"REFRACTIVE OUTCOME OF CILIARY SULCUS IMPLANTED INTRAOCULAR LENSES"

By

DR. LEKSHMY M.S, M.B.B.S

Dissertation submitted to

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH CENTRE, TAMAKA, KOLAR

In partial fulfillment of the requirements for the degree of

MASTER OF SURGERY

IN

OPHTHALMOLOGY

Under the guidance of

DR. SANGEETHA T, MBBS, MS, FPRS

Professor and HOD

Department of Ophthalmology

DEPARTMENT OF OPHTHALMOLOGY

SRI DEVARAJ URS MEDICAL COLLEGE

TAMAKA, KOLAR.

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Professor and HOD,
Department of Ophthalmology,
Sri Devaraj Urs Medical College, Tamaka,
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DR. SANGEETHA T.
Professor and HOD
Department of Ophthalmology,
Sri Devaraj Urs Medical College,
Tamaka ,Kolar
Kolar.

Date
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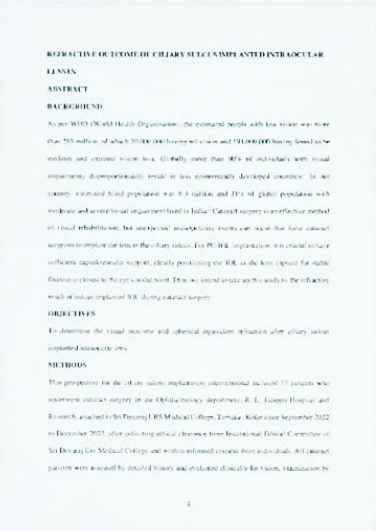

REFRACTIVE OUTCOME OF CILIARY SULCUS IMPLANTED INTRAOCULAR LENSES

ABSTRACT

BACKGROUND

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Tamaka, KOLAR-563103

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LIST OF ABBREVIATIONS

AC	Anterior chamber	MRSE	Mean refraction spherical equivalent
ATR	Against-the-rule astigmatism	OVD	Ophthalmic visco elastic device
AC IOL	Anterior chamber intraocular lens	PCR	Posterior capsular rupture
AL	Axial length	PC–IOL	Posterior chamber intraocular lens
ACD	Anterior chamber depth	PCCC	Posterior Continuous Curvilinear Capsulorrhexis
BCVA	Best Corrected Visual Acuity	PMMA	Polymethyl methacrylate
CTR	Capsular tension ring	PC	Posterior capsule
CCC	Continuous Curvilinear Capsulorrhexis	SPA IOL	Single-piece acrylic intraocular lens
CME	Cystoid Macular Edema	SRK	Sanders Retzlaff Kraff
DM	Descemet Membrane	SICS	Small incision cataract surgery
D	Diopter	SER	Spherical equivalent refraction
ECCE	Extracapsular cataract extraction	TID	Iris transillumination defects
ELP	Effective lens position	UGH	Uveitis-glaucoma hyphema syndrome
IOL	Intraocular lens	UBM	Ultrasound bio microscopy
IOP	Intraocular pressure	VA	Visual Acuity
K	Keratometry	WHO	World Health Organization
Log MAR	Log of minimal angle of resolution	WTW	White to white diameter
LT	Lens thickness	ZD	Zonular dialysis

ABSTRACT

BACKGROUND

Although cataract surgery is a safe and effective method of restoring sight, unexpected intraoperative events can force cataract surgeons to implant the lens in the ciliary sulcus, which affords long-term stability and safety. As it produces sub- optimal visual outcomes the power of the new IOL must be changed to reflect the new location. In general, surgeons empirically subtract 0.50 to -1.50 diopters (D) from the IOL power calculated before surgery. Thus, we aimed to study to the refractive outcome of sulcus implanted IOL during cataract surgery.

OBJECTIVES

To determine the difference in the predicted and postoperative spherical equivalent refraction – "Refractive shift" and the IOL power for in the bag and ciliary sulcus IOL implantation.

METHODS

This prospective interventional study included 77 patients who underwent cataract surgery in the Department of Ophthalmology, R. L. Jalappa Hospital and Research Centre , attached to Sri Devaraj URS Medical College, Tamaka , Kolar from September 2022 to December 2023, after obtaining ethical clearance from Institutional Ethical Committee of Sri Devaraj Urs Medical College and CTRI. Following the written informed consent from the subjects, they were evaluated by detailed history and standard protocol for cataract surgery. Posterior capsular rent cases were identified and PCIOL was placed in ciliary sulcus with IOL power 0.5 D or 1 D less than calculated IOL power for in the bag implantation. The

preoperative and postoperative visual acuity, spherical equivalent and complications were noted on day 1, after 1 week and 1 month.

RESULTS:

Out of 77 patients 20 (26%) were males and 57 (74%) females with mean age of 63.50 ± 10.445 years. The right eye was operated in 39 (50.6%) and left eye in 38 (49.4%) patients, the laterality distribution being almost equal. The most common risk factors were hypertension 24 (31.16%), Diabetes mellitus 22 (28.5%), mature cataract 17 (22%) and pseudo exfoliation 15 (19.48%) patients. Maximum number of PCR occurred during the stage of cortical wash 38 (49.4%), nucleus prolapse 18 (23.4%), hydro dissection 13 (16.9%), IOL placement 5 (6.6%) and PC polishing 3 (3.8%) of cataract surgery. The mean preoperative and postoperative VA is 1.039 ± 0.745 and 0.189 ± 0.177 log MAR respectively. [P <0.001] Good visual outcome was observed in 74 (96.1%) and borderline in 3 (3.9%). The mean predicted and postop spherical equivalent was 0.0108 ± 0.00977 and 0.0586 ± 0.17787 (D) respectively. [P <0.001].

A statistically significant difference was also noted while comparing the mean virtual power 21.50 ± 1.9596 (D) and actual power of the IOL implanted 22.046 ± 1.9377 (D). [P <0.001]. Early postoperative complications noticed were striate keratopathy in 11 (14.5%) followed by iritis 8 (10.5%), IOL pigment dusting 12 (15.8%) and endothelial pigment dusting in 10 (13.2%) eyes. The late complications were Cystoid macular edema 5(6.6%), IOL decentration 2 (2.6%) and iris IOL contact in 2 (2.6%) eyes.

