improvement in visual acuity

S.no	Pre op V/A	No of patients	V/A after 1 week	V/A after 8 weeks	Total	
					No	%
1	6/9	10	3	6	9	90%
2	6/12	5	1	3	4	80%
3	6/18	4	1	2	3	75%
4	6/24	1	-----	1	1	100%
5	6/36	2	1	-----	1	50%
		22	6	12	18	80%

Improvement in visual acuity



Improvement in Deviation:

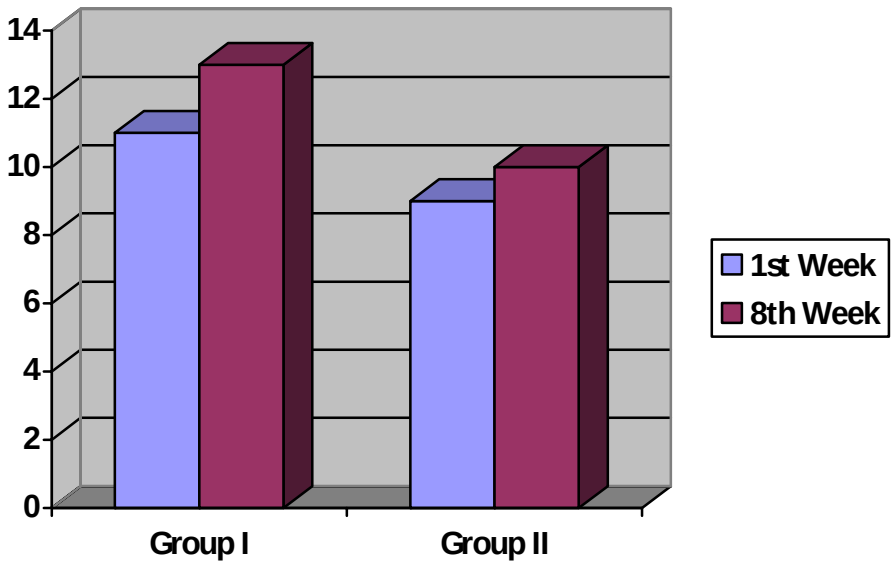
A favourable outcome in group I contributing 14 patients with preoperative deviation of 30-60 prism dioptres was defined as orthophoric postoperatively.

A favourable outcome in group II contributing 11 patients with preoperative deviation of 60-90 prism dioptres was defined as postoperative deviation within +/- 10prism dioptres (consecutive – residual deviations) postoperatively.

Of 14 patients in group I, 11 cases (79%) were orthophoric in the first week which increased 13 (93%) in 8 weeks postoperatively. Of 11 patients in group II, 9 cases (82%) had residual / consecutive deviation with in 10 prism dioptres, which increased to 10 (91%) in 8 weeks postoperatively.

S .No	Preop in Δ	Number of cases	1 week	8 week
1	30-60	14	11	13
2	60-90	11	9	10
Total		25	20	23

Improvement in deviation



Improvement in amblyopia:

Out of 8 eyes which had a preoperative strabismic amblyopia, 2 cases showed improvement in 1st post operative week. 6 cases showed improvement in the 8th week (82%). 6 cases had one line improvement. 2 cases had two line improvement of visual acuity in Snellens chart.

S.No	No of cases Preop amblyopia	Post op 1 week	8week
1	8	2	6

Gain in BSV:

Out of 25 cases none of them had BSV preoperatively. At the end of 8 weeks of surgery, 8 patients had some grades of BSV. 5 of them had simultaneous macular perception (SMP). 2 of them had SMP and fusion. One had SMP, fusion and stereopsis.

S.No	No of cases	Preop BSV	Post op BSV 1 week	8week
1	25	0	0	8

A esotropia

A esotropia with no superior oblique over action

Of 6 patients who had A esotropia with no superior oblique muscle over action, 5 patients underwent bimedial recession with upshifting. The procedure was successful in all patients and the patients were orthophoric in all gaze positions.

