A STUDY ON THE INFLUENCE OF INCISION ON POST OPERATIVE ASTIGMATISM IN MANUAL SMALL INCISION CATARACT SURGERY

Dissertation submitted to

The TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY

in partial fulfillment of the regulations for the award of degree

M.S in OPHTHALMOLOGY

Department of Ophthalmology

Government Stanley Medical College & Hospital

The TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY

CHENNAI-01

APRIL 2012

CERTIFICATE

This is to certify that study entitled "A STUDY ON THE INFLUENCE OF INCISION ON POST OPERATIVE ASTIGMATISM IN MANUAL SMALL INCISION CATARACT SURGERY" is the result of original work carried out by Dr. AKSHATA. A.S, under my supervision and guidance at STANLEY MEDICAL COLLEGE,CHENNAI The thesis is submitted by the candidate in partial fulfilment of the requirements for the award of M.S. Degree in Ophthalmology, course from May 2009 to April 2012 at the Stanley Medical College , Chennai.

UNIT CHIEF HEAD OF THE DEPARTMENT

DEAN INCHARGE

ACKNOWLEDGEMENT

I express my deep gratitude to my DEAN INCHARGE Dr.R.SELVI.$_{M.D}$, Government Stanley medical college for permitting me to do this study.

With overwhelming respect and gratitude, I thank Prof & HOD Dr K BASKER, M.S,D.O., for giving opportunity to work on this thesis project, his valuable advice and guidance, in this endeavor. His kind attitude and encouragement have been a source of inspiration throughout this study, which helped me to do my best in this effort.

I express my sincere and heartfelt thanks to my respected teacher Unit chief and guide Prof Dr. K KANMANI, $_{MS, DO.}$ for his guidance and suggestions. His concern for excellence and perfection inspired me right through the study.

I am thankful to prof.Dr.Thangarani.M.S for her support & guidance.

I am very grateful to Prof. Dr P Kumaravel $_{M.S.}$, for his support and guidance.

I am grateful to my Assistant professors Dr.S.Venkatesh$_{M.S}$,Dr.A.Nandhini $_{M.S.,}$ Dr. Vinayagamoorthy$_{M.S}$, Dr. B.Meenakshi $_{M.S}$,Dr. P. Geetha $_{M.S.,D.O}$, for rendering their valuable suggestions, supervision throughout the progress of work.

I am thankful to all my colleagues for their support.

Finally, I am deeply indebted to all my patients for their sincere cooperation for completion of this study.

LIST OF ABBREVIATIONS USED

ATR: Against-Rule Astigmatism.

BCVA: Best Corrected Visual Acuity.

CF: Counting Fingers.

D: Diopters.

HM+: Hand Movements +

MSICS: Manual Small Incision Cataract Surgery.

mm: Millimeters.

NA: No Astigmatism.

PMMA-IOL : Polymethyl Methacrylate Intraocular Lens.

PL+: Perception of Light +

SI: Superior Incision.

SIA: Surgically Induced Astigmatism.

WTR: With-Rule Astigmatism.

UCVA: Uncorrected Visual acuity

CONTENTS

LIST OF PICTURES

LIST OF TABLES

LIST OF GRAPHS

INTRODUCTION

INTRODUCTION

When assessing recent changes in modern cataract and intraocular implant surgery,the single most pressing challenge faced by surgeon today is the need to achieve predictable and accurate refractive outcomes.Recent progress in cataract surgery has heightened patient expectations and having a good post operative uncorrected visual acuity is considered a norm.

The control of postoperative astigmatism is the key in meeting these expectations.The concept of surgically induced astigmatism has added entirely unique dimension to cataract surgery with emphasis more focussed on refractive aspect of surgery in present era.

Over the years a better understanding of various preoperative and intraoperative determinants of surgically induced astigmatism has made it possible to actually plan out the surgical intervention and their modification according to preoperative state of astigmatism of patient in order to achieve minimum possible post operative astigmatism.The purpose of modern cataract surgery is not only cataract extraction followed by IOL implantation but also to reduce or correct existing astigmatism.

Estimates of incidence of significant naturally occurring astigmatism vary widely from 7.5% to 75%. Pre-existing astigmatism is present in over 60% of all patients scheduled for cataract surgery. It is thought that 3% to 15% of eyes

may have 2 or more dioptres (D) of astigmatism and 15 % to 25% of cataract patients undergoing surgery have more than 1.5 dioptres of astigmatism.

In order to achieve the reduction of post operative astigmatism, instrumentation and surgical techniques have been constantly refined. The most modern one being sutureless cataract surgery. With the advent of sutureless small incision cataract surgery the amount of surgically induced astigmatism has significantly reduced and also post operative refraction stabilises. Surgical planning for refractive cataract surgery should be more precise taking into consideration the location of cylinder, type of cylinder, age of the patient , status of the fellow eye , along with size ,location and configuration of cataract incision which itself has astigmatic effects.

There are certain characteristics of self sealing small incisions with respect to length and configuration that impart not only self sealability but also astigmatic neutrality to these incisions. Self sealing scleral tunnel incisions have varied with respect to width and configuration of groove which represents the external or scleral incision opposed to internal or corneal portion of the incision.

Several methods to correct astigmatism during cataract surgery include

1) Astigmatic keratotomy
2) Incision at steeper meridian during surgery
3) Limbal relaxing incision
4) Corneal relaxing incision
5) Toric intraocular lenses

Incision being the first and most important determinant of post-operative astigmatism which can be modified in various ways in terms of size, shape, axis, location and direction to reduce the degree of post operative astigmatism.Various theories have been put forward to explain the factors responsible for surgically induced astigmatism,

1) Astigmatism is proportional to cube length of the incision
   (Jim Gills & Doug Koch)
2) Incisional funnel (Paul Koch)

Other factors being:

1) Techniques of wound construction
2) Shape & configuration of external scleral incision
3) Internal corneal incision which is crucial in securing a stable wound
4) Distance of the optical centre
5) Action of the eyelids & orientation of scleral fibres.

The scleral tunnel incision was introduced in early eighties in an attempt to provide a better wound healing with less surgically induced astigmatism. This has become most favoured incision technique in recent past for sutureless, small incision non phaco cataract surgery. Although the size of external incision varies from 5-8 mm, it is called small incision cataract surgery

since architectural design renders sutureless & self sealing property to the incision

PRESENT STUDY:

The cataract incision is much more than just being a port of access to anterior chamber. It is a most important structural variable in cataract surgery.

In this context we have undertaken a study designed to determine the significance of effects of various types of incision like superior, temporal & superotemporal incision depending on steeper axis and its effect on pre-existing astigmatism.

AIM OF THE STUDY

AIM OF THE STUDY

- To determine the outcome of incision at steeper meridian in Manual Small Incision Cataract Surgery with IOL implantation in reducing the pre-operative astigmatism.
- To evaluate the type of post operative astigmatism.
- To assess the change in the pattern of corrected astigmatism over a period of 6 months.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

HISTORY:

The management of cataract has been removal of lens since ancient times. The cataract surgery was practiced by sushruta in as early as 800 BC, he is considered to be father of cataract surgery. He used blunt needle passing through conjunctiva & sclera behind iris in a blind approach to displace lens posteriorly. This is called couching. The technique of cataract surgery has gradually changed from ICCE to ECCE & now it is small incision cataract surgery & phacoemulsification.

After the development of operating microscope, the last 25 yeras have produced rapid advancement in cataract surgery wound architecture. As the technology for removing the cataract has advanced, there has been gradual trend towards smaller incisions moving from superior scleral to the temporal scleral location in an attempt to reduce the intraoperative complication & post operative astigmatism.[1]

Richard P Kratz (1983) is generally credited as the first surgeon to move from limbus posteriorly towards sclera, thus enhancing wound healing & reducing surgically induced astigmatism.[2,3]. Girard & Hoffman were first to call the posterior incision a "scleral tunnel incision"[4]. Louis J Girard, Goerge Rodriguez & Mary L M (1984) demonstrated that the scleral tunnel is more effective than scleral flap in reducing the post operative astigmatism[5]. In 1990,

Mc Farland demonstrated self sealing corneoscleral tunnel with inner corneal lip[6]. Paul H Earnst introduced the concept of an internal corneal lip (triplanar) incision[7]. Jack A Singer in 1991 conducted a prospective clinical trial to evaluate induced astigmatism through a pocket incision "frown incision"[8]. In 1991 Koch described the astigmatically neutral "INCISIONAL FUNNEL"[9]. In 1991 American society of cataract & refractive surgeons meeting in Boston announced sutureless cataract surgery.

Cravy T V in 1991, proposed routine use of lateral approach to cataract extraction to achieve rapid & sustained stabilisation of post operative astigmatism[23]..Bluementhal (1992) described hydroexpression of nucleus with glide & popularised the MSICS technique[10].

Nikhil S & Sawhney S (2005) had shown that surgically induced astigmatism was higher in superior scleral incision than superotemporal than in temporal incision in MSICS [11].

ANATOMICAL CONSIDERATIONS[14]

It is essential to know the anatomy of the eye with relation to the tissues manipulating before surgery.

Cornea:

It is a transparent, avascular structure occupies the centre of the anterior pole of the globe and forms ant 1/6th of the outer coats of the eye ball. The anterior and

posterior surfaces of the human cornea can be approximated in schematic eye calculations by radii of curvature of 7.8 and 6.5 mm respectively. The radius of curvature of the anterior surface translates into a vergence power of approximately 48.8 diopters (D), which accounts for roughly three quarters of the total refractive power of the eye's optical system. Externally, the cornea appears elliptical with its vertical chord shorter than its horizontal chord (10.6 versus 11.7 mm for males and 9.6 versus 10.7 mm for females). The posterior cornea appears circular with a diameter of 11.7 mm. The central cornea is thinner and measures about 0.52mm where as the peripheral cornea measures about 0.67mm in thickness.

Sclera

It forms the posterior 5/6th of globe. It is covered by tenon's capsule which also covers the recti muscles. Radius of curvature of sclera is about 12 mm. Sclera is thickest at the posterior pole measures about 1 mm. It is thinnest at the insertion of recti muscles & measures about 0.3 mm , at equator it measures 0.4-0.6mm & is about 0.8mm at the limbus.

Limbus

Surgical limbus is 2 mm transitional zone between clear cornea and sclera. The external landmarks of surgical limbus are

1) Anterior limbal border –

Is a anterior boundary of a surgical limbus with a prominent ridge created

by insertion of conjunctiva and Tenons capsule into the sclera. It overlies termination of Bowman's membrane

1) Mid limbal line –

It marks the termination of Descemet's membrane, most useful landmark

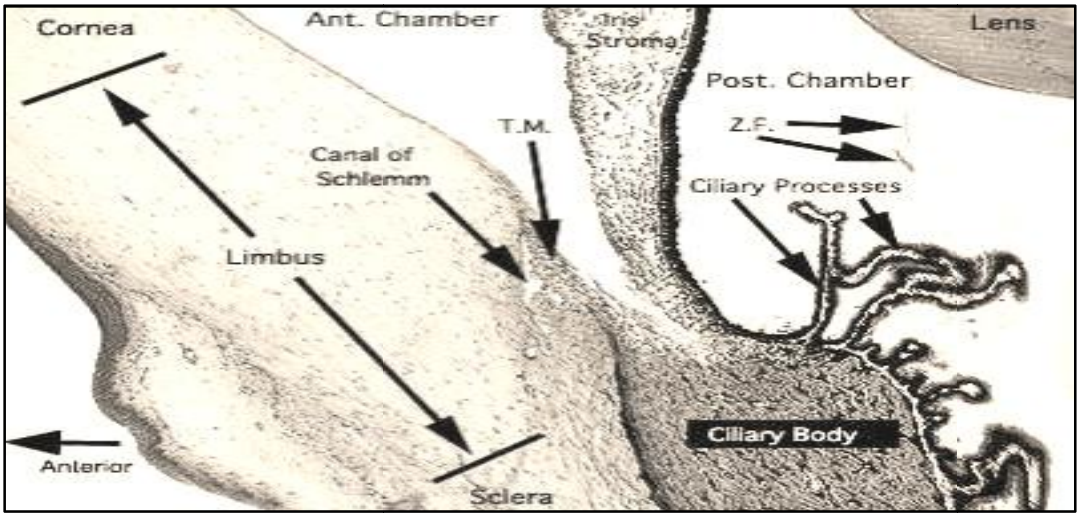


Figure 1: Cross section of the limbus.

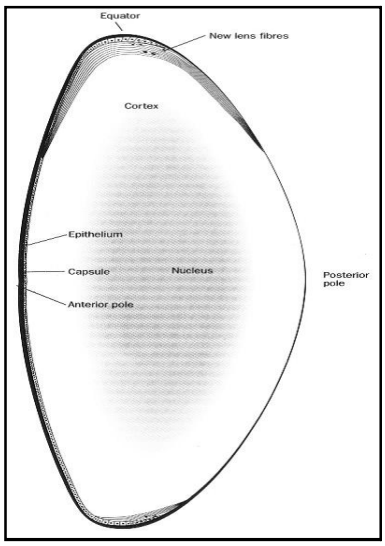
2) Posterior limbal border (sclero limbal junction) –

It lies 1 mm behind the mid limbal line. It overlies scleral spur forms Posterior border of surgical limbus. Blue zone is a transparent zone seen posterior to anterior limbal border vary in extent from 0.8 mm superior and inferiorly, 0.4 mm nasal and temporally.

White limbal zone 1mm circumferentially which lies between mid limbal line and posterior limbal border, it overlies trabecular meshwork.

Lens :

Adult human lens is asymmetrical, spheroid, which does not possess nerves,vessels, connective tissue. Diameter of 9-10mm, thickness of 4-5mm. The lens has anterior and posterior surfaces and the border where the two meet is known as equator. Curvature of anterior surface is 9mm and posterior surface is 5.5mm



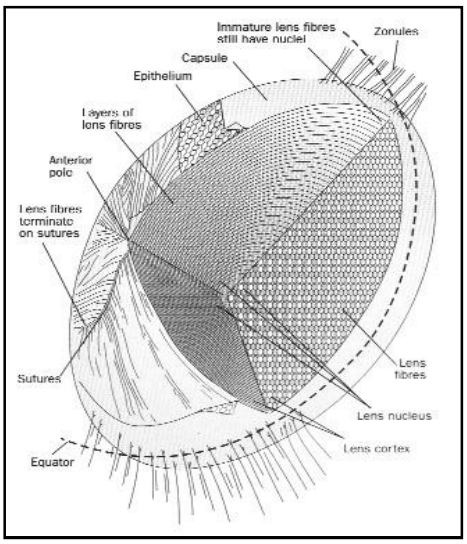


Figure 2 Figure 3

Figure 2 and 3: cross section of the lens

The lens consists of

- Capsule,
- Anterior epithelium
- The cement substance of amorphous material
- The lens fibres

Posterior pole is thinnest (4microns), equator thickest (17microns), and the anterior pole intermediate (9-14microns).

For the purpose of cataract surgery lens can be anatomically divided into ;

1) Capsular bag with subcapsular epithelium
2) Superficial cortex – soft lens matter that can be aspirated
3) Immediate epinucleus with semi soft lens that emulsified or aspirated

Nucleus – that can be fractured, fragmented and phacoemulsified.

PHYSIOLOGICAL CONSIDERATIONS

ASTIGMATISM [12]

Sir Isaac Newton (1727) was the first to consider the question of astigmatism. Thomas Young (1811) attributed this defect to the lens. Airy (1827) was first to correct astigmatism with cylindrical lens. Von Helmholtz (1856) described the optics of aphakic eye. Donders (1864) showed that ATR follows cataract surgery and the importance of this anomaly. Von Reuss (1869) measured astigmatism following cataract extraction with Keratometer. Snellen in 1869 suggested that placing the incision on the steep axis would reduce the corneal astigmatism.

Irwin and Borigh (1970) defined astigmatism as a refractive condition in which a variation of power exists in the different meridians of the eye.

Miller Stephen J defined astigmatism as an “error of refraction in which a point of light cannot be made to produce a punctate image upon the retina by a correcting spherical lens.

The term astigmatism is derived from Latin word “Stigma” (meaning a point).Thus astigmatism means “without a point”. Astigmatism induces distortion of the image, in the principal meridians the distortion of the image is about 0.3% per dioptre of astigmatism and oblique astigmatism produces 0.4degree of tilt per dioptre of astigmatism monocular but it will produce major alteration in binocular perception. [13]

Difference in corneal contour is responsible for most of the astigmatic error of the eye. Astigmatic aberration is also present on the posterior surface of the cornea and the lens and these tend to mitigate the astigmatic error of the anterior surface of the cornea

Astigmatism may be an error either of curvature , lens or refractive index.