CONCLUSION:

This study demonstrates that implanting an IOL in the ciliary sulcus is well tolerated by patients. Postoperative visual outcomes were favourable, with minimal treatable

complications observed and the IOLs remained well-positioned and well-tolerated in the sulcus. Although IOLs specifically designed for placement in the lens capsule are not typically recommended for insertion in the ciliary space (unless power reduction by 0.5 to 1 D is applied), no safety concerns were identified. There were no cases of elevated intraocular pressure or chronic uveitis noted during follow-up examinations of these patients.

Keywords : Cataract surgery, Ciliary sulcus, Intraocular lens, Posterior capsular rent, Spherical Equivalent.

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INTRODUCTION

INTRODUCTION

According to the WHO (World Health Organization), the estimated people with visual impairment was more than 285 million, of which 39 million were blind and 191 million were found to be moderate and severe vision impairment. Globally more than 90% of individuals with visual impairment disproportionately reside in low- and middle-income countries.[1] In India, estimated blind population was 8.3 million and 31% of global population with moderate and severe visual impairment lived in India.[2] Cataract was found to be the leading cause of avoidable blindness globally (47.8%) followed by glaucoma (12.3%) and age related macular degeneration (8.7%).[3]

Cataract surgery now ranks as the most frequently conducted intraocular procedure worldwide, with constantly improving outcomes. Until the 1980s, the intracapsular technique was popular, which did not include support for an intraocular lens (IOL) by the lens capsule, so the lens was displaced into the vitreous (couching).[4] By 17th century, Jacques Daviel introduced the extracapsular cataract extraction (ECCE) and variations of manual ECCE continue to be utilized today.[5]

Refinements in surgical techniques have given way to newer techniques like manual small incision cataract surgery and phacoemulsification with in-the-bag PC-IOL implantation which have emerged as the preferred procedures for managing cataracts.

A different approach involves using an automated aspiration system to emulsify the lens nucleus and extract the fragments through ultrasound.[6] For PC-IOL implantation, it is crucial to have sufficient capsulozonular support, ideally positioning the IOL within the capsular bag for stable fixation that is closest to the eye's nodal point. This also resulted in fewer wound-related and vitreous-related complications and quicker visual rehabilitation.

Michael Blumenthal was the pioneer in describing manual small incision cataract surgery (SICS), which facilitated rapid visual recovery and minimized astigmatism.[7] The fundamental principle of SICS revolves around constructing a small, self-sealing incision for the extraction of the cataractous lens.[8]

COMPLICATIONS [9,10]

A. INTRA OPERATIVE COMPLICATIONS

1. Tunnel related complications [short, long, tight]
    - Small incision – hinder nucleus delivery, endothelial and iris damage.
    - Long incision – poor closure, wound leakage and against-the-rule astigmatism (ATR).
    - An anterior incision – lack adequate sealing, leakage and ATR.
    - A posterior incision – characterized by its wide tunnel, bleeding and risk of premature entry, complicates nucleus delivery and instrument manipulation.
    - Superficial dissection – buttonholing and premature entry, while deep dissection – lead to scleral disinsertion.
2. Descemet's Membrane (DM) Detachment – due to incorrect keratome direction, shallow anterior chamber depth, a bent blade tip, forceful insertion of an IOL or cannula through a tight incision
3. Extension of Continuous Curvilinear Capsulorrhexis (CCC)
    - A small CCC can complicate nucleus prolapse and cortical aspiration, increasing the risk of posterior capsular rupture (PCR), zonular dialysis (ZD) and residual cortex.
    - A large CCC can hinder the placement of the intraocular lens within the capsular bag.
    - Radialization of capsulorrhexis may occur in hyper mature cataracts due to increased intralenticular pressure.
4. Iris Injury: Direct injury may cause sphincter tears, iridodialysis or iris prolapse leading to hyphema.

5. Intraoperative Miosis: Can complicate nucleus delivery.
6. Zonular Dialysis (ZD) – Pre-existing weak zonules, small CCC, fluid entrapment during hydro dissection, excessive force during nucleus prolapse or IOL implantation and inadvertent capsular edge aspiration can cause ZD.
7. Posterior Capsular Tear – occurs during hydro dissection in posterior polar cataracts, cortical clean-up, inadvertent pull on the anterior capsular tag or capsular polishing resulting in nucleus drop.
8. Endothelial damage following nucleus prolapse and nucleus delivery.
9. Expulsive choroidal haemorrhage – risk factors include long axial length, high intraocular pressure (IOP) , vitreous loss, hypertension, arteriosclerosis and anticoagulant use.

B. POSTOPERATIVE COMPLICATIONS

1. Hyphema, IOL malposition, Dry eye
2. Wound Leak and shallow anterior chamber
3. Corneal Complications: oedema, striate keratopathy, bullous keratopathy, Descemet's membrane detachment and recurrent erosion.
4. Residual Cortex: Improper or inadequate cortical wash can lead to uveitis.
5. Post operative rise in Intraocular Pressure
6. Posterior Dislocations of IOL: Possibly caused by an unrecognized tear in the posterior capsule.
7. Vitritis and Vitreous Haemorrhage.
8. Post operative astigmatism – due to Long incisions, prolonged effects of cautery through heat-induced scleral shrinkage, Lens tilt and the utilization of anterior chamber IOLs.

C. LATE POSTOPERATIVE COMPLICATIONS

1. Cystoid Macular Edema (CME) – Occurs after Posterior capsular rupture(PCR), where anterior chamber pressure plays a significant role in the extent of vitreous prolapse, potentially leading to CME due to stretch forces.
2. Posterior Capsular Opacification
3. Pseudophakic bullous keratopathy
4. Endophthalmitis
5. Retinal Detachment

CAUSES OF LOSS OF CAPSULAR AND ZONULAR SUPPORT

1. Excessive pressure during manual nucleus expression through a small incision.
2. An anterior capsule tear resulting from can-opener capsulotomy may extend posteriorly if a capsular tag is caught during irrigation-aspiration and pulled.
3. The posterior capsule may be inadvertently caught by the irrigation aspiration probe.
4. Direct trauma can occur during IOL insertion.
5. Inadequate decompression during hydrodissection may lead to excessive build-up of intracapsular fluid and capsular rupture.
6. Accidental aspiration during removal of soft lens matter may cause direct tearing of the posterior capsule.