One patient who underwent bimedial recession with upshifting and bilateral lateral rectus resection with downshifting had a residual esotropia of 5 prism dioptres which was not increasing in up and down gazes. Hence the A pattern was corrected.

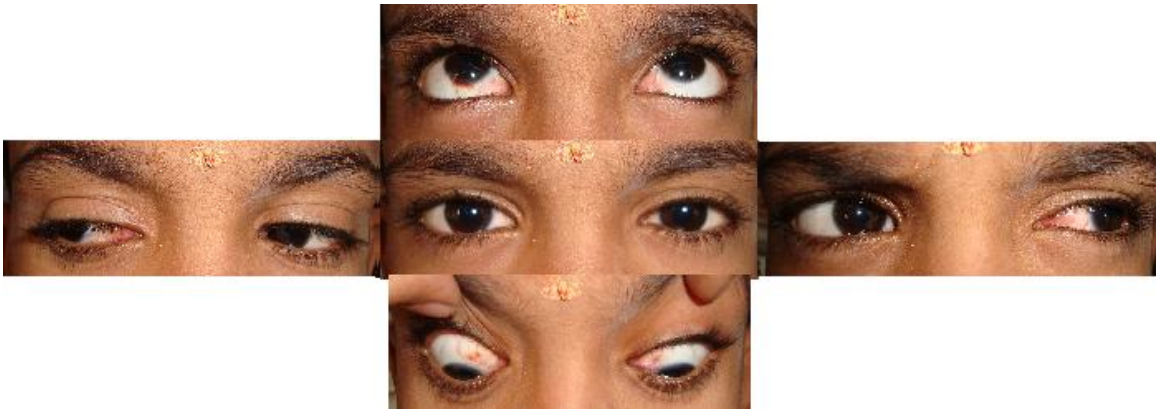
A-esotropia with minimal superior oblique over action:

Two patients who had A esotropia with minimal superior oblique over action underwent bimedial recession with upshifting. The patients were orthophoric in all gaze position. Hence the A pattern was corrected.

A esotropia with no superior oblique overaction

Before surgery

After surgery



A Exotropia

A-exotropia with no superior oblique over action

Of one patient with A exotropia with no superior oblique over action underwent bimedial rectus resection with downshifting and bilateral lateral rectus with upshifting had a residual deviation of 5 prism dioptres which was not increasing in up and down gaze. Hence the A pattern was corrected.

A exotropia with minimal superior oblique over action:

Of one patient with A exotropia with minimal superior oblique over action underwent bimedial rectus resection with upshifting and bilateral lateral rectus with downshifting had a consecutive eso deviation of 5 prism dioptres in the first postoperative week, which became orthophoric in all gazes in the 8^{th} postoperative week.

A exotropia with minimal superior oblique over action.

Before surgery

After surgery

V Esotropia

V esotropia with no inferior oblique over action:

Of two patients who had V-esotropia with no inferior oblique over action underwent bimedial recession with downshifting. One patient was orthophoric in all gazes and one patient had residual eso of 5 prism dioptres which was not increasing in up and down gazes. Hence the V pattern was corrected.

V esotropia with minimal inferior oblique over action:

Of two patients who had V-esotropia with minimal inferior oblique over action underwent bimedial recession with downshifting. Both the patients were orthophoric in all gazes. Hence the V pattern was corrected.

V esotropia with severe inferior oblique overaction:

Of 3 patients who had V esotropia with severe inferior oblique over action, all of them underwent bimedial recession with inferior oblique recession. All of them had a residual esodeviation of 10 prism dioptres which was not increasing in up and down gazes. Hence the V pattern was corrected.

V esotropia with no inferior oblique over action

Before surgery

After surgery

V esotropia with severe inferior oblique over action

Before surgery

After surgery

V-Exotropia

V exotropia with no inferior oblique over action:

Of 3 patients who had V exotropia with no inferior oblique over action, all 3 underwent bimedial resection with downshifting and bilateral lateral rectus recession with upshifting. 2 patients were orhtophoric in all gazes. One patient had residual exotropia of 10 prism dioptres which was no t increasing in up and down gazes. Hence the V pattern was corrected.