1) Curvature astigmatism; Is due to alteration in normal curvature of refractive media of the eye. The types of curvature astigmatism are:

a) Corneal astigmatism
b) Lenticular astigmatism
c) Retinal astigmatism
d) Scleral astigmatism

a) Corneal astigmatism :- Curvature astigmatism, if of high degree is usually corneal in nature. Congenital anomaly of small degree is almost invariable. The most common error is the one where vertical curvature is greater than the horizontal (about0.25D). This is known as “with the rule astigmatism” and is accepted as physiological. As age advances, it tends to

increase to a very slight extent, but in older age it tends to disappear or reverse itself to an inverse astigmatism or “against the rule astigmatism’where in vertical curvature is less than horizontal curvature.

An acquired astigmatism is not infrequently seen, diseases of the cornea result in deformity, like keratoconus , ulceration, inflammations, trauma and surgery.

b) Lenticuar astigmatism: It is also very common, but in great majority of cases anomalies are very small.

c) & d) Retinal and sclera astigmatism

Are very rare, usually they are seen together in posterior staphyloma.

2) Errors in centration: - If the IOL is placed obliquely or out of line of the optical system of the eye causes astigmatism. Traumatic lens subluxation has similar effect.

3) Errors of refractive index:- Is due inequalities in the refractive index of the different sectors of the optical medias. This is usually slight.

Classification:

Broadly there are two types of astigmatism.

A) Regular Astigmatism

1) Simple astigmatism
2) Compound astigmatism
3) Mixed astigmatism

B) Irregular Astigmatism

A) Regular Astigmatism:

Here the two principal meridians i.e. direction of greatest and least curvatures of cornea lies at right angles to one another. This is determined by manifest refraction and manual keratometry.

Simple Astigmatism:

Where one of the foci falls upon the retina and the other focus may fall in front or behind the retina i.e. –

a) Simple myopic astigmatism: Where one of the foci falls on retina and the other falls in front of retina.

b) Simple hypermetropic Astigmatism: One of the foci falls on retina and the other falls behind the retina.

Compound Astigmatism:

Neither of the two foci lies upon the retina but both are –

a) Compound myopic astigmatism where both foci are placed in front of the retina.

b) Compound hypermetropic astigmatism where both foci are placed behind the retina.

Mixed Astigmatism: Where one focus is in front of the retina and the other behind the retina so that refraction is hypermetropic in one direction and myopic

in the other. Such patients have comparatively less symptoms because “circle of least diffusion” is formed on the retina.[12]

Regular astigmatism can further divided into

a) *With the Rule (Direct) (WTR):*

Is physiological type where vertical curve is greater than the horizontal i.e. the meridian with the greatest refractive power is near vertical in orientation or close to 90*or the meridian of least curvature makes an angle of less than 30*with horizontal plane. This is called with the rule because similar astigmatic condition exists normally by the pressure of the eyelid.

b) *Against the Rule (Indirect)(ATR):*

The meridian of least curvature makes an angle less than 30□ with vertical plane or the meridian with greatest refractive power is near horizontal in orientation or close to180*

CORNEAL ASTIGMATISM

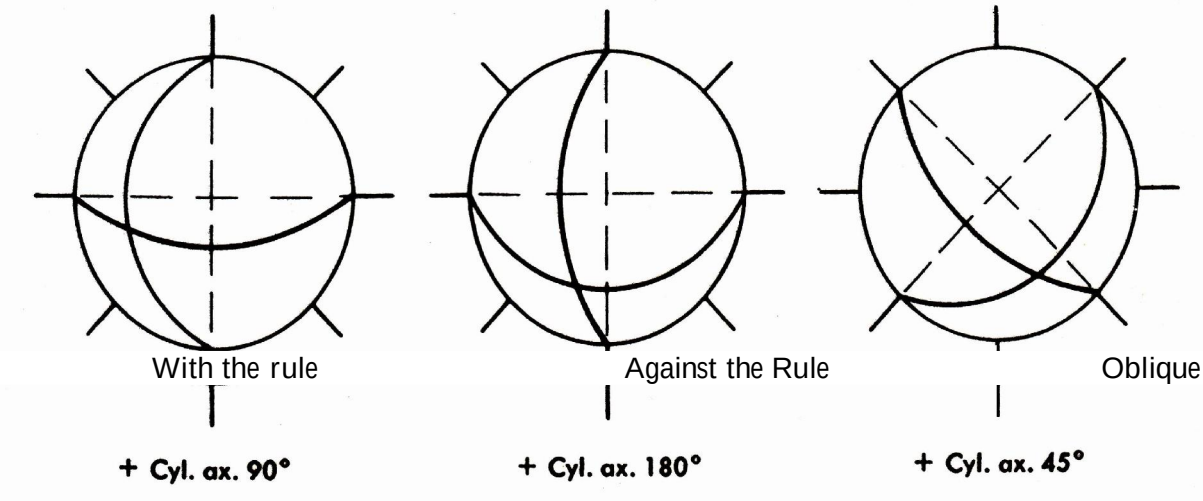


Figure 4: showing types of corneal astigmatism

c)Oblique Astigmatism:

The principle meridians are greater than 30* from vertical or horizontal meridian but still at right angles to each other

B) Irregular Astigmatism:

Refraction in different meridians conforms to no geometrical plane and refracted rays have no planes of symmetry. This is found only in pathological conditions of the cornea i.e. irregular healing following injury, inflammation or ulceration. This exists when the distribution of refracting power over the cornea is irregular. That prevents the cornea from forming a single point focus. This cannot be corrected with spherocylindrical spectacles.

WOUND HEALING [14]

Though the precise knowledge of wound healing in human eye is not known, the present concepts of wound healing are based on animal studies. Healing following a cataract surgery depends on factors such as the location of the incision, presence or absence of sutures and individual patient variations.

Healing of limbal incision;

Classically after incision wound becomes filled by a mass of highly vascularised granulation tissue derived from episclera. The wound is filled with fibrinous exudates from subconjunctival and episcleral vessels. This coagulation

causes adherence of conjunctival flap to the underlying tissue. This is re enforced by ingrowths of fibroblasts connective tissue, which extends into full thickness of wound. Stromal fibrocytes do not play a role in healing of limbal incisions. Remodelling of the wound is slow and may take as long as 2 years.

Healing of scleral incision:

Healing of scleral incision differs greatly, when sclera is incised its fibres do not swell but tend to contract, there are no epithelial or endothelial surface to bridge the gap, the stromal cells of sclera hardly take part in healing of a wound so that healing by minimal intention does not occur. Instead highly vascular tissues on one side or other, the episclera or uvea actively participates in repair while the sclera itself plays a more or less passive role. Within 24 hours after incision the region is invaded by leucocytes which originates from the vessel in the neighbourhood, their role is mainly phagocytic to remove injured tissue. After 48 hours leucocytes disappear & area is dominated by activity of histiocytes & vascular elements mainly derived from episclera & conjunctiva. The sclera itself remains relatively inert with edges of wound remaining clear, while the proliferating fibrous tissue run between them at right angles. Healing of scleral incision therefore has been related to secondary intention. The scleral incisions do not heal as effectively as corneal or limbal incisions. However when a scleral incision is used, it usually does not remain scleral in its entire depth. It is usually bevelled or made in planes so that deeper portion assumes the characteristics of limbal or corneal wound healing.

Healing of sclerocorneal tunnel:

Sclero-corneal tunnel healing is complex because the initial groove & peripheral portion of tunnel are in sclera. The tunnel goes through the limbus into the peripheral cornea & the anterior chamber entry is corneal. According to Jaffe the healing process is different in each of the 3 zones.

Immediately after an incision, the corneal fibres swell in an attempt to seal the opening, but the scleral fibres contract. About 2 days after scleral incision histiocytes & vascular elements from episclera & subconjunctiva move into the incision site & proliferating fibrous tissue begins to form, running at right angles to clear cut scleral edges. After several weeks the fibres begin to align themselves like scleral fibres but the scar is always histologically distinguishable. The sclera itself remains inert.

In limbal portion of the tunnel which is entirely midstromal, stromal fibroblasts are inactive & play a very little role in wound healing. Healing of limbal stroma depends upon fibrous ingrowth from episclera. It may take as long as 2 years or more for stroma to become relatively normal.

Once the incision passes into peripheral corneal stroma the healing process is different initially. After incision there is 3-5 day lag phase during which corneal fibrocytes transform into fibroblasts, which then form new connective tissue. Atleast a month is required for consolidation. At anterior

chamber entry, the cut edges of descemet's membrane does not reunite 24-48 hours after injury, endothelial cells at the edge of wound begin to proliferate to cover the retracted edges of descemet's membrane. Proliferating endothelial cells produce a new basement membrane which after 2-3 years thickens to form new descemet's membrane which is half of the original thickness. Evidence suggests that scleral pocket incision probably do not heal any faster than limbal incision[15].

Astigmatic consideration in MSICS

The size, shape & location of external incision influence the induced astigmatism after cataract surgery. Paul S Koch formed a composite illustration called "INCISIONAL FUNNEL".

This concept arose from mathematical relationships:

1) The corneal astigmatism is directly proportional to the cube length of the incision (Gill & Sanders).
2) Astigmatism is inversely related to distance from the limbus (Jaffe, Samuel Mesket).

Geometrically, the incisional funnel consists of an imaginary pair of curved lines diverging outward from the limbus. Incisions made within this funnel will be for all practical purposes astigmatism equivalent (Paul S Koch, Singer). Short incisions can be made close to

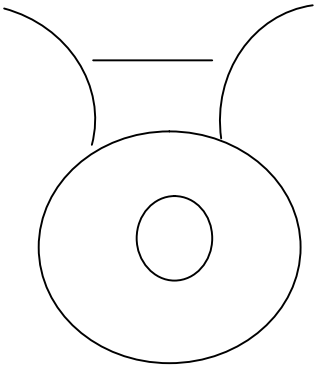


Figure5. 2 Straight incision in incisional funnel

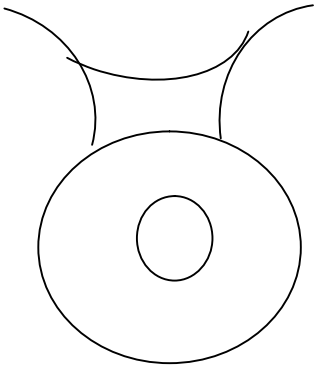


Figure5. 1Frown incision in incisional funnel

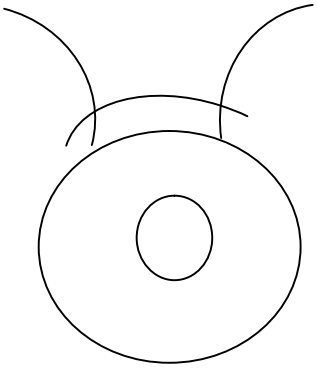


Figure5. 4 Smile incision outside incisional funnel

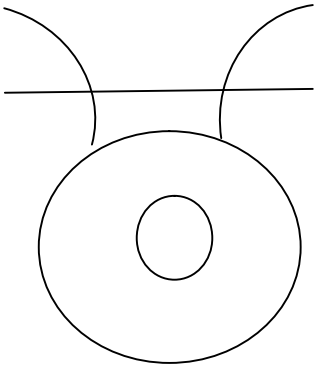


Figure 5.3 straight incision outside incisional funnel

Fig 5: showing incisional funnel

limbus & longer ones further away & all will have equivalent corneal stability, but more posterior placement of incision also hampers the surgery by increasing the length of the tunnel & restricting the movement of the instruments.

Curvilinear limbus parallel incisions extend outside this funnel & are hence unstable. The straight incision placed at the same distance still falls outside funnel but not as much & is more stable than curvilinear incision but not as stable as frown or chevron incision which lie entirely within the funnel.

The following characteristics of the incision affect the post operative astigmatism:

Shape of external incision

1) Curvilinear incision: This traditional incision follows the curve of the limbus, the entire anterior edge of incision has no support & can easily displace towards the limbus, creating a potential for wound slide & against the rule drift in astigmatism. This induces high astigmatic changes upto 4.0D WTR cylinder to 2.0D ATR cylinder with time. This prolongs the visual rehabilitation of the patient.
2) Straight (tangential) incision: A straight line is the shortest possible distance between two points & such an incision is shortest possible for any given IOL size. The anterior edge of a straight incision is directly adjacent to incision ends & does not displace towards the limbus, decreasing the potential for wound slide & ATR drift in astigmatism. A straight incision is more stable than curvilinear incision & can fit within incisional funnel if made far enough from the cornea [16].
3) Frown incision: Jack Singer hypothesized that radicalizing each half of a scleral tunnel incision by curving it away from the corneal limbus would limit the amount of wound slide & against the wound drift in astigmatism. This technique is named "frown" incision because of its appearance to the surgeon. As the incision ends are placed farther from the cornea & incision falls within

the incisional funnel it becomes more stable, as does the cornea & the patient's astigmatism [17].

4) Chevron (inverted V) incision: The inverted V incision, first described by Gills is similar to the frown incision, in that its ends diverge posteriorly rather than a smooth curve. In both chevron & frown incisions it is difficult to convert the incision to ECCE in case of complication as the ends of incision are diverging posteriorly[18].

Length of the external incision:

Length of external incision in SICS will be around 5.5 to 7mm depending on size & density of nucleus & the method used to deliver it out of the anterior chamber. The amount of astigmatism is less with smaller incisions compared to longer ones.

Paul Ernest studied the astigmatism induced by 12mm, 7mm, 4 mm incisions. At 3 months postoperatively the following findings were observed

Incisional length	Postoperative induced astigmatism	
	3 months	8 months
12 mm	3.09 D	
7 mm	1.92 D	1.32 D
4 mm	1.05 D	0.99 D

Table 1: Post op astigmatism for different size of incisins

Location of incision:

Posterior incision: In manual SICS, the incision is made 2mm behind the limbus which decreases the surgically induced astigmatism, with greater wound healing surface with watertight seal.

Site of incision: as the cornea flattens along the meridian of the scleral section, incision can be fashioned on the steep meridian of the pre-existing astigmatism.

Astigmatism induced in manual SICS done with a superior, superotemporal & temporal scleral tunnel incision have been compared. Induced astigmatism was lower in temporal & superotemporal groups compared to superior group. The superior incision is likely to induce about 1.28 D of astigmatism as suggested by centroid (1.28 D 2.9 degrees).one can aim to neutralize a pre-existing astigmatism of 1.25 D at 90 degrees. A shift in incision site to the superotemporal or temporal sclera is recommended except in patients in a patients with pre-existing with the rule astigmatism of 1.0 D.

The temporal location is farthest from visual axis & any flattening due to wound is less likely to affect the corneal curvature at the visual axis. When the incision is located superiorly both gravity & eyelid blink tend to create a drag on the incision. These forces are neutralized better with temporally placed incision because incision is parallel to the vector of the forces. With the rule astigmatism by temporal incision is advantageous because most elderly cataract patients have preoperative against the rule astigmatism. The superotemporal incision also is free from the effect of gravity & eyelid pressure & tends to induce less astigmatism[19]

Effect of sutures: A longer tunnel is usually closed with sutures. Any incision greater than 7mm has to be sutured to prevent excessive post operative

astigmatism. Closure of the incision with sutures brings the wound edges back together. Radial sutures pull the scleral flap & the cornea to an unphysiological position & can disturb the internal entry site, which is the astigmatism control site. Therefore radial sutures may cause astigmatism instead of correcting it. Horizontal sutures make the incision watertight & as the vertical vectors are eliminated, it gives a more physiological closure. It is less prone to disturb the internal site & hence cause less astigmatism.

SURGICALLY INDUCED ASTIGMATISM

For over a century, it has been recognised that cataract incisions influences astigmatism. Since the early 1990's it has been observed that astigmatism after the cataract extraction is generally ATR variety, which is caused by some degree of steepening of the corneal meridian at right angles to the direction of the incision, termed as "surgically induced astigmatism"[20]

The simple rule to follow is that wherever you make the incision that area will flatten. As the incision on the cornea or sclera creates a tissue gape, the gape causes corneal flattening along the meridian of the incision and steepening in the meridian 90 degrees away[21].