However, in the absence of this support it becomes a great challenge for a surgeon, who is faced with many decisions including when to implant the intraocular lens and which type of intraocular lens should be implanted not to leave the patient aphakic. Alternatively, PC-IOL can be placed in the ciliary sulcus without additional support if there is less than 3-mm lens subluxation and the anterior capsular rim remains intact. However, if insufficient capsular support is present, alternative methods of IOL implantation should be considered.

Alternatives to place the IOLs[11]

Implanting an IOL in the presence of deficient capsular or zonular support is undeniably the most challenging scenario for any cataract surgeon. It necessitates selecting the most suitable technique, IOL design, and material, which are predominantly determined by the specific case and the surgeon's preferences.

1. Anterior chamber IOL
2. Iris-fixated IOL (including anterior and posterior iris claw IOL)
3. Sulcus-fixated IOL
4. Scleral-fixated IOL (comprising sutured and suture less intrascleral haptic-fixated IOL)

However, in an alternate scenario posterior, capsular rupture could happen at the end of phacoemulsification and the use of 3-piece foldable IOLs being placed in ciliary sulcus remains an appropriate alternative. Such type of IOLs are foldable and, hence, can be injected through a 2.8–3.0 mm incisions. However, certain IOLs frequently used in clinical practice do not have a dialling hole in the optic. Furthermore, as it has been observed and mentioned that this technique will not be applicable while implanting foldable single piece IOLs although it is noteworthy that the latter will be an unlikely choice in case of deficient support.[11]

There are certain precautions which ensure safe placement of IOLs in deficient capsular support such as using a bimanual technique with iris repositor and sinsky hook, injecting an IOL into the anterior chamber first followed by careful dialling into the sulcus, and finally the accurate assessment of sulcus support and judicious use of OVD goes a long way toward a successful refixation.[12]

Undeniably, placing an IOL in cases with deficient capsular support either as a primary or secondary procedure remains a challenge and the present technique can be a simple and effective approach toward increasing the window of safety. Without adding significantly to surgical time or expertise, this technique provides enhanced safety to a novice surgeon, especially in resource-limited settings where MSICS remains a popular choice for cataract surgery.

AIMS AND OBJECTIVES

AIMS AND OBJECTIVES

Primary objective

To determine the difference in the preoperative predicted and postoperative spherical equivalent refraction - “Refractive shift”

Secondary objectives

1. To determine the difference in the IOL power for in the bag implantation and for the IOL implanted in the ciliary sulcus
2. To assess intraoperative and postoperative complications

REVIEW OF LITERATURE

REVIEW OF LITERATURE

ANATOMY OF LENS

Lens is an elastic, avascular, transparent, highly refractive biconvex crystalline structure with an anteroposterior diameter of 3.5 mm – 5mm in adults and equatorial diameter of 9-10mm and a refractive index of lens is 1.39. Placed behind the iris in the patellar fossa of anterior vitreous surface, it consists of the Lens capsule, Anterior lens epithelium and Lens fibres.

Lens capsule – a thin transparent highly elastic, hyaline basement membrane surrounding the lens, is composed of type IV collagen and glycosaminoglycans and its thickness varies from 5 um to 25 um. It is thicker anteriorly and at the equator than at poles. Accommodation is aided by the elastic nature of capsule.

Epithelium – the cellular part of lens located between the capsule and the lens fibres are simple, cuboidal polygonal shaped cells with round nuclei in the centre becomes columnar peripherally near the equator. Cells are absent over the posterior capsule as they are used up during development of lens. This epithelium is metabolically active which divide and form new cells which eventually becomes the lens fibres.

Lens fibres – are moulded by elongating anterior epithelial cells of equatorial region moving to the center as new fibres are laid down. The concentrically arranged lens fibres meet and form the erect Y and inverted Y shaped sutures to form irregular dendritic patterns responsible for the flattened biconvex spherical shape of lens.

ZONULES:

The zonules of Zinn also called the suspensory ligaments of lens extending from ciliary body to lens circumferentially are composed of mucopolysaccharides and glycoproteins. The thick, strong fibres of anterior insertions are dense and bundled. The equatorial fibres are present abundantly, becomes less as age advances. The most numerous posterior zonular fibres arise from ora serrata or ciliary processes and their insertions are not well-organised.

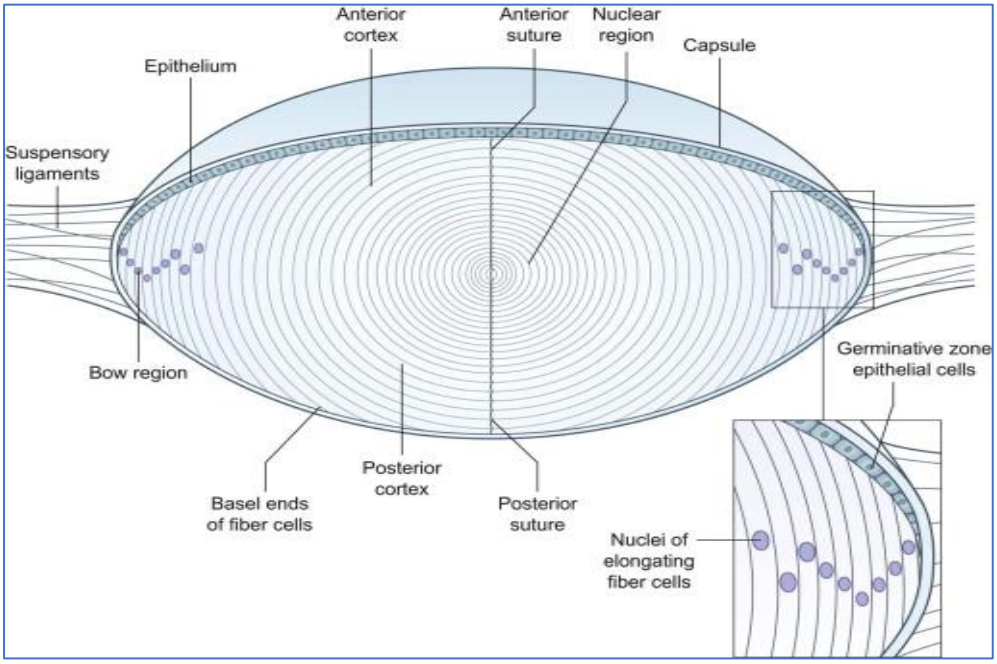


Fig 1: Diagram of the adult human lens

ANATOMY OF THE CILIARY SULCUS

The anatomy of Ciliary sulcus has been evaluated using endoscopic imaging and ultrasound biomicroscopy (UBM).