V exotropia with minimal inferior oblique over action:

Of 2 patients who had a V exotropia with minimal inferior oblique over action, both underwent bimedial resection with downshifting and bilateral lateral rectus recession with upshifting. 1 patient was orthophoric in all gazes. One patient had residual exotropia of 10 prism dioptres which was not increasing in up and down gazes. Hence the V pattern was corrected.

V exotropia with severe inferior oblique over action:

Of 2 patients who had a V exotropia with severe inferior oblique over action, both underwent bimedial resection and bilateral lateral rectus recession with inferior oblique recession. 1 patient was orthophoric in all gazes. One patient had residual exotropia of 20 prism dioptres in the first postoperative week which decreased to 10 prism dioptres in 8^{th} postoperative week which was not increasing in up and down gazes. Hence the V pattern was corrected.

V exotropia with minimal inferior oblique over action

Before surgery

After surgery

V exotropia with severe inferior oblique overaction.

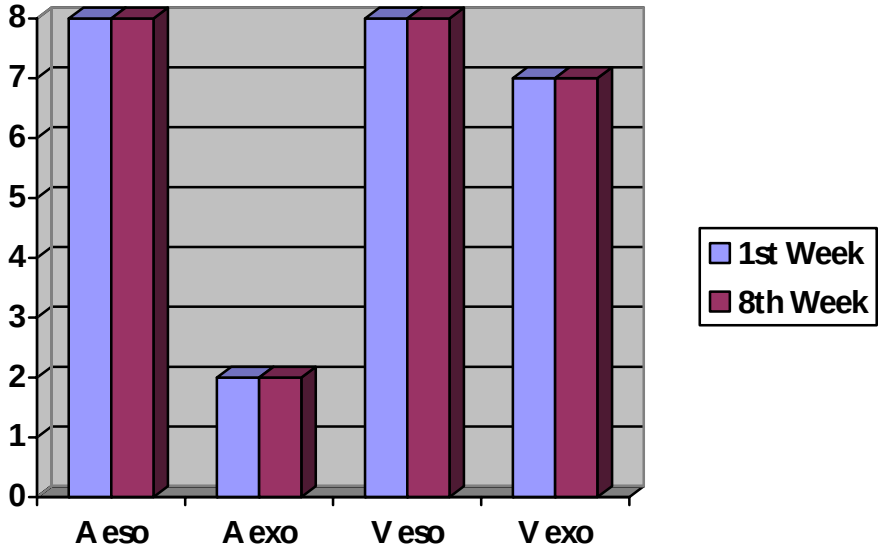
Before surgery

After surgery

Results of AV pattern correction

Pattern	No	After 1 week	After 8 week
A-eso	8	8	8
A-exo	2	2	2
V-eso	8	7	7
V-exo	7	6	6

Results of AV pattern correction



SUMMARY:

Analysis of the efficiency of transposition surgery of horizontal and oblique muscle in correction A-V pattern yielded the following inferences.

A-V pattern with no oblique overaction

Vertical upshifting and downshifting of medial and lateral recti along with recession – resection had a favourable outcome in A-V patterns with no oblique overaction.

A-V patterns with minimal oblique overaction

Vertical upshifting and downshifting of horizontal recti along with recession – resection was also effective in patients with A-V patterns with minimal obliqure over action. For whom weakening of oblique muscle was not needed.

A-V pattrns with severe oblique overaction

Weakening of oblique muscle in A-V Patterns with severe oblique overaction along with recession – resection surgery had a favourable outcome.

Improvement in visual acuity:

Transposition of horizontal oblique muscle surgeries yielded an improvement in visual acuity postoperatively in both A-V patterns with and without oblique over action.