Suture produces local tissue compression resulting in peripheral flattening and central steepening along the meridian of the incision and flattening 90 degrees away.[22]

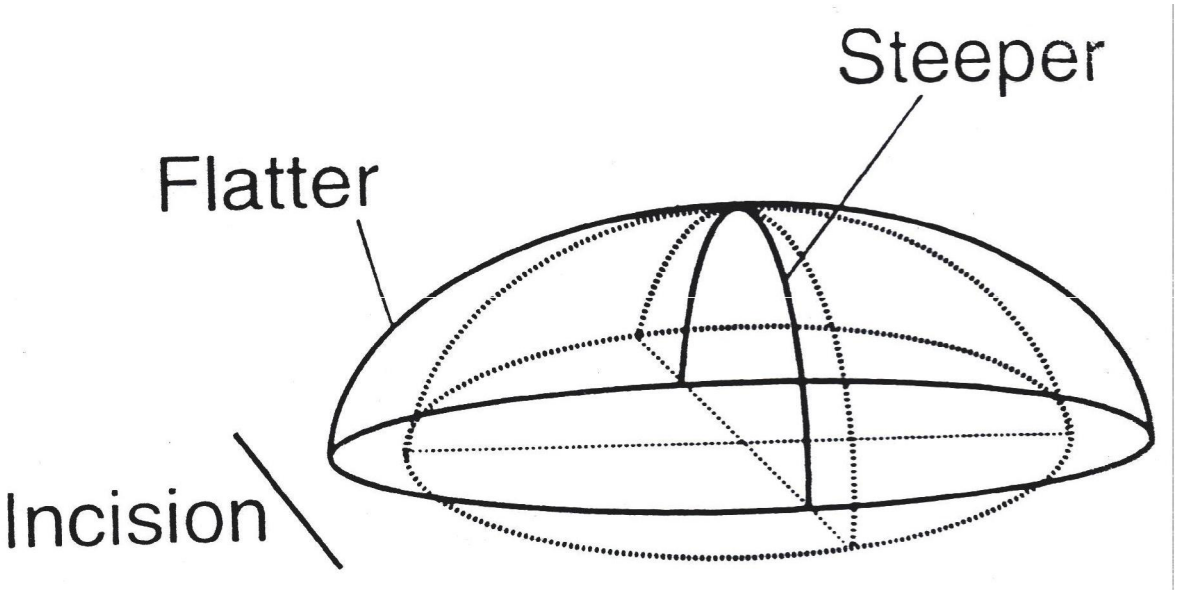


Figure 6 shows after self sealing cataract surgery flattening in the incised axis with steepening 90degrees away. Dotted line indicates pre operative corneal shape , while the solid line indicates post operative one. 29s

Incision over the superior meridian produces "against the rule" astigmatism and incision over the temporal meridian produces "with the rule'astigmatism.[23]

It is well established that following factors induces greater astigmatism:

1. A longer incision
2. A corneal incision
3. A limbal parallel incision
4. A uniplanar incision
5. A sutured incision

An obvious approach to reduce the chance of astigmatic shift would therefore be to shift to an incision that is small, away from cornea, either straight or frown shaped to stay within astigmatically neutral zone, multiplanar

& one that can be safely left unsutured. Also wounds with square configuration (length = width) are considered desirable.

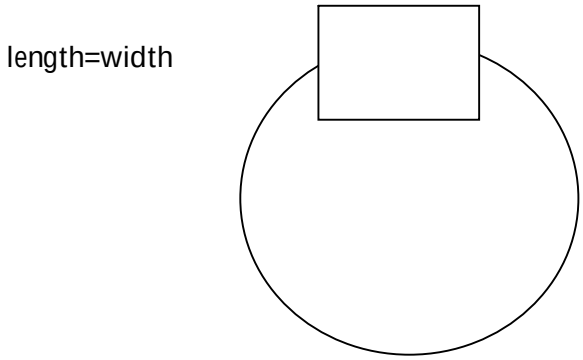


Figure 7: length= width tunnel

ACHIEVING EMMETROPIA

The cataract surgeon can modify his wound parameters to undo any

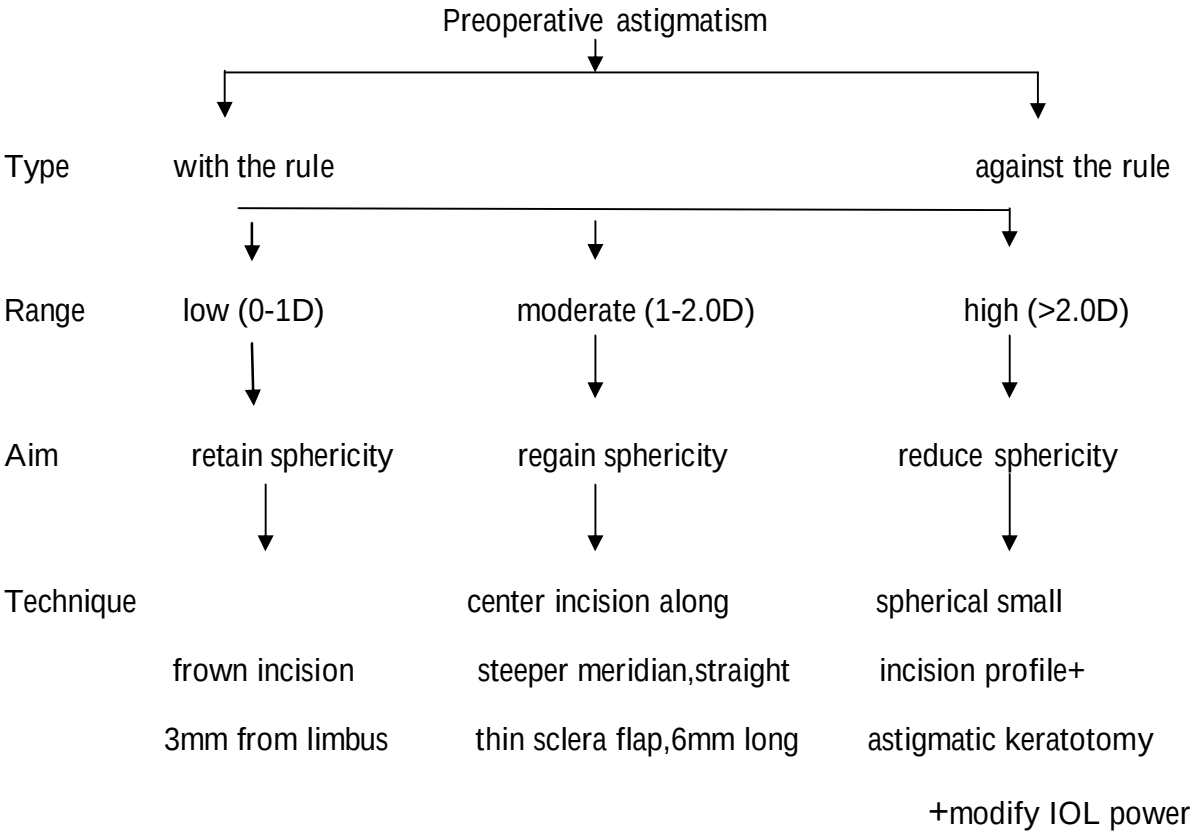


FIG 7: Aims of cataract surgery in preoperative astigmatism

undesirable pre operative astigmatism. Pre-op astigmatism can be low (0 to 1.0 D), moderate (1.0 to 2.0 D) or high (> 2.0 D).

The concept of astigmatic funnel arose from two mathematical relationship. Firstly that corneal astigmatism is directly proportional to the cube of the length of the incision & the second is that it is inversely related to distance from the limbus. Incisions made within the funnel for all practical purposes astigmatism equivalent. Curvilinear limbus parallel incisions fall outside this funnel & hence unstable.

Calculation of surgically induced astigmatism by the following formulae

1. Simple substraction: it's the easiest method to calculate SIA. There is subtraction of power of astigmatism preoperative from postoperative regardless of the axis.

SIA= Postoperative astigmatism- Preoperative astigmatism

2. Algebraic Method.
3. Polar Analysis of Naeser.
4. Cravy's Trigonometric Polar Analysis.
5. Jaffe's Vector Analysis.
6. Olsen's Vector Decompensation.

Measuring the corneal curvature:

1. Keratometers (Ophthalmometers):

The first keratometer was devised by Helmholtz in 1854. The instrument uses an image doubling technique to measure the radius of curvature and location of refracting surfaces of the eye. Javal and Schoitz in 1881, simplified the Helmholtz instrument by restricting its use to measurement of the curvature of the cornea and included the ability to measure surface astigmatism.

MIRES OF KERATOMETER

Following the Javal-Schoitz keratometer, the micrometer and the Bausch& Lomb keratometers have come into vogue. Although techniques were available to measure the radius of curvature by reflection, measurements on the eye were difficult because of image movement. Doubling the image, which involves separating the image beam into two parts and measuring the distance between the two images, eliminated this problem since the two images move together when the eye moves.

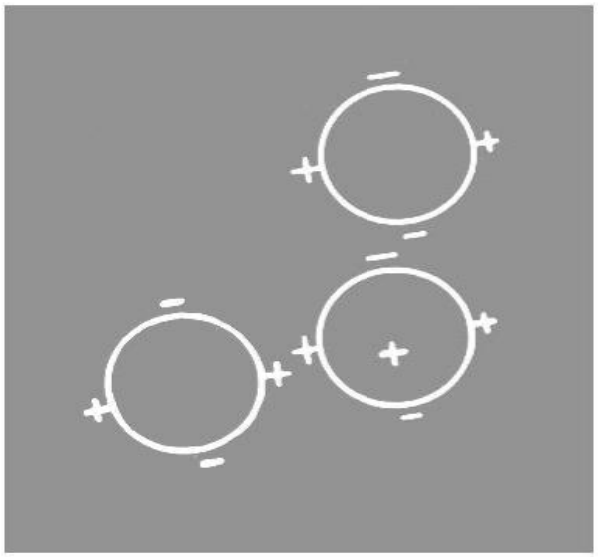


Figure 8: mires in keratometer

The Bausch and Lomb Keratometer:

The instrument comprises a lamp system that illuminates the mires by a diagonal mirror. Light from the mire strikes the cornea producing an image behind it. The mire, having fixed dimensions, image size depends on the corneal radius. The image formed now acts as an object for the optical system. Light from the object is gathered by an objective lens and focused to a plane farther along the central axis. A four aperture diaphragm is located near the objective lens. Beyond the diaphragm are two doubling prisms, one with base up and the other with base out. The prisms can be moved independently, parallel to the central axis of the instrument. Light passing through the left aperture of the diaphragm is deviated by the base up prism to place one image above the control axis. Light passing through the right aperture is deviated by the base out prism placing a second image to the right of the control axis.

Figure 9: Bausch & lomb keratometer

Light through the upper and lower apertures does not pass through either prism and an image is produced on the axis. The total area of upper and lower

apertures is equal to the area of each of the apertures, making the brightness of all three images equal. The upper and lower apertures also act as a Scheiner's Disc, doubling the central image when the instrument is not properly focused on the corneal mire image. The eye piece lens gives a magnified view of the double images.

Automated Keratometry:

Figure 10: automated keratometer

Here, the reflected image of a target is focused onto a photodetector which measures the image size and the radius of curvature is computed. The target mires are illuminated with infrared light and an infrared photodetector is used. The image is measured in many meridians and the power and axis of the major meridians are computed. As the performance here is quicker than ocular movements, no doubling device is needed.

Intraoperative Keratometry:

Barraquer was the first surgeon to advocate the use of keratometer during asurgical procedure. Troutman developed a qualitative device that projects a series of dots onto the cornea in the form of a circle. In the presence of

astigmatism, the circle is seen as an ellipse. Terry was the first to develop a quantitative surgical keratometer. While some studies have shown intraopertive keratometry to reduce suture induced astigmatism, some have found a poor correlation between intraoperative keratometric readings and final postoperative astigmatism.

Computed Corneal Topography:

A computed screen simulates a piece of graph paper divided into many small squares or pixels. Video camera signals are put into the computer resulting in an image on the screen. The curvature of the cornea that corresponds to the rings in every location is determined. A detailed map of the cornea is obtained in which values of corneal curvature at each location of the ring appear. These numerical values can be represented as colour maps, where cooler colours represent flatter areas and warmer colours steeper areas.

There are several methods to correct astigmatism during phacoemulsification cataract surgery. They include

1) Astigmatic Keratotomy (AK)
2) Limbal Relaxing Incisions (LRI's)
3) Corneal Relaxing Incisions (CRI's)
4) Toric Intraocular lenses
5) Steep meridian incision for surgery.

Of the above techniques only steep meridian incision can be utilised in MSICS for predictable optimum results post operatively. (2)

MATERIAL AND METHODS

MATERIAL AND METHODS

This study of evaluating the outcome of incision at steeper meridian in reducing pre-operative astigmatism in manual small incision cataract surgery.

Duration: December 2009 to October 2011 at Stanley Medical College, Chennai

Sample size: 100 eyes of 100 patients who underwent cataract surgery with pre operative astigmatism more than 0.75 to 2.5diopter were enrolled in the study.

Intervention: Manual small incision cataract surgery with IOL implantation with straight incision at steeper meridian

Study design: Prospective interventional case series study.

Full informed consent was taken from all patients after explaining procedure in their local language. Ethical clearance was obtained from the ethical committee of our institute.

Inclusion criteria:

1) Patients aged between 30 to 70 years.
2) Pre-existing corneal astigmatism of 0.75 to 2.5dioptres
3) Primary Cataract

Exclusion criteria:

1) Keratoconus
2) Irregularly irregular astigmatism

3) Any previous surgery on the eye
4) Corneal degeneration , dystrophies , scars
5) Glaucoma
6) Collagen vascular diseases.
7) Posterior segment pathologies affecting the visual outcome
8) Any vision threatening complication during surgery.
9) Failure to place the IOL in the capsular bag
10) Suturing the wound
11) Premature entry or button hole of flap
12) Scleral disinsertion
13) Any complication necessitating enlargement of the main incision
14) Second procedures within the follow-up period

Pre operative evaluation;

- Detailed history
- Ocular examination: slit lamp examination, intraocular pressure & Detailed fundus examination
- Refraction to know the quantity of cylinder,
- Keratometry using Bosch & Lomb type keratometer & automated keratometer to know the axis of the cylinder.

  Preoperative mydriasis is achieved using 0.5% tropicamide, 5% phenylephrine eye drops, 1% cyclopentolate eye drops & NSAID drops.

Surgical procedure

Anaesthesia: peribulbar block.

Procedure:

Standard guidelines for the procedure for MSICS were followed. Straight incision was placed 2 mm posterior to the limbus & the length of incision being 6.5 mm. The incision was centered at 12 o' clock, 1:30 o' clock & 3 o' clock for superior, superotemporal & temporal incision respectively. The IOL implanted was rigid PMMA IOL of optic size 6.0 mm.

Post operative evaluation

- Follow up Evaluation done on Day1, 1st week, 3 week, 6th week & 6th month post operatively.
- Antibiotic-steroid drops 1hourly then tapered in around 4-6 weeks
- Cycloplegics bd for 1 week, Oral NSAIDS for Day 1 and as per requirement
- Uncorrected and Best corrected visual acuity (UCVA &BCVA),
- Refraction and keratometry was done at each follow up.
- Slit lamp biomicroscopy to assess the wound site.
- Any complications in the course were noted and treated accordingly
- Data was collected and compared with regard to pre operative and post operative astigmatism.

Statistical analysis was done using x^2 test, student t test, and probability tests.

OBSERVATIONS AND DISCUSSION

OBSERVATIONS AND DISCUSSION

As mentioned in materials and methods section 100 eyes of 100 patients who underwent manual small incision cataract surgery were evaluated for preoperative and postoperative astigmatism. All the patients completed 6 months follow up. Data was entered on the excel spreadsheet.

Student "t' test, x^2 test , z test were applied to compare the mean values of variables. A p-value of <0.05 is taken as statistically significant.