The precise sulcus-to-sulcus distance is estimated to range between approximately 11.0–12.5 mm, based on anatomical assessments of the ciliary body, corneal diameter and white-to-white measurement.[13] This distance exceeds the posterior surgical limbus, with an average limbus-ciliary sulcus distance of 0.9 mm when considering both sides.[14] These measurements support the use of IOL haptics with a diameter greater than 12.5 mm in the ciliary sulcus, facilitating stable haptic fixation by creating outward tension.[15]

- The average angle of the ciliary sulcus was found to be 66.3 ± 20.0 degrees.
- The average distance from the deepest point of the ciliary sulcus to the tip of the ciliary processes was 0.535 ± 0.137 mm.
- The average length of a perpendicular line from the deepest part of the ciliary sulcus to the sclera was 1.52 ± 0.197 mm.

- The average length of a line drawn parallel to the posterior iris surface from the deepest part of the ciliary sulcus to the scleral surface was 2.48 ± 0.305 mm.
- The distance between the posterior surgical limbus and the perpendicular line drawn from the deepest part of the ciliary sulcus to the sclera (referred to as AC) measured 0.41 mm.
- The anticipated distance between the point of emergence of a needle inserted into the deepest part of the ciliary sulcus and the posterior surgical limbus during ab interno ciliary sulcus suture fixation of an IOL would be 2.37 mm (0.41 mm + 1.96 mm).

The structure of the ciliary sulcus, comprises two distinct surfaces: the upper surface constituted by the posterior iris and the lower surface constituted by the fused ciliary processes. The lack of gaps or irregularities on the underside suggests that it is suitable for haptic placement.

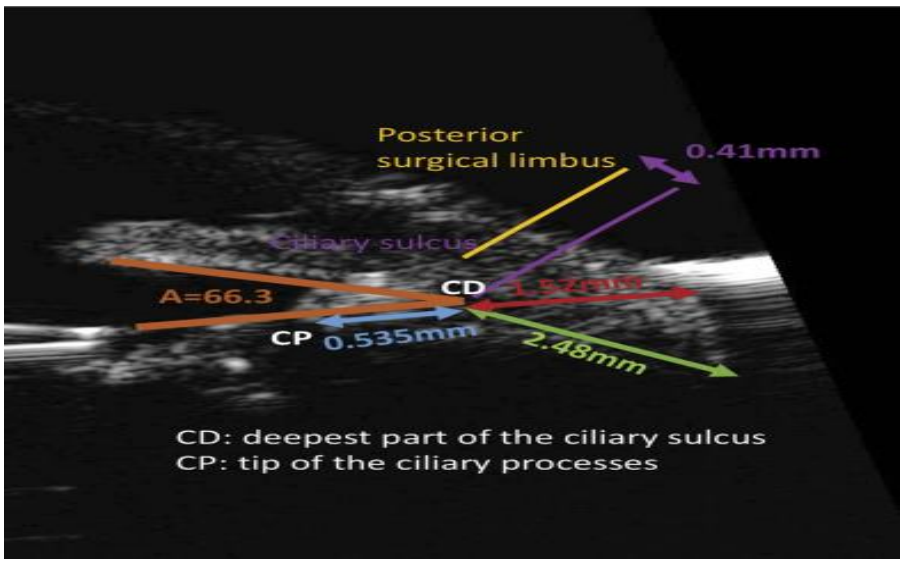


Fig 2: Anatomical measurements and landmarks based on UBM imaging. Angle of the ciliary sulcus (A) = 66.3 degrees, distance from CD to CP = 0.535 mm, length of perpendicular line from CD to sclera = 1.52 mm, and length of line parallel to posterior iris surface from CD to sclera = 2.48 mm

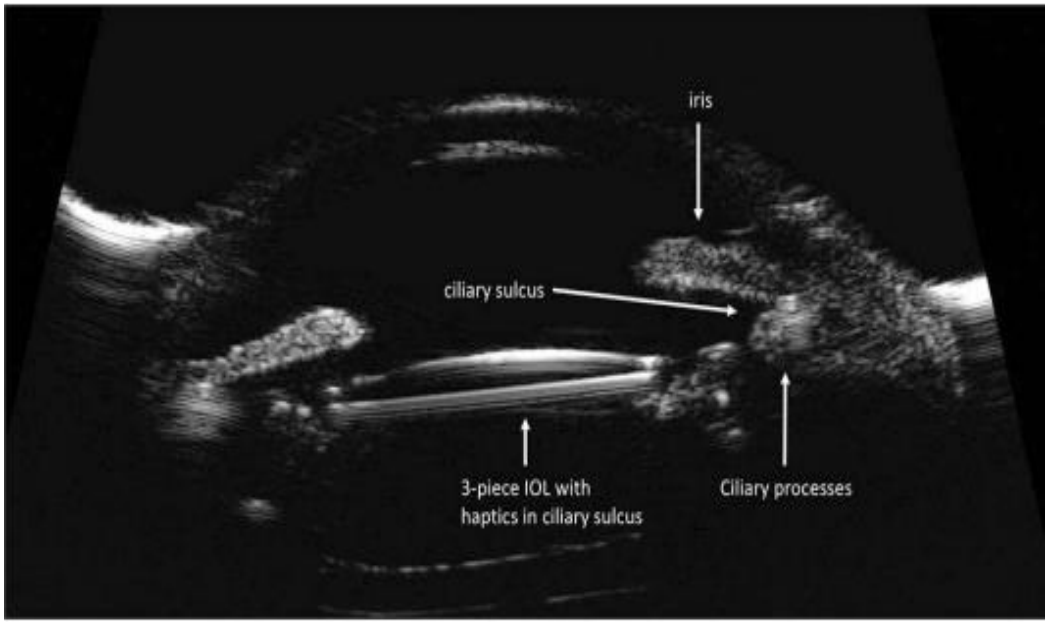


Fig 3: High-frequency ultrasound biomicroscopic image showing a well-positioned 3-piece intraocular lens in the ciliary sulcus.