Improvement of amblyopia:

Transposition of horizontal and oblique muscle surgeries also yielded an improvement of vision in amblyopic cases in both A-V patterns with and without oblique over action.

Gain in binocular single vision:

Transposition of horizontal and oblique muscle surgeries showed gain in BSV in patients with A-V patterns with and without oblique over action.

CONCLUSIONS:

1. Vertical transposition of horizontal muscle along with recession and resection was effective in A-V patterns in no oblique muscle over action.
2. Vertical transposition of horizontal muscle along with recession-resection was also effective in A-V patterns with minimal oblique muscle over action.
3. Oblique muscle weakening was not necessary in A-V patterns with minimal oblique muscle overaction.
4. Weakening of oblique muscle was effective in patients with A-V patterns with severe oblique muscle overaction along with recession – resection surgery.
5. Patients who underwent transposition of horizontal and oblique muscle surgeries for AV patterns had an improvement in visual acuity.
6. Patients who underwent transposition of horizontal and oblique muscle surgery for AV patterns also had an improvement in amblyopia.
7. Patients who underwent transposition of horizontal and oblique muscle surgery for AV patterns also had a gain in BSV.

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PROFORMA

Name Age Sex M/F Unit

OP /IP Number: Orthoptic Number:

Complaints and Duration

Squint / Defective vision / others

History

Age of onset

Deviation, if noticed

- Type of deviation
- Uniocular – RE/LE, Alternating
- Intermittent / Constant
- Variability if any

Abnormal head posture

Diplopia

Defective vision

Photophobia / Closing one eye

Past H/O motor / mental deficit

Treatment history and effect of treatment

- Glasses / Medical / Orthoptic / Surgery

Birth history

- Any maternal illness during gestation
- Birth asphyxia / trauma

Family history

- Family H/O squint. Mode of treatment, if any
- H/O consanguinity

Examination

General examination

- CNS

General ophthalmic examination

- Head posture
- Epicanthus / hypertelorism / facial asymmetry
- Anterior segment and pupil
- Vision

	Right	Left
Distance without glasses		
Distance with glasses		
Near without glasses		
Near with glasses		

Present glasses power

In children

Fundus

Refraction Drug used

Motor

Extraocular movements

- Ductions
- Versions

Near point of convergence

Near point of accommodation (where indicated)

Cover test	Near	Distance	Far distance
Without Correction			
With Correction			
Alternate Cover test			

Measurement of Deviation

Hirschberg test

Prismbar cover test

- Near
- Distancc
- In all gazes

Synoptophore

- Objective FR — Subjective FR
  - FL — FL

In all gazes

Maddox rod test

Maddox tangent scale

Maddox wing test

Sensory: State of binocular function

By Synoptophore

- SMP
- Fusion
- Stereoscopic vision
- Retinal correspondence: Normal / Abnormal
- If abnormal: Harmonious / Unharmonious

Other tests of Stereopsis

Worth four dot test — without glasses — with glasses

- For distance
- For near

Fundus:

Fixation:

Final Diagnosis:

Advice:

Surgery:

Immediate post op assessment:

- Visual acuity
- Orthophoric
- Undercorrected
- Overcorrected
- Diplopia

Late follow up:

- Visual acuity
- Binocular vision
- Cosmetic appearance

KEY TO MASTER CHART

Column	Abbreviation	
3.	Yrs	Years
4.	M	Male
	F	Female
6.	UCVA	Uncorrected visual activity
	RE	Right eye
	LE	Left eye
7.	Ref err	Refractive error
	DS	
	DL	
8.	CV	Corrected visual activity
9.	UP	Up gaze
	DOWN	Down gaze
	PRIM	Primary gaze
	VD	Visual deviation
13.	SOOA	superior oblique overaction
	IOOA	Inferior oblique overaction
14.	BSV	Binocular single vision
	DOM	Dominant eye
15.	N	Normal
	A	Amblyopia
16.	F,S	foveal, steady fixation
	F,U	Foveal, unsteady fixation
	E	Eccentric fixation
17.	ACS	alternate convergent squint
	RCS	right convergent squint
	LCS	left convergent squint
	RDS	right divergent squint