Indications for surgery

All the patients operated were having cataract of different type and grade

Type of cataract	No of patients	Percentage (%)
Mature cataract	13	13%
Posterior subcapsular cataract	58	58%
Nuclear cataract	22	22%
Cortical cataract	6	6%
Posterior polar cataract	1	1%

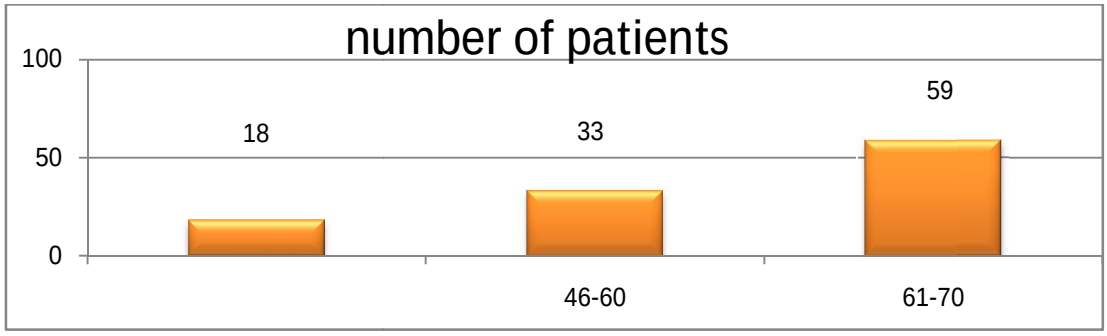
Table 2 types of cataract

Age Distribution

Selected patients age ranged from30 years to 70 years with mean age 58.075 $\pm$ 11.581 years.

Age	Count	percentage
30-45yrs	18	18%
46-60yrs	33	33%
61-70yrs	59	59%

Table 3: showing age distribution



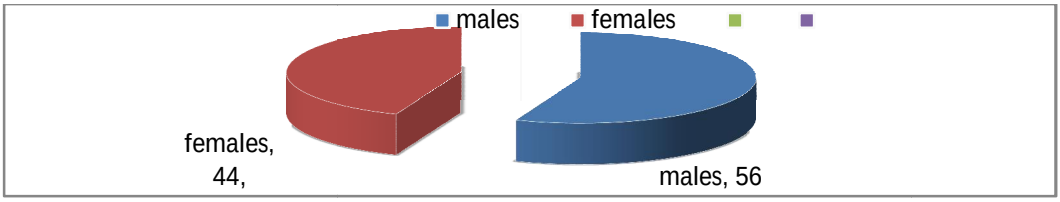
Graph 1: showing age distribution

Sex distribution

Out of the 100 patients who underwent surgery, 56 were males and 44 were females.

Sex	Number	Percentage
Male	56	56%
Female	44	44%
Total	100	100%

Table 4: showing sex distribution



Graph 2: pie diagram showing sex distribution .

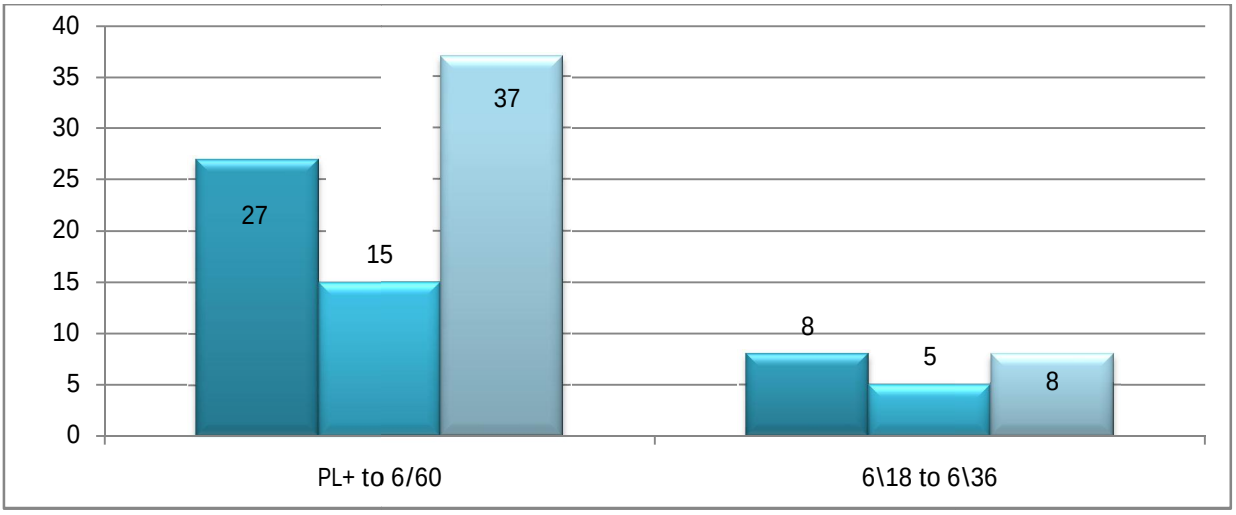
The mean age of the patients is 58.075 ± 11.581 years ranged from 31to 70yrs. Male to female ratio is 1.3: 1. Age and sex did not have any bearing in performing the surgery.

Pre operative visual acuity :

Pre operatively 79 patients had BCVA of 6/60 or less & 21 patients had 6/36 to 6/18.

Range	No of patients			Total
	Superior group	Superotemporal	Temporal group	
PL+ to 6/60	27	15	37	79
6/36 to 6/18	8	5	8	21

Table 5: Pre op visual acuity



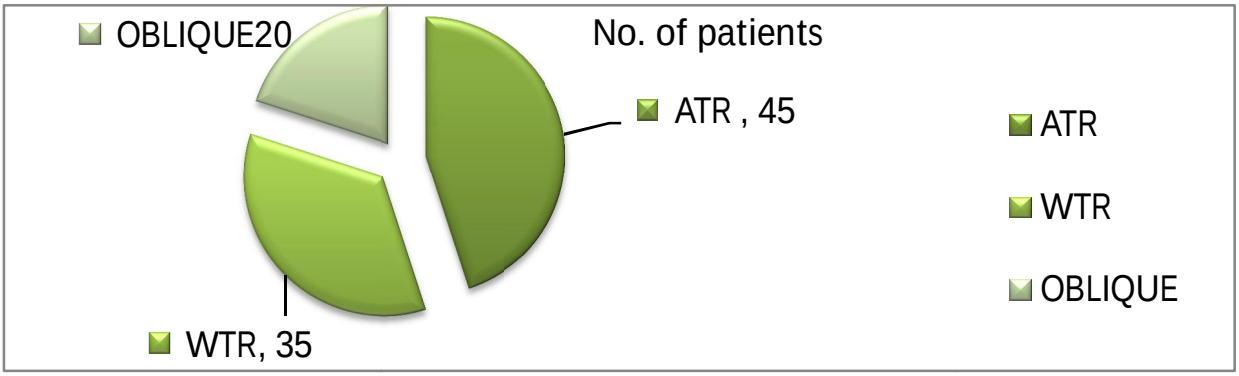
Graph 3: Pre op visual acuity

Pre operative astigmatism:

In the present study pre operatively 45 patients had against the rule, 20 patients had oblique and 35 patients had with the rule astigmatism. The mean preoperative astigmatism was 1.4670D ± 0.55D.

Type of astigmatism	No of patients	Mean astigmatism
ATR	45	1.64 D
OBLIQUE	20	1.27 D
WTR	35	1.37 D

Table 6: Type of astigmatism pre operative



Graph 4: type of astigmatism

Post operative astigmatism:

In patients with With The Rule astigmatism the mean post operative astigmatism at 1 week is 0.93D ± 0.25D with decrease of 0.42D (31.11%), At 6 weeks it was 0.82D±0.26D with reduction of 0.53D (39.26%)of astigmatism, at 6 months mean post operative astigmatism was 0.539±0.22D with a reduction of 0.82D (60.74%) when compared to preoperative astigmatism. Two patients showed against the rule shift & 5 patients showed oblique astigmatism at 1st & 6 weeks. At 6 months 2 patients had against the rule astigmatism.

In patients with Against The Rule astigmatism the mean post operative astigmatism at 1 week is 0.631D ± 0.3D with decrease of 1.01D (61.59%), At 6 weeks it was 0.58D±0.2D with reduction of 1.06D (64.24%)of astigmatism, at 6 months mean post operative astigmatism was 0.56±0.26D with a reduction of 1.08D (65.85%) when compared to preoperative astigmatism.

In patients with Oblique astigmatism the mean post operative astigmatism at 1 week is 0.59D ± 0.25D with decrease of 0.68D (53.54%), At 6 weeks it was 0.60D±0.19D with reduction of 0.67D (52.76%)of astigmatism, at 6 months mean post operative astigmatism was 0.58±0.18D with a reduction of 0.69D (54.33%) when compared to preoperative astigmatism.

In all patients the mean post operative astigmatism at 1 week is 0.718D ± 0.29D with decrease of 0.74D (50.68%), At 6 weeks it was 0.679D±0.26D with reduction of 0.78D (53.42%)of astigmatism, at 6 months mean post operative astigmatism was 0.658±0.25D with a reduction of 0.80D (54.79%) when compared to preoperative astigmatism.

Astigmatism	Pre op mean	1 week Mean	6 week Mean	6months Mean
WTR	1.35D	0.93D	0.82D	0.53D
ATR	1.64D	0.63 D	0.58 D	0.56 D
OBLIQUE	1.27 D	0.59 D	0.60 D	0.58 D
Total	1.46D	0.71D	0.67D	0.65D

Table 7: Post operative residual astigmatism at 1wk, 6wk, 6m.

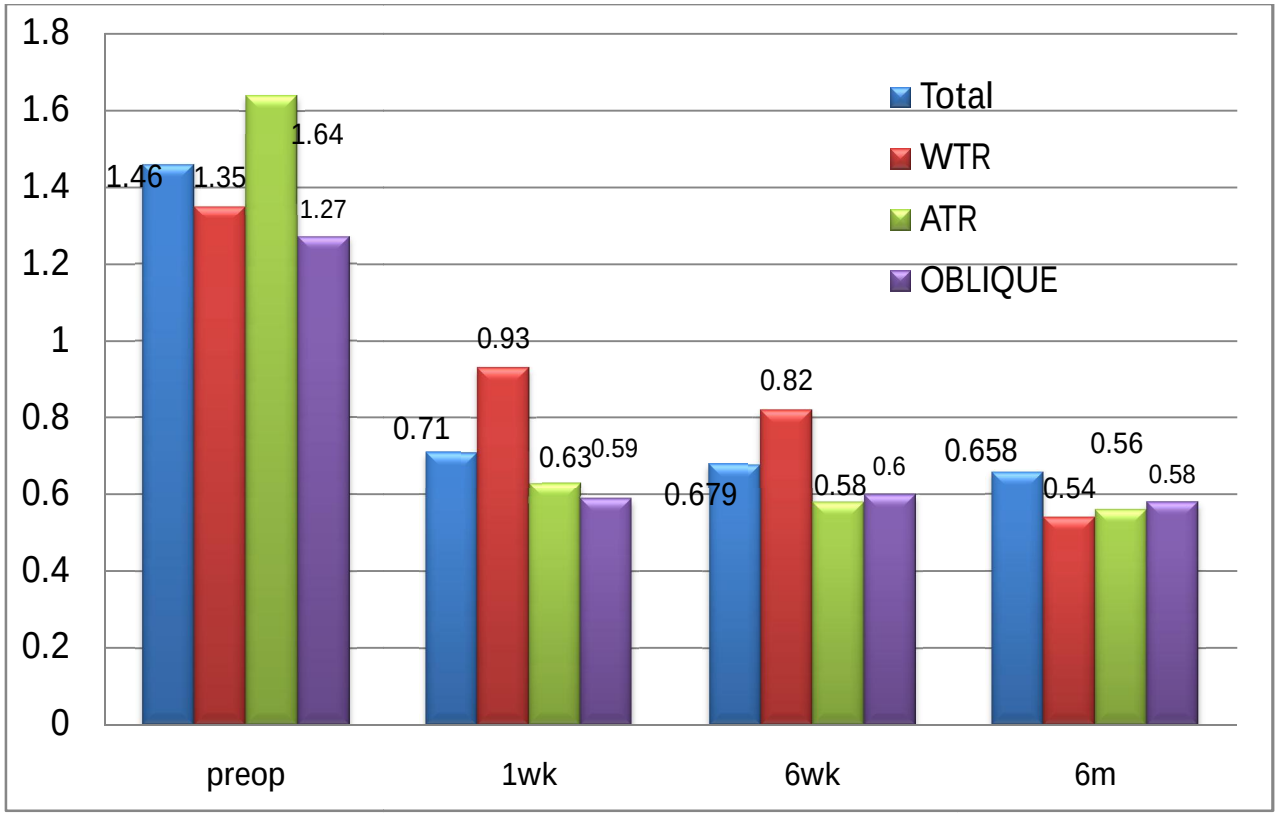
Between the WTR (60.74%),oblique(54.33%) and ATR (65.85%) at 6m there is statistically significant difference (p = 0.043) between the amount of reduction.

In patients with superotemporal & temporal incisions the post op astigmatism remained stable over a period of 6 months with change of 0.79% & 4.26% respectively. But in superior incisions cases(WTR) there is a wide fluctuation in the amount of corrected astigmatism with change of 29.63% of astigmatism.

Percentage of reduction in relation with WTR or ATR astigmatism:

	Pre op	1 week post op			6 week post op			6 months post op		
	Mean ± SD	Mean ± SD	Red	% of Red	Mean ± SD	Red	% of Red	Mean ± SD	Red	% of Red
Total	1.46D ± 0.55D	0.718D ± 0.29D	0.74D	50.68%	0.679D ± 0.26D	0.78D	53.42%	0.658D ± 0.25D	0.80D	54.79%
WTR	1.35D ± 0.48D	0.938 ± 0.25D	0.42D	31.11%	0.824D ± 0.25D	0.53D	39.26%	0.539D ± 0.22D	0.82D	60.74%
OBLIQUE	1.27D ± 0.35D	0.59D ± 0.21D	0.68D	53.54%	0.60D ± 0.19D	0.67D	52.76%	0.58D ± 0.18D	0.69D	54.33%
ATR	1.64D ± 0.57D	0.631D ± 0.3D	1.01D	61.59%	0.58D ± 0.2D	1.06D	64.24%	0.56D ± 0.26D	1.08D	65.85%

Table 8; comparison between preoperative and post operative decrease in amount of astigmatism at 1wk, 6wks, 6months for OBLIQUE, WTR, ATR and total astigmatism.



Graph no 5: showing pre operative and post operative astigmatism at 1 week, 6weeks,and 6 months of total , WTR,ATR astigmatism.

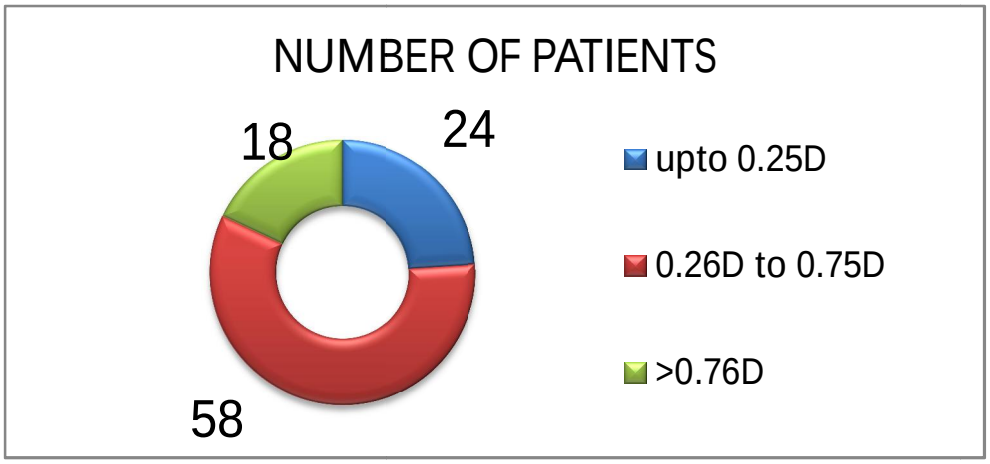
Results of different studies are compared with our study at 6 months in the following table:

Study	Superior incision	Superotemporal	Temporal incision
Present study	0.82D±0.21D	0.69D±0.18D	1.08D±0.26D
Gokhale(2005)	1.36D±1.03D	0.51D±0.49D	0.67D±0.4D
Haldipurkar(2009)	1.2D	0.8D	0.95D
Lyhne N(2000)	0.61D	--	0.41D
Irina S B(2004)	1.65D	--	0.71D

Table 9: showing comparison with various studies

Post operative quantity of manifest keratometric astigmatism :

In our study 24 of 100 (24%) had astigmatism less than 0.25D , 58(58%) patients had 0.26 to 0.75 D, and 18(18%) patients had more than 0.76D postoperatively at 6 months.



Graph 6: Post operative quantity of manifest keratometric astigmatism

In superotemporal incision it reduced 0.69 D of the pre-existing astigmatism which remained stable over a period of 6 months without much fluctuation with good visual recovery.