INDICATIONS FOR SULCUS INTRAOCULAR LENS IMPLANTATION[16]

A. Capsular Rupture

B. Zonular dehiscence

C. Piggyback IOL

A. Capsular Rupture

1. **Scenario 1:** In cases of an anterior capsular tear without extension, a single-piece acrylic IOL can be safely placed in the capsular bag. Positioning the haptics at a 90-degree angle from the tear minimizes tension on the bag, thus lowering the risk of tear extension. However, if a radial tear extends into the posterior capsule during insertion, the IOL must be explanted and replaced with a three-piece IOL suitable for placement in the ciliary sulcus.
2. **Scenario 2:** In cases where an anterior capsular tear extends to the posterior capsule, the compromised area is sealed with viscoelastic substance and the IOL is then positioned in the ciliary sulcus.

3. **Scenario 3:** In cases of a posterior capsular tear with an intact anterior capsule, the IOL can be positioned either in the sulcus or in the capsular bag. When placed in the sulcus, the entire IOL may be implanted within this space. Alternatively, the haptics can be positioned in the sulcus while gently inserting the optic into the bag, ensuring a well-centered anterior capsulotomy. Opting for in-the-bag placement eliminates the need for IOL power adjustment and facilitates optic capture, which effectively seals the IOL and prevents vitreous from entering the anterior chamber.

B. Zonular dehiscence: If the extent of zonular loss measures less than one-quarter of the circumference, a conventional capsular tension ring (CTR) can be inserted along with the IOL in the capsular bag. In the absence of a CTR or a modified Cionni, the IOL can be positioned in the sulcus. However, in cases of severe pseudoexfoliation or zonular compromise resulting from trauma, sulcus placement of the IOL is performed, with a CTR underneath, as placing the lens in the capsule might further stress the zonules, leading to IOL decentration.

C. Piggyback IOL: Patients who experience postoperative refractive discrepancy have three choices for correcting it— exchanging the IOL, undergoing corneal refractive surgery or receiving a piggyback IOL implantation in the ciliary sulcus helps maintain the integrity of the capsular bag and helps mitigate the risk of vitreous loss, which is higher during IOL exchange procedures.

CONTRAINDICATIONS TO SULCUS IOL IMPLANTATION[16]

1. When anterior capsule support is insufficient, alternative fixation techniques such as iris fixation, scleral fixation or the use of an anterior chamber intraocular lens (ACIOL) may

be necessary. However, caution is recommended regarding ACIOL use in patients with shallow anterior chambers and compromised corneas.

2. Following pars plana vitrectomy in patients lacking capsule support, options include scleral fixation, ACIOL and iris-fixated IOL. Iris fixation is discouraged due to post-vitrectomy iridodonesis.

COMPLICATIONS OF CILIARY SULCUS IMPLANTATION[17,18]

Severe complications associated with sulcus IOL placement often stem from poor IOL selection. All patients who receive single-piece acrylic IOL implantation in the ciliary sulcus are reported to experience the following:

a) Secondary pigment dispersion – Pigment granules tend to accumulate predominantly on the haptic, but they also appear on the peripheral optic and haptic–optic junction. Can also cause the formation of Krukenberg spindles and hyperpigmentation of the trabecular meshwork.
b) Elevated intraocular pressure (IOP)
c) Secondary pigmentary glaucoma
d) Intraocular haemorrhage
e) Iris transillumination defects (TIDs) caused by the optic and relatively thick, flexible haptics with squared edges and unpolished sidewalls
f) Recurrent iridocyclitis due to the sharp edges of the IOL contacting posterior iris vasculature, leading to chronic uveal inflammation and recurrent microhyphemas
g) Uveitis-glaucoma-hyphema (UGH) syndrome
h) Vitreous haemorrhage
i) Endophthalmitis
j) Cystoid macular oedema
k) Lens decentration resulting in symptomatic edge glare

Consequently, many of these eyes eventually require surgical intervention, including IOL exchange.

POSTERIOR CAPSULE RUPTURE

A posterior capsular rent (PCR) represents the prevailing intraoperative challenge encountered

in the course of performing cataract surgery that poses a potential threat to vision. Dealing with PCR may necessitate supplementary surgical interventions due to vitreous prolapse and nucleus drop, risk of subsequent complications, impacting the final visual outcome. The frequency of posterior capsule rupture in reported studies shows considerable variation, ranging from 0.2% to 14%. Even experienced cataract surgeons encounter PCR at rates between 0.45% and 3.6%. Several predisposing factors contribute to PCR like:

A. **Patient-related aspects** – advanced age, agitation, deep-set eyes, reduced visibility due to corneal opacities, pterygium, thick arcus senilis or band keratopathy

B. **Intraocular factors** – miosis, small capsulorrhexis, capsulorrhexis-radial tear, shallow anterior chamber depth, floppy iris syndrome, specific cataract types, pseudoexfoliation syndrome, zonular dehiscence and dense asteroid hyalosis.

C. **Surgeon-related factors** – surgical experience also plays a role in predisposing to PCR.

- Forceful hydrodissection in cases of incomplete capsulorrhexis [posterior polar cataracts, traumatic cataracts, pseudoexfoliation, mature, and hypermature cataracts].
- During the removal of the last fragment of the nucleus following a transient surge post-occlusion in phacoemulsification.
- During the implantation and adjustment of an intraocular lens.
- Cortex tags from incomplete capsulorrhexis get entrapped during cortical wash.