	LDS ADS	left divergent squint alternate divergent squint
18.	a-eso a-exo v-eso v-exo	a esotropia a exotropia v esotropia v exotropia
19.	MR LR BMR BLR IO res rec	medial rectus lateral rectus bilateral medial rectus bilateral lateral rectus inferior oblique resection recession
20.	O resi cons	orthophoric residual consecutive

LIST OF SURGERIES PERFORMED:

S.no	Name	age/sex	OP/IP no	date of surgery	diagnosis	surgery performed
1	Mr.Janakiraman	63/m	381737	15-06-2006	RE-IMC	LE- ECCE with PCIOL
2	Ms.Tamilarasi	28/f	72845	17-06-2006	RE-chalazion	Incision & curettage
3	Ms.Jagadha	68/f	382247	26-06-2006	LE-IMC	LE- ECCE with PCIOL
4	Mr.Laxminarayanan	29/m	86745	15-07-2006	RE-pterygium	Excision-Bare sclera
5	Mrs.Chinnamma	70/f	81979	23-09-2006	RE_dacryocystitis	Dacryocystectomy-RE
6	Mrs. Kuppammal	45/f	386101	28-10-2006	LE-MC	LE- ECCE with PCIOL
7	Mrs.Jayamary	48/f	390542	21-03-2007	LE-Nuclear cataract	LE- ECCE with PCIOL
8	Mrs.Devaki	28/f	32670	20-05-2007	RE-Dermolipoma	Excision
9	Mr.Parthasarathy	54/m	393166	22-06-2007	RE-MC	RE-ECCE with PCIOL
10	Mr.Venkatasubbiah	72/m	56407	08-08-2007	RE-Corneal Ulcer	Paracentesis with AC Amphotericin Wash
11	Mrs.Muniammal	67/f	393872	27-08-2007	RE-PCC	RE-ECCE with PCIOL
12	Mr.Kannan	35/m	60184/9914	22-08-2007	LE-mixed ulcer	LE-TKP
13	Mrs.Raniammal	40/f	331456	25-08-2007	RE-endophthalmitis	RE-Vit Tap/ Intravit Antibiotics

14	Mr.Venugopal	40/m	66211/10018	25-08-2007	LE-mixed ulcer	LE-TKP
15	Mrs.Thulasi	60/f	395669	17-09-2007	LE-MC	LE- ECCE with PCIOL
16	Mrs.Krishnammal	55/f	395991	26-09-2007	RE-IMC	RE-SICS with PCIOL
17	Mr.Muthiah	70/m	395729	21-09-2007	RE-IMC	RE-SICS with PCIOL
18	Mrs.Umayal	60/f	43144/9595	26-08-2007	RE-Panophthalmitis	RE-Evisceration
19	Mrs.Muniammal	60/f	55348	01-09-2007	RE_dacryocystitis	Dacryocystectomy-RE
20	Mr.Gopal	72/m	396124	03-10-2007	RE-Chr ACG	RE-ECCE with Trab
21	Mrs Parvathy	45/f	398891	14-02-2008	RE-Corneal Tear With iris prolapse	Corneal Tear Suturing with Prolapse Repair
22	Mrs.Lakshmi	55/f	399419	21-02-2008	RE-IMC	RE-SICS with PCIOL
23	Mr.Rajendran	59/m	404859	05-08-20068	RDS - ADS	Recession – Resection surgery
24	Mrs.Vislakshi	60/f	402574	24-05-2008	LE-PCC	LE-SICS with ACIOL
25	Mr.Dhinakaran	62/m	405131	05-08-2008	LDS - ADS	Recession – Resection surgery
26	Mr.Soundarrajan	59/m	421342	19-09-2008	RE-IMC	RE-SICS with PCIOL