In superior incision it reduced 0.82 D of the pre-existing astigmatism which showed wide range of fluctuation from 1 week to 6 week which got stabilized over a period of 6 months.visual recovery showed fluctuation depending on the fluctuation in the amount of astigmatism.

In temporal incision early rehabilitation of visual recovery could be due to the fact that temporal incision is farther from visual axis than the superior incision & any flattening due to wound is less likely to affect the corneal

curvature at the visual axis. When the incision is located superiorly, both gravity & eyelid blink tend to create a drag on incision. These factors are neutralized well with temporally placed incision because incision is parallel to vector of forces. The superotemporal incision also, is probably free from effect of gravity & eyelid pressure &tends to induce less astigmatism.

In our study 62 patients had residual astigmatism of 0.5D or less, 20 patients had 0.51D to 0.75D, 17 patients had 0.76D to 1.0D & 1 patient had 1.25D of residual astigmatism.

The desirable goal in cataract surgery in cataract surgery is to leave the patient with 0.5D or less of astigmatism to have optimum visual recovery. Trinadade et al suggest the benefit of low simple myopic astigmatism in pseudophakes for better uncorrected near visual acuity. Mild residual astigmatism will provide pseudo accommodation which helps in good near as well as distant vision.

Various studies:

Richard P Kraft (1983) was the first surgeon to move from the limbus posteriorly towards the sclera, thus enhancing wound healing & reducing surgically induced astigmatism.[2,3]

Cravy TV (1991) used 6.5mm sclera temporal incision & found that minimal & stable post operative astigmatism, along with early & sustained visual recovery.[23]

C.Vass & R.Menapace (1994) studied 20 cases & showed that in patients who had temporal incision, there was a mean flattening of 0.4 to 1.0D in temporal region.[24]

Neilson PJ (1995) studied the refractive effects of clear corneal & corneoscleral tunnel incision, 3.5mm & 5.2mm respectively in cataract surgery. The temporal incision resulted in WTR induced change & superior incision resulted in ATR induced changes.[25]

Irina S B, Edwart Y, Sandi C, Dimitri T A, Walter J S(2004) in their prospective study, 178 eyes were studied. At 6 weeks temporal incision yielded a mean SIA of 0.74D & the nasal incision of 1.65 D. This trend of SIA persisted at 6 months, 0.71 D temporal & 1.41 D for nasal incision.[26]

Morlet N, Minassian D, Dart J (2001) concluded that any residual astigmatism is best when it is WTR than ATR & worse when it is oblique.[13]

Nikhil S G & Saurabh S (2005), in their study they concluded that the amplitude of astigmatism in superior incision was 1.45±0.94 D than in temporal incision group which was 0.67±0.65 D.[11]

Change in the post operative axis

Shift in axis	TEMPORAL INCISION no. of eyes			% of pts at 6m
	1 week	6 week	6 months	
< 15*	34	34	39	87%
15-30*	11	11	6	13%
> 30*	0	0	0	0%

Table 10: shift in axis postoperatively over a period of follow up of 6months in temporal incision group

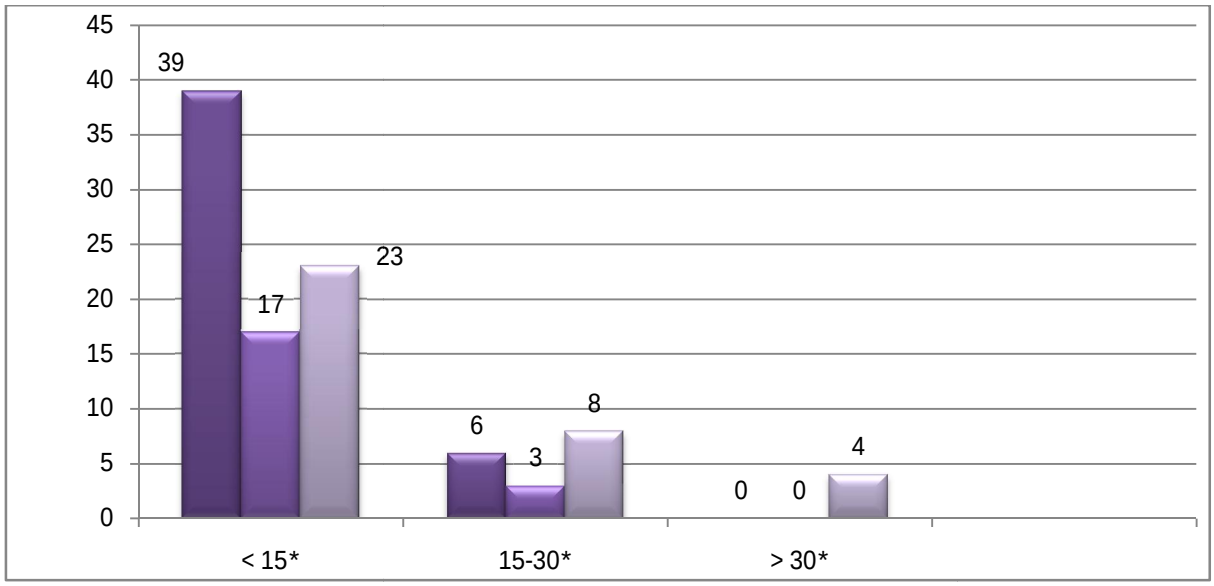
Shift in axis	SUPEROTEMPORAL no. of eyes			% of pts at 6m
	1 week	6 week	6 months	
< 15*	17	16	17	85%
15-30*	3	4	3	15%
> 30*	0	0	0	0%

Table 11: shift in axis postoperatively over a period of follow up of 6months in superotemporal incision group

Shift in axis	SUPERIOR INCISION no. of eyes			% of pts at 6m
	1 week	6 week	6 months	
< 15*	19	21	23	66%
15-30*	5	4	8	23%
> 30*	11	10	4	11%

Table 12: shift in axis postoperatively over a period of follow up of 6months in superior incision group

Post operatively change in the axis was analyzed shows shift of axis of less than 15 degrees to the pre operative value in 87%,85% & 66% of patients at 6months of follow up in temporal, superotemporal & superior group respectively. Shift of 15 to 30 degrees was seen in 13%, 15% & 23% of patients in temporal, superotemporal & superior group respectively. A shift of >30 degrees was seen in 11% of patients of superior incision group. As compared to other two groups shift of axis was found to be more in superior incision group.



Graph 7 : Shift in axis of <15*,15-30*,<30* at 6 months.

In our study 69 out of 100 patients showed shift in the axis of <15 degree, 17 patients had shift in axis between 15 to 30 degree & only 4 patients in superior incision group showed a shift more than 30 degree. In our study most of patients

showed less than 15 degree in the shift of axis of astigmatism. It is always better to undercorrect the patients astigmatism than to flip the axis of the astigmatism

Post operative visual acuity:

Post operatively at 1 week UCVA of 6\6 to 6/18 in 66% patients, 6\24 to 6/60 in 34% patients, . 100% of patients had 6\6 to 6/18 as BCVA.

Post operatively at 6 week UCVA of 6\6 to 6/18 in 85% patients, 6\24 to 6/60 in 14% patients, only one patient had UCVA of less than 6/60. 100% of patients had 6\6 to 6/18 as BCVA.

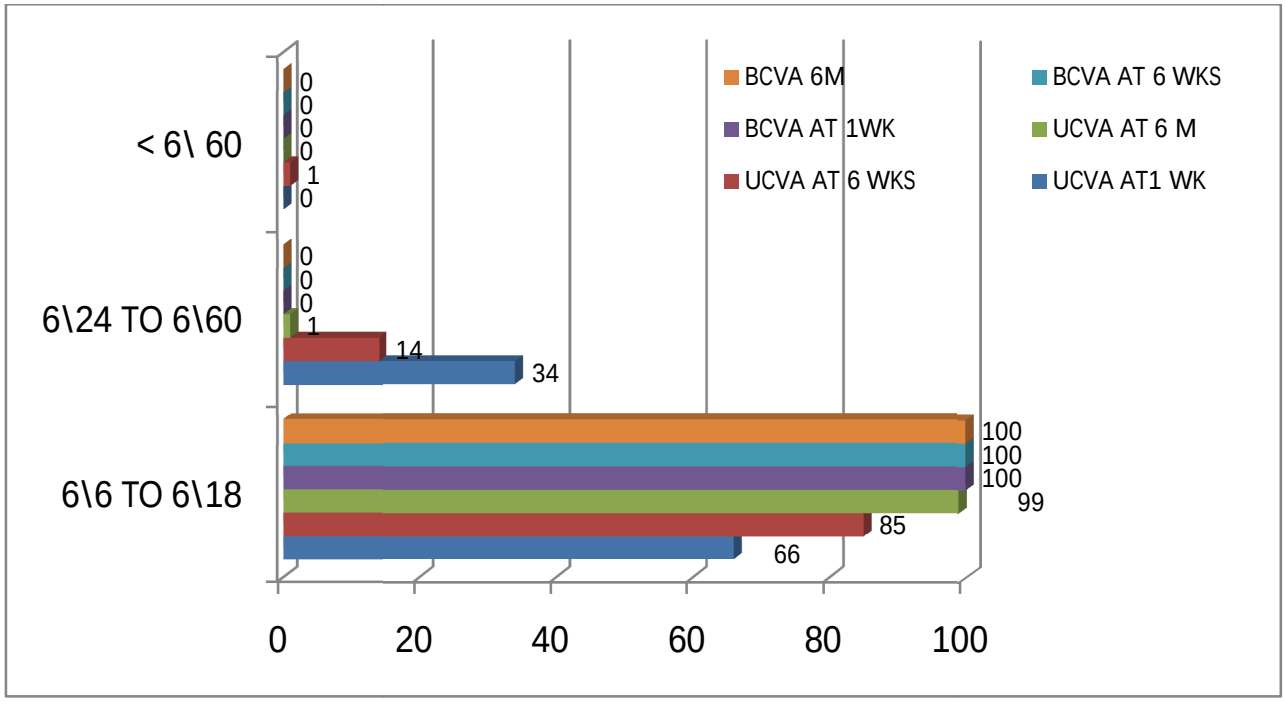
UCVA	temporal			superotemporal			superior			ALL CASES		
	1 w	6 w	6 m	1 w	6 w	6 m	1 w	6 w	6 m	1 w	6 w	6 m
6/6 to 6/18	31	40	45	15	19	20	20	26	34	66	85	99
6/24 to 6/60	14	5	0	5	1	0	15	8	1	34	14	1
Less than 6/60	0	0	0	0	0	0	0	1	0	0	1	0

Table 13: Post operative UCVA at different points of time

Post operatively at 6 months UCVA of 6\6 to 6/18 in 99% patients, 6\24 to 6/60 in 1% patients, . 100% of patients had 6\6 to 6/18 as BCVA.

BCVA	temporal			superotemporal			superior			ALL CASES		
	1 w	6 w	6 m	1 w	6 w	6 m	1 w	6 w	6 m	1 w	6 w	6 m
6/6 to 6/18	45	45	45	20	20	20	35	35	35	100	100	100
6/24 to 6/60	0	0	0	0	0	0	0	0	0	0	0	0
Less than 6/60	0	0	0	0	0	0	0	0	0	0	0	0

Table 14: Post operative BCVA at different points of time



Graph 8: Post operative UCVA & BCVA at different points of time.

Advantages of steep axis incisions:

1) Technical ease
2) No extra instruments required
3) Preservation of optical qualities of cornea
4) Better post operative UCVA
5) No need of additional measures to correct post op astigmatism
6) No induced irregular astigmatism

Disadvantages:

1) Moderate variability in accuracy
2) Can correct maximum upto 1D of astigmatism. Patients with higher astigmatism need additional measures.

Limitations of our study:

1) Manual keratometry rather than computerized videokeratography was used for keratometric astigmatism measurement & only one keratometric reading was taken at each visit.
2) Intraoperative keratometry were not used.

RESULTS

RESULTS

Among the pre operative details in 79% patients had vision between PL+ to 6/60 & 21% had vision between 6/36 to 6/18. Mean preoperative astigmatism was 1.46 D.

Outcome of the study at 6 months follow up are as follows:

1) Mean post operative astigmatism was 0.65D with a reduction of 0.8D (54.79%) when compared to preoperative astigmatism ($p<0.001$).

2) In patients with WTR astigmatism mean post operative astigmatism was 0.539±0.22D with a reduction of 0.82D (60.74%) when compared to preoperative astigmatism.Two patients showed against the rule shift & 5 patients showed oblique astigmatism at 1st & 6 weeks. At 6 months 2 patients had against the rule astigmatism.

3) In patients with ATR astigmatism mean post operative astigmatism was 0.56±0.26D with a reduction of 1.08D (65.85%) when compared to preoperative astigmatism.

4) In patients with oblique astigmatism mean post operative astigmatism was 0.58±0.18D with a reduction of 0.69D (54.33%) when compared to preoperative astigmatism. There is a difference in astigmatic correction in all the three groups.

5) In our study 62% patients had residual astigmatism of 0.5D or less, 20% patients had 0.51D to 0.75D, 17% patients had 0.76D to 1.0D .

6) Post operatively at 6 months UCVA of 6\6 to 6/18 in 99% patients, 6\24 to 6/60 in 1% patients, . 100% of patients had 6\6 to 6/18 as BCVA.

7) Post operatively change in the axis was analyzed shows shift of axis of less than 15 degrees to the pre operative value in 87%,85% & 66% of patients at 6months of follow up in temporal, superotemporal & superior group respectively.A shift of >30 degrees was seen in 11% of patients of superior incision group. As compared to other two groups shift of axis was found to be more in superior incision group.

The results of the study were comparable with other similar published studies.

CONCLUSION

CONCLUSION

Incision at steeper meridian is a simple, safe, effective procedure to correct mild to moderate preoperative astigmatism at the time of cataract surgery.

Post operative vision & astigmatism remained stable over a period of 6 months of follow up in superotemporal group & temporal group while superior incision group showed fluctuation in astigmatism in initial 6 weeks post operatively which stabilized over a period of 6 months.

Due to change in the surgical orientation, temporal & superotemporal approach may require little practice, if one considers the preoperative astigmatism when selecting the location of incision in MSICS, one an minimize post operative keratometric surgically induced astigmatism.

A simple modification in incision placement produces comparable results to other sophisticated procedures & hence offers a way to attain better surgical outcome with limited resources available in most of the set ups.