- The nucleus may hydroprolapse or be hooked out through a small capsulorrhexis during small incision cataract surgery, applying undue pressure on the posterior capsule.
- Manipulating within the capsular bag without adequately pressurizing the anterior chamber can cause the lax posterior capsule to become displaced and entrapped.
- Polishing of the posterior capsule.
- Direct contact of the posterior capsule with the phacoemulsification probe, chopper or dialer

TYPES OF CAPSULAR TEARS[12]

I A: Perpendicular Pre-equatorial

I B: Acute-Angled Pre-equatorial

II A: Perpendicular Post-equatorial

II B: Acute-Angled Post-equatorial

III: Pre-equatorial with Argentinian flag sign

IV: Post-equatorial with Argentinian flag sign

V: Mini Punch

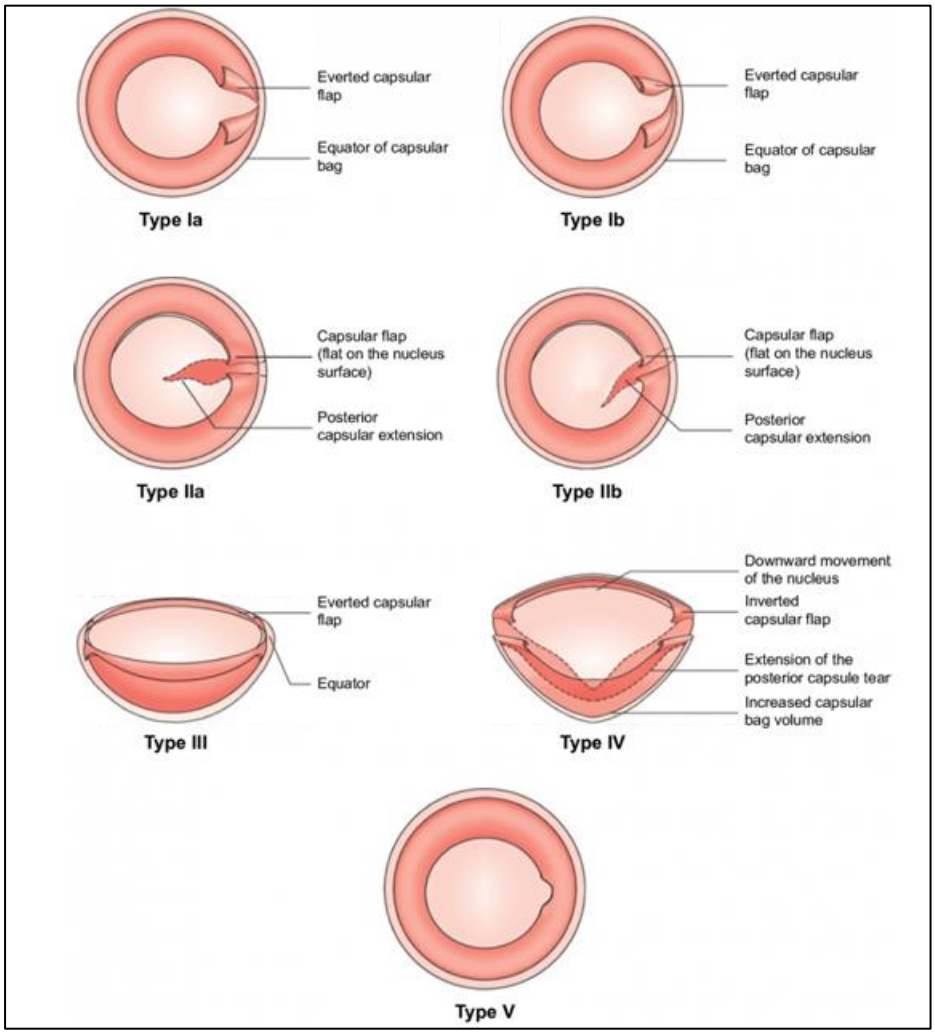


Fig 4: Types of Capsular Tears According to Location

Signs of early posterior capsular rent (PCR) or zonular dehiscence[19]

- Abrupt deepening of the anterior chamber with transient pupil dilation
- Fleeting appearance of a clear red reflex in the peripheral field
- Difficulty rotating a previously mobile nucleus
- Reduced efficacy in sculpting the nucleus with noticeable tremulous movements
- Unexpected difficulty in embedding the phaco needle into the nucleus
- Excessive tilting of one end of the nucleus
- Partial descent of the nucleus into the anterior vitreous space

Management of Posterior capsular rupture

- When a posterior capsular rent is detected, it's crucial for the surgeon not to withdraw the phaco probe immediately.
- Viscoelastic material is carefully introduced into the capsular bag through a side port using their non-dominant hand to achieve proper inflation, prior to removing the probe.
- This precautionary measure is crucial in maintaining the stability of the anterior chamber, thereby reducing the risk of anterior chamber collapse, which could potentially result in a larger rent, disturbance of the anterior hyaloid face and vitreous prolapse into the anterior chamber.
- Ensuring the preservation of the anterior chamber's integrity throughout the management of a posterior capsular rent is essential to mitigate additional complications.
- Next step is to assess the presence of vitreous in the anterior chamber. If vitreous is present, it may be observed trailing towards the wound due to its propensity to migrate. Alternatively, staining the margin of the rent with triamcinolone acetonide can reveal the presence of vitreous as it will be stained.
- Subsequent action involves nucleus management. If the posterior capsular rent is small and there is a soft nucleus remaining, it can be gently displaced from the site of the rent using a second instrument, allowing phacoemulsification to proceed. Care should be taken to maintain a low aspiration flow rate and vacuum to avoid post-occlusion surge.
- For a large brunescent nucleus it is advisable to change to small incision surgery.
- Remaining cortex and epinucleus, is removed by bimanual irrigation aspiration technique with low flow and low vacuum settings. Cortex located away from the capsular rent should be carefully aimed toward the tear site, avoiding the opposite direction. An alternative approach is the "dry aspiration" method and extraction through visco expression.

- If the nucleus has partially slipped into the vitreous, it is advisable not to pursue its retrieval immediately, but retrieved by a specialist in vitreoretinal surgery.
- Anterior vitrectomy is essential to mitigate a variety of potential postoperative complications, including vitreous wick syndrome, vitreous touch syndrome, endophthalmitis, cystoid macular edema, glaucoma and tractional retinal detachment.
- The bimanual technique for infusion during vitrectomy is preferable over coaxial cannulas. Because the Coaxial infusion cannulas have the propensity to enlarge the PCR and excessively hydrate the vitreous.

IOL SELECTION FOR PCR

When the capsulorrhexis is intact, the preferred method is to implant a three-piece intraocular lens in the ciliary sulcus. A single-piece IOL, which lacks angulation and has sharp edges, can cause iris chafing and lead to various long-term issues. To ensure stability, the IOL's optic should be captured through the continuous curvilinear capsulorrhexis (CCC). If a small posterior rent is present but a posterior continuous curvilinear capsulorrhexis (PCCC) is successfully performed, a single-piece IOL can be safely placed in the capsular bag.

SURGICAL SCENARIO	IOL OPTION
Intact capsular bag with a small PCR and no vitreous prolapse	Multi piece IOL in sulcus
Small PCR with successful PCCC	Single piece IOL in the bag
Large PCR but intact capsulorrhexis	Multi piece IOL in sulcus with optic capture in the capsular bag
Inadequate capsular support for PC IOL placement	Scleral fixated or iris fixated lens
Dropped nucleus	Anterior vitrectomy, good cortical clean up, do not try to retrieve the dropped lens matter, place the IOL as mentioned above, suture the wound and refer to VR surgeon

Table 1: IOL selection for PCR

Prevention of rupture of the posterior capsule

- Maintaining the integrity of the capsulorrhexis margin is crucial for preventing PCR.
- Refrain from performing cortical cleaving hydrodissection in cataracts where the posterior capsule is compromised. Attempting cortical cleaving hydrodissection in such cases often results in posterior capsular blowout and "pupillary snap".
- Understanding the phase where a posterior capsular breach occurs is essential. It typically occurs towards the conclusion of cataract surgery, either (a) while emulsifying the last nuclear piece, (b) during the irrigation and aspiration procedure, or (c) while polishing the posterior capsule.

TYPES OF INTRAOCULAR LENSES[21]

C. BASED ON METHOD OF FIXATION:

1. Anterior Chamber intraocular Lens (ACIOL)

- Lenses that are entirely positioned in front of the iris and are supported within the angle of the anterior chamber.
- The indications for anterior chamber IOLs are intra operative rupture of posterior capsule, zonular dialysis or secondary lens implantation.
- Safety and efficacy depends on the minimal contact of IOL with the drainage angle, stability within the anterior chamber with a complete absence of micromovement in the angle, no iris chaffing and no endothelial touch with adequate anterior vaulting and haptics resting on the scleral spur.
- Malposition result in erosion of the ciliary body, angle recession, bullous keratopathy.

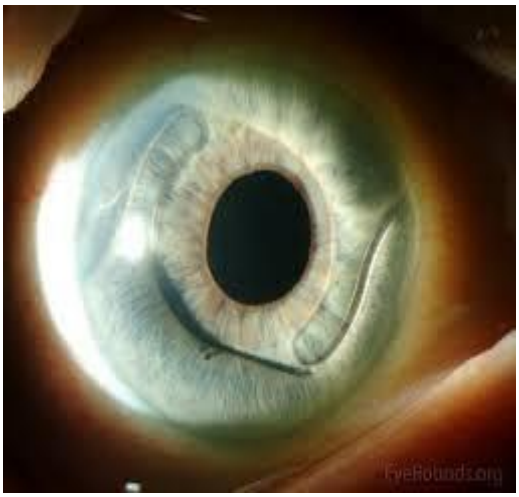
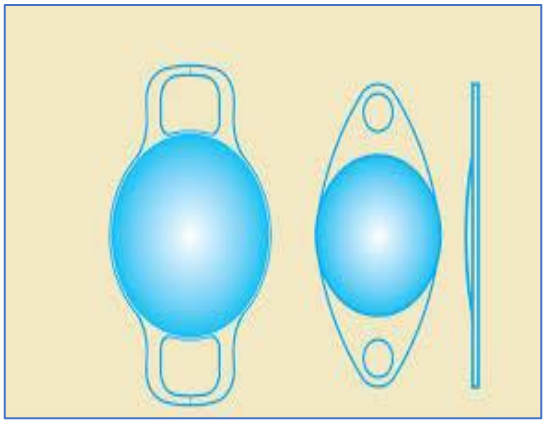


Fig 5: Anterior chamber intraocular lens

2. Iris – supported lenses

- These lenses are affixed onto the iris using sutures, loops or claws. The predictability of the iris position with iris-claw lenses typically ensures accurate IOL power calculations.
- Its stable fixation minimizes late decentration or dislocation and it can be easily removed or replaced.
- However, there are certain drawbacks: decentering, pupil deformation and the need for a skilled, bimanual implantation technique with high manufacturing standards to ensure claw function and prevent iris chafing.
- May result in recurrent UGH (uveitis- glaucoma- hyphema) syndrome.



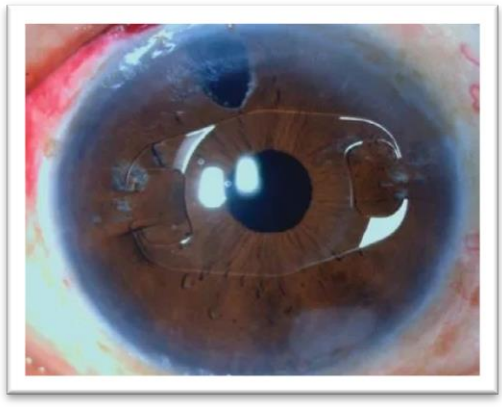


Fig 6 : Iris claw lens

3. **Posterior chamber IOL**

- They are positioned behind the iris, either in the capsular bag or ciliary sulcus.
- Ciliary sulcus fixation – The ciliary sulcus is the space in the posterior chamber delineated anteriorly by the peripheral iris, laterally by the uveal tissue adjacent to the inner scleral wall and posteriorly by the ciliary process. The haptics of the IOL positioned in this region utilize uveal fixation with sufficient anterior capsule remains. A centrally positioned sulcus lens is preferred over an asymmetrically placed capsular bag lens to prevent later decentration.
- In-the-bag fixation – The IOL implanted within the capsular bag after creating a complete continuous curvilinear capsulorrhexis, is considered anatomically optimal. This offers advantages such as better centration, a more stable effective lens position, enhanced predictability in power calculation and IOL selection, resulting in fewer complications and reduced posterior capsule opacification. For rigid IOLs like PMMA, insertion into the capsular bag is done with Kelman-McPherson forceps and then dialled into place with a Sinsky hook. For foldable IOLs like Silicone/ Acrylic, they are either injected into the bag or inserted with folding forceps and then positioned accordingly.
- Scleral fixated IOL: In cases of complete loss or intraoperative defects in capsular support, such as subluxations, scleral fixation of the IOL is the preferred method during secondary IOL implantation. However, this surgical technique is challenging and comes with potential complications including retinal detachment, choroidal haemorrhage, lens dislocation, suture exposure, endophthalmitis, glaucoma and persistent cystoid macular edema.