BIBLIOGRAPHY

Bibliography

1. Akura J, Kaneda S, Hatta S, Matsura K: controlling astigmatism in cataract surgery requiring relatively large self sealing incisions. J Cataract Refractive Surgery 2000:vol 26: 1650-9
2. Colvard D M, Kratz R P, Mazzocco T R. Clinical evalution of Terry Surgical Keratometer. Journal Am Intraocular implant Soc 6:249-51
3. Masket S, origin of sclera tunnel methods. J Cataract Refractive Surgery 1993; 97: 450-56
4. Girard L J, Hoffman R F, Scleral tunnel to prevent induced astigmatism. American Journal of ophthalmology 1984:97:450-6
5. Girard L J, Jorge R, Mary L M. Reducing surgically induced astigmatism by using scleral tunnel. AJO 1984:97;450-6
6. Mc Farland M S. Surgeon undertakes phaco, foldable IOL series. Ocular Surgery News March 1, 1990; 8(5):1, 15
7. Ernest P H, Lavery K T, Kiessling L A. Relative strength of sclerocorneal & clear corneal incisions constructed in cadaver eyes. Journal Of Cataract & Refractive surgery 1994;207;626-9
8. Singer J A, Frown incision for minimising induced astigmatism after small incision cataract surgery with rigid optic IOL. Journal Of Cataract & Refractive surgery 1991;17;677-88

9. Koch P S. Structural analysis of cataract incision construction. Journal Of Cataract & Refractive surgery 1991;17(suppl);661-7
10. Blumenthal M, Ashkenazi I, Fogel R, Assia E L. The gliding nucleus. Journal Of Cataract & Refractive surgery 1993;19;435-7
11. Gokhale N S, Sawhney S. Reduction of astigmatism in manual small incision cataract surgery through change of incision site. Indian Journal O f Ophthalmology 2005;53;201-3
12. Astigmatism; David Abrahams: Duke Elder's practice of refraction. 10th edition, B.I Churchill Livingstone: New Delhi: 65-71
13. Morlet N, Minassian D, Dart J. Astigmatism &the analysis of the its surgical correction. British J ophthalmology 2001;85:1127-38
14. American academy of Ophthalmology: External Disease and Cornea. Basic & Clinical Science course. Section 8. San Francisco. 2000-2001
15. Norman S.Jaffe, Mark S Jaffe, Garry S Jaffe, anaesthesia, wound healing, sutures & needles in – cataract surgery & its complications. 6th edition. St Louis Missouri: Mosby; 1997,18-47
16. Kapoor S, Amar Agarwal, Sunita Agarwal & Keiki Mehta. Phacoemulsification, Laser Cataract Surgery & Foldable IOL. 1st edition. New Delhi:Jaypee brothers;1998, 67-80
17. Fine I H. Architecture & construction of self sealing incision for cataract surgery. Journal Of Cataract & Refractive surgery 1991;17;672-3

18. Pallin S L. Chevron incision for cataract surgery. Journal Of Cataract & Refractive surgery 1990;16:779-81.
19. S S Haldipurkar, Hasanain T Shikari, Vishwanath Gokhale. Wound construction in manual small incision cataract surgery. Indian J Ophthalmology:2009;57;9-13
20. Richard L L, Douglas D K, Robert H O, Li Wang. Control of astigmatism in cataract patients, Roger F Steinert. Cataract surgery techniques complications & management. 2nd edition. Philedelphia: Saunders; 2004;253-266
21. Agarwal A, Corneal topography in cataract surgery,In: I.H Fine, Amar Agarwal, Sunita Agarwal, Keiki Mehta. Phacoemulsification, Laser Cataract surgery & Foldable IOL. 1st edition. New Delhi: Jaypee brothers;1998.24-33
22. Jaffe N S, Clayman H M. The pathophysiology of corneal astigmatism after cataract extraction. Ophthalmology 1975;79:515-630
23. Cravy T V. Routine use of lateral approach to the cataract extraction to achieve rapid & sustained stabilisation of post operative astigmatism. Journal Of Cataract & Refractive surgery 1991;17(4):415-423.
24. Vass C, Menapace R. Computerised statistical analysis of corneal topography for the evaluation of changes in corneal shape after surgery. Am J Ophthalmology 1994;118: 177-84

25. Neilson P J. Prospective evaluation of surgically induced astigmatism & astigmatic keratotomy effects of various self sealing small incisions. Journal Of Cataract & Refractive surgery 1995;21(1):43-8

26. Irina S B, Edwart Y, Susan V, Sandi C, Dimitri T A, Walter J S. Astigmatism outcomes of horizontal temporal versus nasal clear corneal incision cataract surgery. Journal Of Cataract & Refractive surgery 2004:30:418-23.

ANNEXURE

PROFOMA CASE SHEET

A STUDY ON THE INFLUENCE OF INCISION ON POST OPERATIVE ASTIGMATISM

Name : Case No. :

Age : IP No. :

Sex : DOA :

Occupation : DOS :

Address : DOD :

1. Presenting complaints

Deminution of Vision Since RE LE

H/O wearing glasses - Yes/No

Anyother Ocular complaints -

Medical History - DM /HTN / IHD/ASTHMA

2. Ocular Examination

a) Visual Acuity Unaided PH BCVA Nr

RE

LE

	RIGHT EYE	LEFT EYE
b) Anterior Segment		
c) Pupil	RRR	RRR
d) Lens	IMC/PSC/MC/HMC	IMC/PSC/MC/HMC
e) Ocular Tension	mmHg	mmHg

f) Fundus

G) DIAGNOSIS

3) Pre Operative Astigmatic Examination :

	RIGHT EYE				LEFT EYE			
	K1	K2	Axis	Total Cyl.	K1	K2	Axis	Total Cyl.
a) Keratometry								

b) Biometry IOL Power

4) Intra Operative notes :

a) Anasthesia Topical/Peribulbar/Subtenon's

b) Site of incision Sup/sup.temp/Temp Sup/sup.temp/Temp

c) Shape of Incision straight straight

d) Position of incision

e) Length of incision

f) Intra Op. complications

5) Post operative course : Rise in IOP, Inflammation & any others

6) Post operative Follow-up

DURATION	KERATOMETRY				UCVA	BCVA
	K1	K2	STEEP AXIS	RESIDUAL ASTIGMATISM		
1 WEEK						
6 WEEKS						
6 MONTHS						

PHOTOGRAPHS

Figure 1superior rectus bridle suture

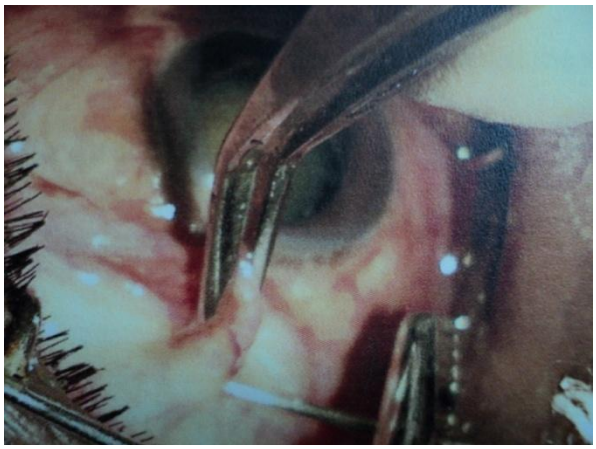


Figure 2 fornix based conjunctival flap

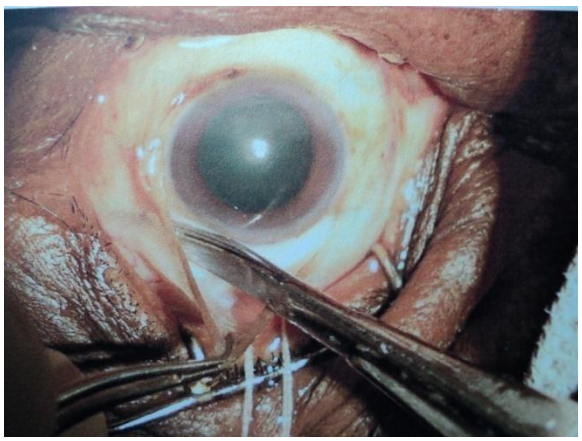


Figure 3 a cauterisation

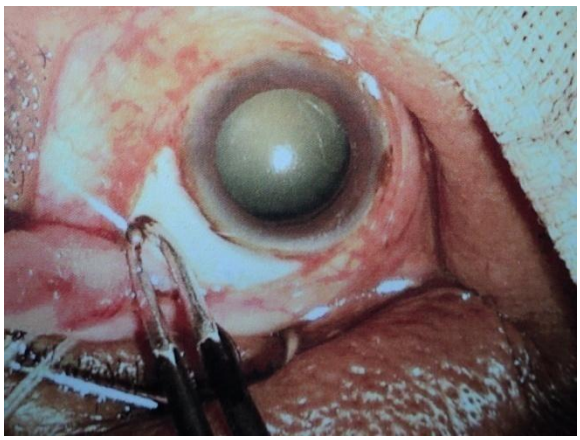


Figure 4 superior incision with sclerocorneal tunnel

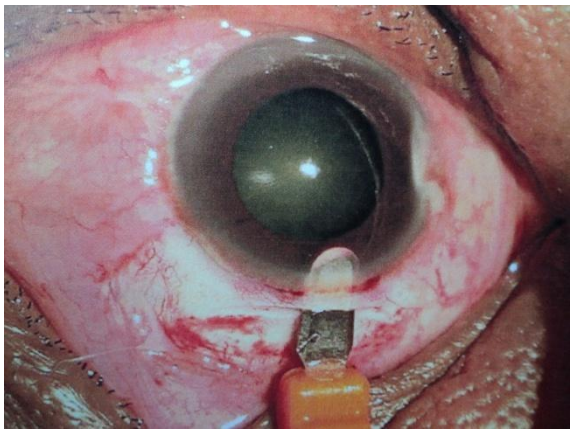


Figure 5 side port

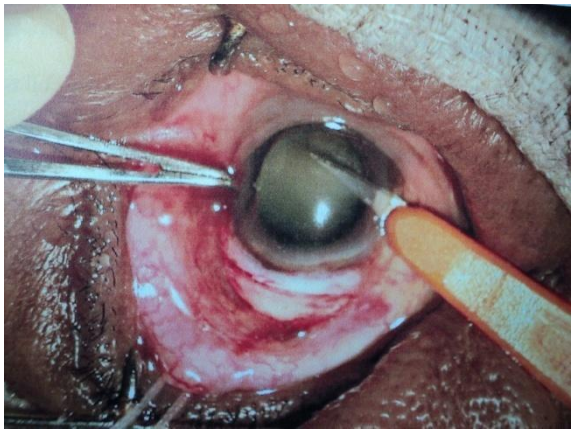


Figure 6 anterior chamber entry with keratome

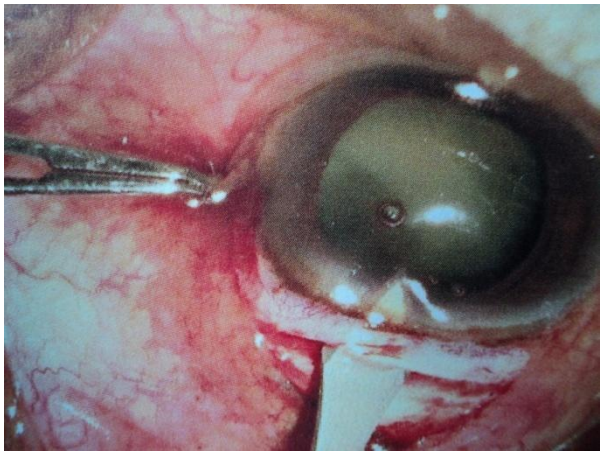


Figure 7 continuous curvilinear capsulorrhexis

Figure 8 extension of incision

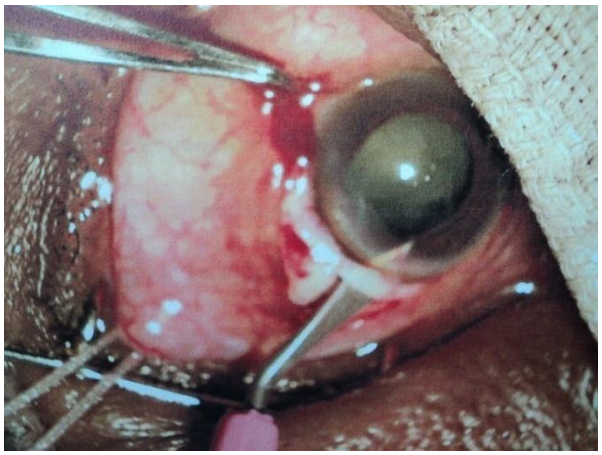


Figure 9 rotation of nucleus

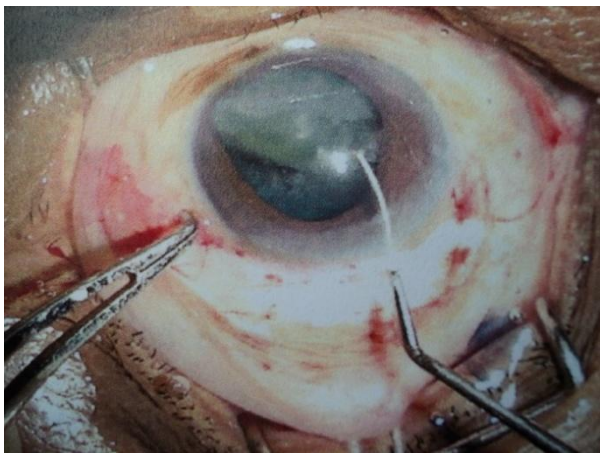


Figure 10 delivery of the nucleus

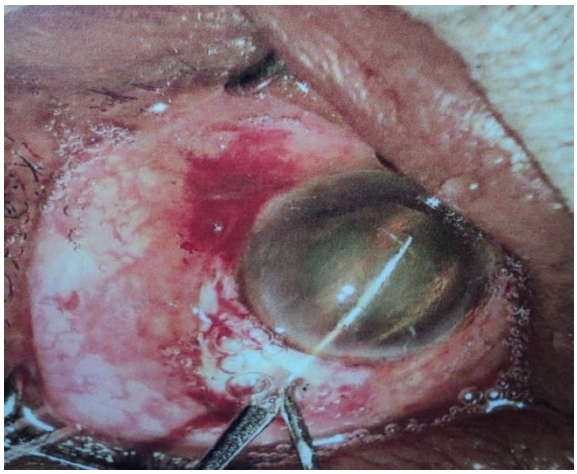


Figure 11 rigid PMMA IOL

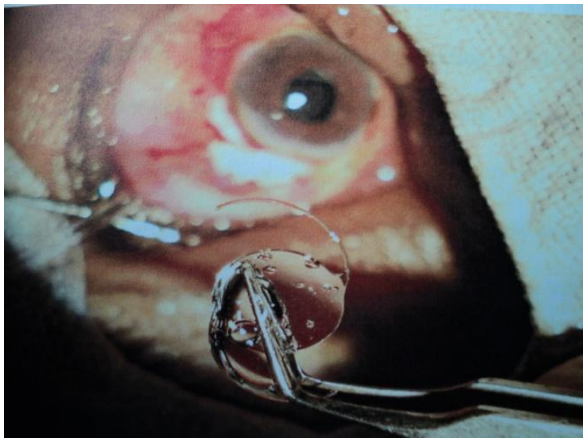


Figure 12 IOL implantation in capsular bag

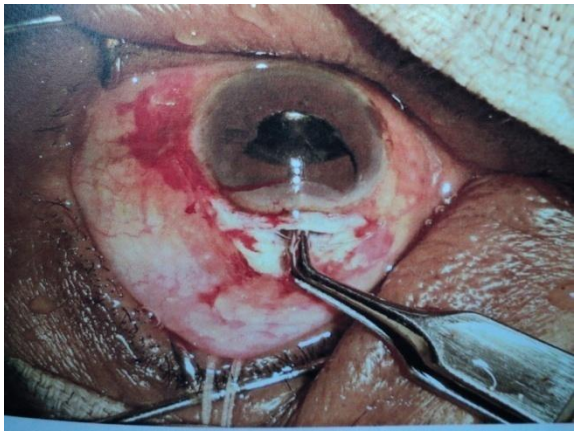


Figure 13 superior straight incision

Figure 14 temporal incision

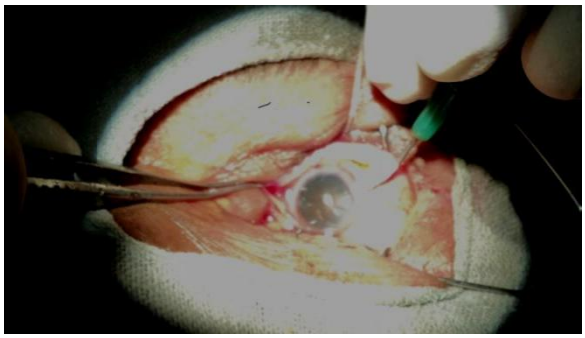


Figure 15 superotemporal incision

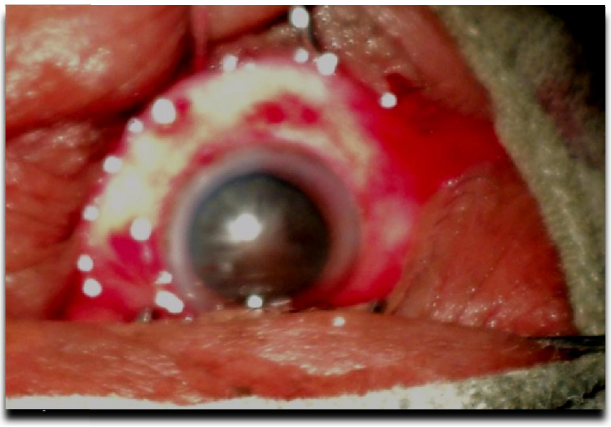


Figure 16 position of surgeon for temporal incision

`

Figure 17 position of the surgeon for superior incision

KEYS TO MASTERCHART

ATR	– against the rule astigmatism
WTR	– with the rule astigmatism
NA	– no astigmatism
OA	- oblique astigmatism
Ast	– astigmatism
D	– Diopters
Res	- Residual astigmatism
IP.NO	– In patient number
K1&2	– keratometry readings
AXIS	- steep axis
K2	– keratometry reading meridian
Pre op	– Pre-operative
Post op	– post operative
SMC	– senile mature cataract
PSC	– posterior subcapsular cataract
NS	– nuclear sclerosis
PPC	– posterior polar cataract
CC	– Cortical cataract
UCVA	– Uncorrected visual acuity
BCVA	– Best corrected visual acuity
CFCF	– counting finger close to face
HM	– Hand movements
PL	–Perception of light
MSICS+PCIOL	–Manual small incision cataract surgery+ posterior chamber IOL
IOL	– intraocular lens

SL No	IP No	patient name	Age(Y	Sex	Diagnosis	BCVA	Pre operative Data					Surgery		Post - op 1wk						Post op 6 wks						Post -op 6 months					
							K1(D)	K2(D)	AXIS(STE	Ast	W/ATR		UCVA	BCVA	K1	K2	AXIS	Ast	W/ATR	UCVA	BCVA	K1	K2	AXIS	Ast	W/ATR	UCVA	BCVA	K1	K2	AXIS	Ast	W/ATR
1	25600	shanmugam	65	M	PSC (RE)	4\60	43.5	44.5	170	1	ATR	MSICS+PCIOL	6\24	6\9	43.25	43.87	160	0.62	ATR	6\18P	6\6P	43.25	43.75	160	0.45	ATR	6\18	6\6P	43.25	43.75	180	0.5	ATR
2	245431	Rajarathinam	64	M	PSC(RE)	6\60	42.75	45	155	2.25	ATR	MSICS+PCIOL	6\36	6\9	44	44.75	165	0.75	ATR	6\18	6\9	44	44.9	165	0.9	ATR	6\12	6\6	44	44.75	170	0.75	ATR
3	26164	Davidraj	54	M	PSC(LE)	4\60	43.12	44.75	180	1.87	ATR	MSICS+PCIOL	6\24	6\12	44	44.5	150	0.5	OA	6\24	6\9	44	44.5	160	0.5	ATR	6\9	6\6	44	44.5	170	0.5	ATR
4	26226	Aisha	45	F	PSC(RE)	3\60	44.25	45.75	165	1.5	ATR	MSICS+PCIOL	6\36	6\12	45	45.25	140	0.25	OA	6\12	6\9	45	45.25	165	0.25	ATR	6\12	6\6	45.25	45	160	0.25	ATR
5	242731	Muniyammal	50	F	PSC (RE)	6\60	44.75	46.75	155	2	ATR	MSICS+PCIOL	6\18	6\6	45.25	45.75	165	0.5	ATR	6\12	6\6	45	45.62	160	0.62	ATR	6\9	6\6	45.62	45	160	0.62	ATR
6	27214	Buhari	69	M	PSC(LE)	6\60	42.75	44.5	180	1.75	ATR	MSICS+PCIOL	6\12	6\6	43.12	43.62	175	0.5	ATR	6\9	6\6	43.25	43.75	165	0.5	ATR	6\9	6\6	43.25	43.75	170	0.5	ATR
7	242712	Jamuna	76	F	SMC(LE)	HM	44	45.87	160	1.87	ATR	MSICS+PCIOL	6\18	6\6	44.75	45.25	180	0.5	ATR	6\12	6\6	44.75	45.25	180	0.5	ATR	6\9	6\6	44.9	45.25	175	0.35	ATR
8	27164	Devagi	79	F	SMC (RE)	1\60	44.62	47.12	155	2.5	ATR	MSICS+PCIOL	6\24	6\6	44.87	46.12	170	1.25	ATR	6\24	6\6	45	46	170	1	ATR	6\18	6\6	45	45.92	170	0.92	ATR
9	27758	Durai	63	M	PSC (RE)	6\ 60	42.75	44	175	1.25	ATR	MSICS+PCIOL	6\12	6\6	43.5	43.75	180	0.25	ATR	6\6	6\6	43.5	43.87	180	0.37	ATR	6\6	6\6	43.5	43.7	180	0.2	ATR
10	27144	Chinnammal	68	F	PSC (LE)	6\ 24	43.62	45.12	150	2.5	ATR	MSICS+PCIOL	6\24	6\6	43	44.5	140	1.5	OA	6\24	6\6	43.5	44.5	145	145	OA	6\12	6\6	43.5	44.5	155	1	ATR
11	27201	shanti	42	F	PSC (RE)	6\ 36	43.5	45.25	165	1.75	ATR	MSICS+PCIOL	6\9	6\6	44.5	45	10	0.5	ATR	6\12	6\6	44.5	45	10	0.5	ATR	6\9	6\6	44.5	45	10	0.5	ATR
12	27806	sakreyas	47	M	PSC(LE)	5\60	44.25	45.75	25	1.5	ATR	MSICS+PCIOL	6\18	6\6	45	45.5	30	0.5	ATR	6\18	6\6	45	45.5	30	0.5	ATR	6\9	6\6	45	45.5	30	0.5	ATR
13	27801	Dhanam	76	F	SMC (RE)	PL+	44	46	165	2	ATR	MSICS+PCIOL	6\24	6\12	47.87	47.12	10	0.75	ATR	6\18	6\12	47.75	47	170	0.75	ATR	6\18	6\12	47.75	47	170	0.75	ATR
14	37885	Quilammal	40	F	CC (RE)	6\60	44.37	46	20	1.62	ATR	MSICS+PCIOL	6\9	6\6	45.62	45	25	0.62	ATR	6\9	6\6	45	45.5	25	0.5	ATR	6\9	6\6	45.5	45	25	0.5	ATR
15	38513	ramalingam	59	M	PSC (LE)	2\60	44.12	46	180	1.88	ATR	MSICS+PCIOL	6\12	6\6	44	45	170	1	ATR	6\12	6\6	44.12	45	165	0.87	ATR	6\12	6\6	44	45	170	1	ATR
16	40446	shankar	70	M	PSC (LE)	3\60	44.5	46.75	170	2.25	ATR	MSICS+PCIOL	6\18	6\6	45.25	46	160	0.75	ATR	6\9	6\6	45.12	45.87	165	0.75	ATR	6\9	6\6	45.12	45.87	170	0.75	ATR
17	38232	Anjalai	46	F	PSC(RE)	4\60	41.5	43	30	1.5	ATR	MSICS+PCIOL	6\12	6\6	42.25	42.75	40	0.5	OA	6\9	6\6	42.25	42.75	30	0.5	ATR	6\9	6\6	42	42.5	30	0.5	ATR
18	38500	Rajeshwari	43	F	SMC(LE)	PL+	45.5	46.75	10	1.25	ATR	MSICS+PCIOL	6\12	6\6	46	46.25	15	0.25	ATR	6\6	6\6	46	46.12	15	0.12	ATR	6\6	6\6	46	46	0	0	NA
19	40557	Ganesan	46	M	CC(RE)	6\36	47.62	49.12	25	1.5	ATR	MSICS+PCIOL	6\9	6\6	48.25	48.5	30	0.25	ATR	6\6	6\6	48	48.5	30	0.5	ATR	6\6	6\6	48	48.5	30	0.5	ATR
20	40862	Dhavid	70	M	NS3(RE)	6\60	43	45	10	2	ATR	MSICS+PCIOL	6\12	6\6	43	44	180	1	ATR	6\12	6\6	43.12	44	170	0.87	ATR	6\12	6\6	43.25	44	170	0.75	ATR
21	38737	Jeenathunisha	69	F	NS2 (RE)	6\60	43.25	44.25	20	1	ATR	MSICS+PCIOL	6\18	6\6	43.5	43.62	170	0.12	ATR	6\9	6\6	43.5	43.5	0	0	NA	6\6	6\6	43.5	43.5	0	0	NA
22	40645	Kuppabai	45	F	PSC (LE)	6\36	45.5	46.75	15	1.25	ATR	MSICS+PCIOL	6\18	6\9	46.87	47.12	10	0.25	ATR	6\6	6\6	46.87	47	10	0.13	ATR	6\6	6\6	47	47	0	0	NA
23	41106	kalappan	70	M	SMC(RE)	PL+	45	47	165	2	ATR	MSICS+PCIOL	6\12	6\6	46	46.5	175	0.5	ATR	6\9	6\6	46	46.37	160	0.37	ATR	6\9	6\6	46	46.25	170	0.25	ATR
24	42258	Gunanidhi	69	M	PSC (LE)	4\60	41.25	42.25	180	1	ATR	MSICS+PCIOL	6\24	6\6	42	42.25	180	0.25	ATR	6\18	6\6	42	42.5	180	0.5	ATR	6\12	6\6	42.5	42	170	0.5	ATR
25	44060	Mohammed	71	M	NS3(RE)	6\36	42.5	44	180	1.5	ATR	MSICS+PCIOL	6\12	6\6	43.25	43.63	160	0.37	ATR	6\9	6\6	43.25	43.5	150	0.25	ATR	6\9	6\6	43.25	43.5	165	0.25	ATR
26	44071	Chokkammal	51	F	NS2(RE)	6\24	43.37	45.37	25	2	ATR	MSICS+PCIOL	6\18	6\6	44	45	30	1	ATR	6\12	6\6	44	45	45	1	ATR	6\12	6\6	44	44.75	30	0.75	ATR
27	45625	Saroja	38	F	PSC(RE)	6\36	42.5	44.12	20	1.63	ATR	MSICS+PCIOL	6\12	6\6	43	44	20	1	ATR	6\12	6\6	43	44	20	1	ATR	6\12	6\6	43.25	44	20	0.75	ATR
28	1045	sara	68	F	PSC (LE)	6\ 60	43.5	45	180	1.5	ATR	MSICS+PCIOL	6\18	6\6	43.75	44.75	160	1	ATR	6\24	6\6	43.5	44.75	170	1.25	ATR	6\18	6\6	43.75	44.75	180	1	ATR
29	44801	Gnanam	48	M	PSC (RE)	3\60	42.37	44.62	180	2.25	ATR	MSICS+PCIOL	6\24	6\6	43	44.5	150	1.5	ATR	6\24	6\6	43	44.25	160	1.25	ATR	6\18	6\6	43	44.25	180	1	ATR
30	3405	periyanayagi	65	F	PSC (RE)	4\60	45.25	46.5	10	1.25	ATR	MSICS+PCIOL	6\12	6\6	45.5	46	20	0.5	ATR	6\12	6\6	45.25	45.75	15	0.5	ATR	6\9	6\6	45.25	45.75	10	0.5	ATR
31	6577	Geetha	66	F	PSC(LE)	PL+	40.75	42.75	25	2	ATR	MSICS+PCIOL	6\18	6\6	41.75	42.75	25	0.75	ATR	6\18	6\6	41.75	42.75	25	1	ATR	6\18	6\6	41.75	42.75	25	1	ATR
32	238	Michel	43	M	NS3(LE)	HM	44.37	45.87	10	1.5	ATR	MSICS+PCIOL	6\12	6\6	44.75	45.5	15	0.75	ATR	6\12	6\6	45	45.5	45.75	0.75	ATR	6\12	6\6	45	45.75	15	0.75	ATR
33	6179	Indrani	65	F	NS2(LE)	1\60	42.25	44	180	1.75	ATR	MSICS+PCIOL	6\18	6\6	43	44	180	1	ATR	6\18	6\6	43	44	180	1	ATR	6\18	6\6	43	44.25	180	1.25	ATR
34	11280	Alathammal	68	F	NS3 (RE)	6\60	44.25	42.25	25	2	ATR	MSICS+PCIOL	6\24	6\6	42.5	43.5	30	1	ATR	6\24	6\6	42.75	43.5	30	0.75	ATR	6\18	6\6	43	44	10	1	ATR
35	1670	Balasundaram	73	M	SMC (RE)	PL+	44.75	43	160	1.75	ATR	MSICS+PCIOL	6\24	6\6	43.75	44.5	180	0.75	ATR	6\12	6\6	43.75	44.25	180	0.5	ATR	6\9	6\6	43.75	44.5	180	0.75	ATR
36	10178	Senthamarai	53	F	PSC (LE)	6\60	43.75	42.75	15	1	ATR	MSICS+PCIOL	6\12	6\6	44.75	45.12	10	0.37	ATR	6\12	6\6	44	44.5	20	0.5	ATR	6\12	6\6	44.75	45.12	180	0.37	ATR
37	491	Mariappan	58	M	PSC (RE)	6\36	44.37	42.87	170	1.5	ATR	MSICS+PCIOL	6\18	6\6	43.5	44	180	0.5	ATR	6\9	6\6	43.5	44	10	0.5	ATR	6\9	6\6	43.5	44	180	0.5	ATR
38	13485	Banumathi	62	F	PSC (LE)	1\60	43	44.75	150	1.75	ATR	MSICS+PCIOL	6\18	6\6	43.5	44.25	160	0.75	ATR	6\18	6\6	43.75	44.25	160	0.5	ATR	6\12	6\6	43.75	44.25	170	0.5	ATR
39	6233	Jayabalan	67	M	NS3 (RE)	2\60	44	45.5	180	1.5	ATR	MSICS+PCIOL	6\18	6\6	44.5	45	10	0.5	ATR	6\18	6\6	44.5	45	10	0.5	ATR	6\9	6\6	44.5	45	15	0.5	ATR
40	7669	Nagalingam	71	M	SMC (RE)	PL+	44.25	45.62	20	1.37	ATR	MSICS+PCIOL	6\24	6\6	44.25	45	180	0.75	ATR	6\12	6\6	44.25	45	170	0.75	ATR	6\12	6\6	44.25	45	10	0.75	ATR
41	13508	Thamarai	48	F	NS2(RE)	6\ 60	45	46.87	170	1.87	ATR	MSICS+PCIOL	6\24	6\6	45	45.87	170	0.87	ATR	6\18	6\6	45.12	45.75	170	0.63	ATR	6\12	6\6	45	45.75	170	0.75	ATR
42	9040	Angammal	60	F	PSC(LE)	6\ 36	43.5	44.5	180	1	ATR	MSICS+PCIOL	6\12	6\6	44	44.12	175	0.12	ATR	6\6	6\6	44	44	0	0	NA	6\6	6\6	44	44	0	0	NA
43	11057	prasad	33	M	PSC(RE)	6\ 60	45.87	47	20	1.12	ATR	MSICS+PCIOL	6\9	6\6	46.5	46.75	20	0.25	ATR	6\6	6\6	46.5	46.75	20	0.25	ATR	6\6	6\6	46.5	46.75	20	0.25	ATR
44	11711	Rajammal	68	F	PSC(LE)	2\60	44	45	180	1	ATR	MSICS+PCIOL	6\6	6\6	44.62	44.75	155	0.13	ATR	6\6	6\6	44.5	44.5	0	0	NA	6\6	6\6	44.75	44.75	0	0	NA
45	10734	vittabai	64	F	PSC(RE)	HM	42.75	44.25	10	1.5	ATR	MSICS+PCIOL	6\18	6\6	43	43.75	180	0.75	ATR	6\12	6\6	43.5	43.87	180	0.37	ATR	6\9	6\6	43.25	43.75	170	0.5	ATR

TEMPORAI INCISION GROUP

SL No	IP No	patient name	Age(Y	Sex	Diagnosis	BCVA	Pre operative Data					Surgery	Post - op 1wk							Post op 6 wks						Post -op 6 months						REMARKS
							K1(D)	K2(D)	AXIS(STEEP)	Ast	W/ATR		UCVA	BCVA	K1	K2	AXIS	Ast	W/ATR	UCVA	BCVA	K1	K2	AXIS	Ast	W/ATR	UCVA	BCVA	K1	K2	AXIS	Ast	W/ATR	
46	10774	Mani	58	M	PSC(LE)	6\ 60	44.25	45.5	45	1.25	OA	MSICS+PCIOL	6\24	6\9	44.75	45.25	40	0.5	OA	6\12	6\6	44.75	45.25	30	0.5	ATR	6\12	6\6	44.75	45.25	35	0.5	OA	
47	11909	Sivanandham	74	M	SMC(RE)	1\60	45.5	46.5	50	1	OA	MSICS+PCIOL	6\18	6\6	46	46.5	50	0.5	OA	6\12	6\6	45.75	45.25	45	0.5	OA	6\9	6\6	46	45.5	50	0.5	OA	
48	10178	sivagami	42	F	PSC(RE)	6\ 60	42.75	44.12	135	1.37	OA	MSICS+PCIOL	6\18	6\6	43.25	43.75	130	0.5	OA	6\9	6\6	43.25	43.75	35	0.5	0A	6\9	6\6	43.25	43.75	35	0.5	OA	
49	11913	Raja	49	M	PSC(RE)	6\ 36	44	45.62	40	1.62	OA	MSICS+PCIOL	6\18	6\6	43.5	44.25	40	0.75	OA	6\12	6\6	43.5	44	40	0.5	OA	6\9	6\6	43.5	44.5	40	1	OA	
50	10443	lakshmi	69	F	PSC(RE)	3\60	42.75	44	140	1.25	OA	MSICS+PCIOL	6\12	6\6	43.25	43.75	115	0.5	WTR	6\12	6\6	43.25	44	115	0.75	WTR	6\18	6\6	43.25	43.75	115	0.5	WTR	
51	12870	Ramdoss	58	M	NS3(LE)	2\60	45	46.5	130	1.5	OA	MSICS+PCIOL	6\18	6\6	45.75	46.12	125	0.37	OA	6\9	6\6	45.25	46	125	0.75	OA	6\12	6\6	45.5	46	125	0.5	OA	
52	11841	Moorthy	70	M	NS3(LE)	PL+	44.75	45.75	55	1	OA	MSICS+PCIOL	6\12	6\6	45	45.5	75	0.5	WTR	6\12	6\6	45.25	45.75	55	0.5	OA	6\9	6\6	45	45.62	55	0.62	OA	
53	13503	Devi	61	F	NS2(LE)	6\ 60	43.25	44.37	145	1.12	OA	MSICS+PCIOL	6\12	6\6	43.25	43.75	140	0.5	OA	6\12	6\6	43	43.62	140	0.62	OA	6\12	6\6	43.25	43.75	130	0.5	OA	
54	11891	James	57	M	PSC(LE)	4\60	44.5	45.5	45	1	OA	MSICS+PCIOL	6\9	6\6	45	45.5	35	0.5	OA	6\9	6\6	45	45.5	45	0.5	OA	6\9	6\6	45	45.5	45	0.5	OA	
55	14035	Desammal	39	F	PSC(LE)	HM+	45.75	47	35	1.25	OA	MSICS+PCIOL	6\12	6\6	46	46.75	40	0.75	OA	6\12	6\6	46.5	47.25	55	0.75	OA	6\12	6\6	46	46.75	55	0.75	OA	
56	16001	Evarnamma	46	F	PSC(RE)	PL+	45.5	47.25	30	1.75	OA	MSICS+PCIOL	6\24	6\6	45	46	30	1	OA	6\24	6\6	45.25	46	30	0.75	OA	6\18	6\6	46	46.5	30	0.5	OA	
57	16354	Gopal	61	M	NS2(LE)	4\60	46.75	45	65	1.75	OA	MSICS+PCIOL	6\24	6\9	45	46	75	0.75	WTR	6\18	6\6	45.25	46	75	0.75	WTR	6\12	6\6	45	45.75	75	0.75	WTR	
58	16937	Malliga	57	F	NS3(RE)	6\ 36	45.25	44	65	1.25	OA	MSICS+PCIOL	6\12	6\6	44.5	45	70	0.5	WTR	6\12	6\6	44.5	45	70	0.5	WTR	6\12	6\6	45	44.25	70	0.67	WTR	
59	17511	kandaswamy	65	M	PSC(LE)	6\60	42	43.75	55	1.75	OA	MSICS+PCIOL	6\24	6\6	42.25	43.25	75	1	WTR	6\18	6\6	42	43.12	75	1.12	WTR	6\18	6\6	43	42	50	1	OA	
60	18255	Ramaih	60	M	PSC(RE)	6\ 36	44.75	45.75	130	1	OA	MSICS+PCIOL	6\18	6\9	45	45.5	120	0.5	WTR	6\9	6\6	45.25	45.5	80	0.25	WTR	6\12	6\6	45	45.5	125	0.5	OA	
61	19243	Manikam	75	M	SMC(RE)	6\ 36	42.75	43.75	60	1	OA	MSICS+PCIOL	6\24	6\6	43.25	43.75	55	0.5	OA	6\12	6\6	43.25	43.75	50	0.5	OA	6\9	6\6	43	43.5	45	0.5	OA	
62	19684	veeapondi	52	M	CC(RE)	6\60	41.75	43.12	40	1.37	OA	MSICS+PCIOL	6\18	6\6	42	42.75	40	0.75	OA	6\12	6\6	42	42.75	40	0.75	OA	6\9	6\6	42.25	42.75	40	0.5	OA	
63	20950	Amrutham	61	F	PSC(LE)	6\60	43	44	135	1	OA	MSICS+PCIOL	6\12	6\6	43.5	44	130	0.5	OA	6\12	6\6	43	43.5	130	0.5	OA	6\9	6\6	43.5	43	125	0.5	OA	
64	22402	Samburnam	56	F	CC(RE)	6\60	45	44	35	1	OA	MSICS+PCIOL	6\12	6\6	44	44.5	45	0.5	OA	6\9	6\6	44	44.5	45	0.5	OA	6\9	6\6	44	44.5	45	0.5	OA	
65	24344	vijaykumar	71	M	PSC(LE)	6\ 36	43.25	44.5	125	1.25	OA	MSICS+PCIOL	6\12	6\9	44	44.5	125	0.5	OA	6\12	6\6	44	44.5	110	0.5	WTR	6\9	6\6	44	44.25	100	0.25	WTR	
													SUPEROTEMPORAL INCISION GROUP																					

SL No	IP No	patient name	Age(Y	Sex	Diagnosis	BCVA	Pre operative Data					Surgery		Post - op 1wk							Post op 6 wks							Post -op 6 months						REMARKS
							K2D)	K1 (D)	AXIS(S	Ast	W/ATR		UCVA	BCVA	K2	K1	AXIS	Ast	W/ATR	UCVA	BCVA	K2	K1	AXIS	Ast	W/ATR	UCVA	BCVA	K1	K2	AXIS	Ast	W/ATR	
66	22532	kondaih	69	M	SMC(RE)	PL+	46.5	47.5	90	1	WTR	MSICS+PCIOL	6\24	6\6	47	47.25	120	0.25	WTR	6\18	6\6	47	46.5	125	0.5	OA	6\9	6\6	46.25	47.25	150	1	ATR	
67	24336	Anthony	65	M	CC(RE)	6\60	42.75	44.12	90	1.37	WTR	MSICS+PCIOL	6\18	6\6	43	43.5	110	0.5	WTR	6\18	6\6	43.5	43	160	0.5	ATR	6\12	6\6	43.25	43.75	160	0.5	ATR	
68	25201	Kattaih	37	M	PSC(RE)	3\60	43.25	44.25	70	1	WTR	MSICS+PCIOL	6\24	6\6	43.75	43	30	0.75	ATR	6\24	6\6	43	44	30	1	ATR	6\18	6\6	43.25	44	75	0.75	WTR	
69	25939	Ramayi	65	F	PSC(LE)	4\60	44	46.12	110	2.12	WTR	MSICS+PCIOL	6\36	6\6	44	45.75	45	1.75	OA	6\24	6\6	44	45.63	60	1.63	OA	6\18	6\6	44.5	45.5	90	1	WTR	
70	26341	Muttulakshmi	40	F	PSC(RE)	6\ 60	42.75	45	80	2.25	WTR	MSICS+PCIOL	6\36	6\6	42.5	44.25	35	1.75	OA	6\24	6\6	42.75	44	65	1.25	OA	6\18	6\6	43	44	80	1	WTR	
71	29000	Puniakoti	67	M	PSC(LE)	6\ 60	46.5	45.5	90	1	WTR	MSICS+PCIOL	6\24	6\6	46	45	10	1	OA	6\18	6\6	46	45.25	40	0.75	OA	6\9	6\6	46	46.25	90	0.25	WTR	
72	29421	Desam	54	F	PSC(RE)	HM+	44.75	46	100	1.25	WTR	MSICS+PCIOL	6\9	6\6	45.5	45.75	90	0.25	WTR	6\9	6\6	45.5	45.75	90	0.25	WTR	6\9	6\6	45.5	45.75	90	0.25	WTR	
73	31530	Thangammal	73	F	PSC(LE)	5\60	44	45.5	80	1.5	WTR	MSICS+PCIOL	6\9	6\6	44.5	45	75	0.5	WTR	6\9	6\6	44.62	45.12	75	0.5	WTR	6\9	6\6	44.25	44.75	75	0.5	WTR	
74	33560	Yovan	43	M	PSC(RE)	1\60	45	43	95	2	WTR	MSICS+PCIOL	6\24	6\18	43.5	44.5	40	1	OA	6\24	6\9	43.5	44.5	40	1	OA	6\24	6\9	43.5	44.5	75	1	WTR	ARMD
75	34534	Patchiammal	65	F	PSC(LE)	1\60	42.75	45.25	85	2.5	WTR	MSICS+PCIOL	6\24	6\6	43.5	44.5	90	1	WTR	6\18	6\6	43.5	44.25	90	0.75	WTR	6\18	6\6	43.25	44	90	0.75	WTR	
76	36523	Kallappan	74	M	SMC(RE)	CF1	42.75	41	90	1.75	WTR	MSICS+PCIOL	6\24	6\6	40	41.5	80	1.5	WTR	6\24	6\6	40.25	41.5	80	1.25	WTR	6\18	6\6	40.25	41.25	80	1	WTR	
77	37831	Mary	70	F	SMC(RE)	PL+	41.75	43	90	1.25	WTR	MSICS+PCIOL	6\36	6\6	41	43.5	100	2.5	WTR	6\18	6\6	41.25	42.75	80	1.5	WTR	6\12	6\6	41	42	80	1	WTR	
78	38536	Sulthan	67	M	CC (RE)	2\60	43.25	44.25	110	1	WTR	MSICS+PCIOL	6\9	6\6	43.75	44	110	0.25	WTR	6\9	6\6	43.75	44	100	0.25	WTR	6\6	6\6	43.75	44	100	0.25	WTR	
79	40105	Rashida	58	F	NS3(RE)	6\36	45	46.25	100	1.25	WTR	MSICS+PCIOL	6\9	6\6	45.25	46	130	0.75	OA	6\12	6\6	45	45.75	120	0.75	OA	6\9	6\6	45.5	46	90	0.5	WTR	
80	42537	Nazhir	53	M	NS2(RE)	5\60	44	42.25	110	1.75	WTR	MSICS+PCIOL	6\18	6\6	42.5	43.5	110	1	WTR	6\18	6\6	42.5	43.25	110	0.75	WTR	6\12	6\6	42.5	43.25	110	0.75	WTR	
81	44934	Murugan	63	M	PSC(LE)	HM+	43.5	45	100	1.5	WTR	MSICS+PCIOL	6\12	6\6	44	44.5	100	0.5	WTR	6\12	6\6	44	44.5	100	0.5	WTR	6\9	6\6	44	44.5	100	0.5	WTR	
82	45671	Krishnan	57	M	PSC(LE)	6\ 36	44.25	45.5	80	1.25	WTR	MSICS+PCIOL	6\18	6\6	44.5	45	110	0.5	WTR	6\9	6\6	44.5	45	80	0.5	WTR	6\9	6\6	44.75	45	80	0.25	WTR	
83	46831	Nasini	54	F	PSC(LE)	6\ 60	42.25	43.5	75	1.25	WTR	MSICS+PCIOL	6\9	6\6	42	42.87	75	0.87	WTR	6\12	6\6	42.25	42.75	90	0.5	WTR	6\6	6\6	42.75	42.75	0	0	NA	
84	47644	Alamelu	63	F	PSC(RE)	5\60	43.75	42	80	1.75	WTR	MSICS+PCIOL	6\12	6\6	42	42.75	90	0.75	WTR	6\12	6\6	42	42.87	90	0.87	WTR	6\12	6\6	42	42.75	90	0.75	WTR	
85	48901	Allirani	53	F	PSC(RE)	HM+	46.75	44.5	90	2.25	WTR	MSICS+PCIOL	6\18	6\6	45	46	100	1	WTR	6\12	6\6	45	45.75	100	0.75	WTR	6\12	6\6	45	45.75	100	0.75	WTR	
86	51322	vinayaga	41	M	PSC (RE)	6\24	44.5	43.5	70	1	WTR	MSICS+PCIOL	6\6	6\6	44	44.12	90	0.12	WTR	6\6	6\6	44	44.25	90	0.25	WTR	6\6	6\6	44	44.25	90	0.25	WTR	
87	51544	Bhasker	42	M	PPC(LE)	6\ 36	45.5	44.25	110	1	WTR	MSICS+PCIOL	6\6	6\6	44.75	44.92	100	0.17	WTR	6\6	6\6	44.7	45	90	0.25	WTR	6\6	6\6	44.75	45	90	0.25	WTR	
88	52343	Loganathan	68	M	NS2(LE)	6\60	47.5	46.37	100	1.12	WTR	MSICS+PCIOL	6\6	6\6	47	47.25	100	0.25	WTR	6\6	6\6	47	47	0	0	NA	6\6	6\6	47	47	0	0	NA	
89	52765	Sivagami	35	F	NS3(LE)	6\24	44.5	43.25	70	1.25	WTR	MSICS+PCIOL	6\12	6\6	43.5	44	70	0.5	WTR	6\12	6\6	43.5	44	80	0.5	WTR	6\12	6\6	43.75	44	90	0.25	WTR	
90	52983	Kartiken	65	M	PSC(RE)	6\ 36	43.5	44.5	75	1	WTR	MSICS+PCIOL	6\6	6\6	44	44.25	90	0.25	WTR	6\6	6\6	44	44.25	80	0.25	WTR	6\6	6\6	44	44.25	90	0.25	WTR	
91	53211	Venkates	53	M	PSC(RE)	6\ 24	45	46.5	80	1.5	WTR	MSICS+PCIOL	6\9	6\6	45.5	46	65	0.5	WTR	6\9	6\6	45.5	46	90	0.5	WTR	6\9	6\6	45.5	46	90	0.5	WTR	
92	53462	Sarvanan	67	M	PSC(RE)	4\60	44.5	43.5	70	1	WTR	MSICS+PCIOL	6\36	6\6	43	45.5	20	2.5	ATR	6\24	6\6	44	45.5	45	1.5	OA	6\12	6\6	44	44.5	60	0.5	WTR	
93	53854	Rehman	60	M	NS3(RE)	HM+	45.37	46.12	65	0.88	WTR	MSICS+PCIOL	6\36	6\6	44	46.2	110	2.2	WTR	6\24	6\6	44.5	46	100	1.5	WTR	6\18	6\6	44.25	45.25	90	1	WTR	
94	54214	Murugeshwari	46	F	NS2(LE)	1\60	44.87	44.12	95	0.75	WTR	MSICS+PCIOL	6\12	6\6	43.87	44.12	60	0.25	WTR	6\18	6\6	44	44.75	81	0.75	WTR	6\12	6\6	44	44.5	70	0.5	WTR	
95	54678	Manikantan	48	M	NS3(RE)	2\60	43.25	44.25	85	1	WTR	MSICS+PCIOL	6\24	6\6	43.25	44.5	80	1.25	WTR	6\18	6\6	43.25	44.25	90	1	WTR	6\12	6\6	43.25	43.75	100	0.5	WTR	
96	54923	Srinivas	52	M	SMC(RE)	6\24	47	48	120	1	WTR	MSICS+PCIOL	6\24	6\6	46	48	75	2	WTR	6\18	6\6	45.5	47	120	1.5	WTR	6\12	6\6	44.25	45.25	120	1	WTR	
97	55213	Velu	75	M	NS3(RE)	6\60	44	45	110	1	WTR	MSICS+PCIOL	6\36	6\6	43	44.75	75	1.75	WTR	6\60	6\6	43.5	45.5	120	2	WTR	6\18	6\6	43	43.25	75	0.25	WTR	
98	55416	kaniyappan	78	M	PSC(LE)	4\60	44.5	45.5	110	1	WTR	MSICS+PCIOL	6\36	6\6	43.25	45.25	105	2	WTR	6\24	6\6	43	44	60	1	WTR	6\18	6\6	43	43.5	100	0.5	WTR	
99	55765	Asif	65	M	PSC(RE)	2\60	44.5	45.25	95	0.75	WTR	MSICS+PCIOL	6\18	6\6	44.25	45	15	0.75	ATR	6\12	6\6	44.25	45	45	0.75	OA	6\9	6\6	44.25	44.37	90	0.12	WTR	
100	55890	Suryrakala	48	F	PSC(RE)	1\60	43.25	45.5	80	2.25	WTR	MSICS+PCIOL	6\18	6\6	44.12	45.37	85	1.25	WTR	6\12	6\6	44.12	45.49	70	1.37	WTR	6\9	6\6	44	44.25	80	0.25	WTR	
														SUPERIOR INCISION GROUP																			