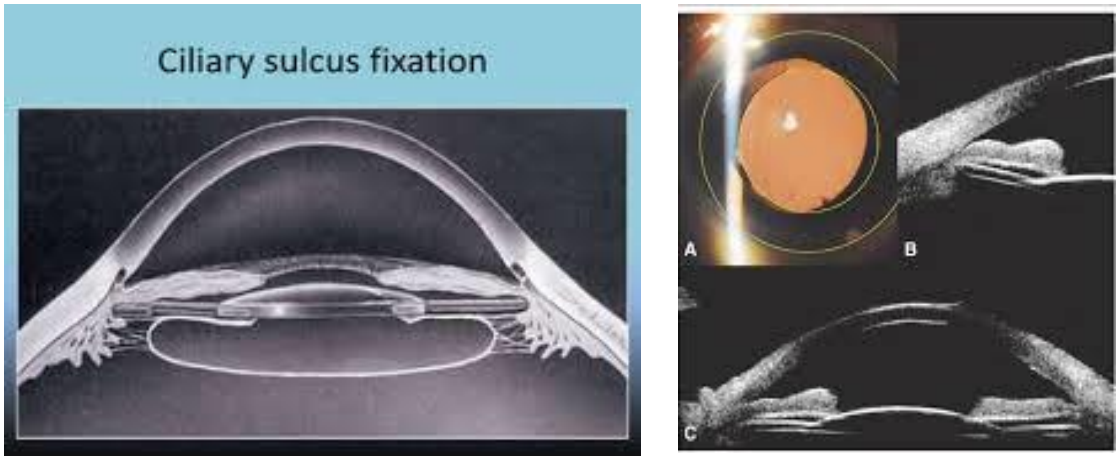


Fig 7: Ciliary sulcus implanted IOL

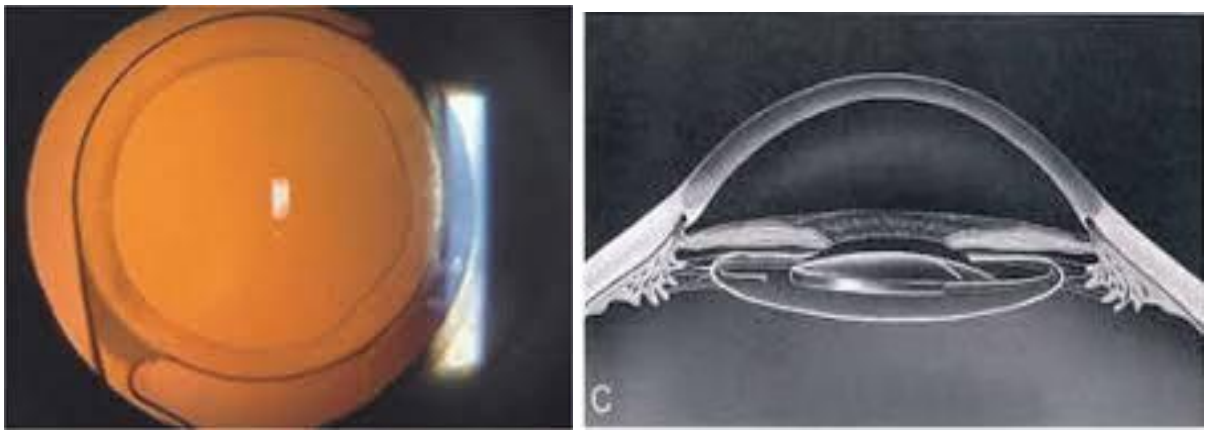


Fig 8: In the bag implanted IOL

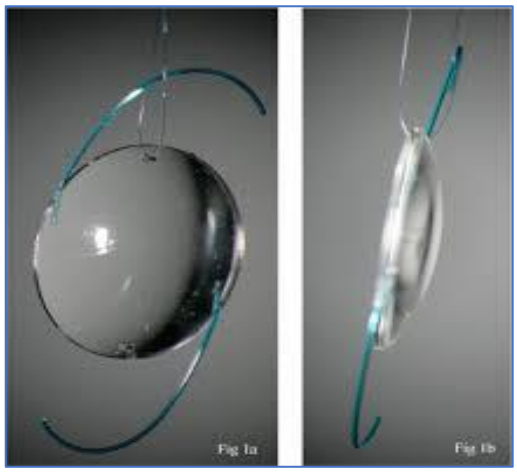


Fig 9: Posterior chamber IOL

Fig 10: Scleral fixated IOL

B. BASED ON THE MATERIAL OF IOL

1. **Rigid lens:** Polymethylmethacrylate is the most commonly used IOL material that is rigid, chemically stable compound, having good optical properties with a low refractive index of 1.49. They need a larger incision for implantation

Fig 11: Rigid PMMA IOL

2. **Foldable IOLs:** These need smaller incision as small as 1.8 mm and made up of silicone, acrylic (hydrophilic or hydrophobic) or hydrogel. However, once inserted into the eye, silicone IOLs tend to unfold abruptly within the bag, whereas acrylic IOLs unfold more gradually, reducing the risk of intraocular structure injury. This characteristic, coupled with the need for smaller incisions and consequent reduction in post-operative astigmatism, positions foldable IOL materials as superior to rigid counterparts. The primary merit of rigid IOL materials, on the other hand, lies in their cost-effectiveness.

Fig 12: Foldable intraocular lens

3. **Rollable IOLs or ultrathin IOLs:** Implantation is done through a 2 mm subincision following microincision cataract surgery or the phacoemulsification technique. Examples include the Acri.Smart lens, made of hydrophilic acrylic material with a refractive index of 1.47 and dioptric power ranging from -25 to +25 D.

Fig 13: Rollable intraocular lens

C. BASED ON FOCUSING ABILITY

1. **Monofocal IOLs:** Conventional intraocular lenses with unifocal power that good distance vision but spectacles were required for near and intermediate work.

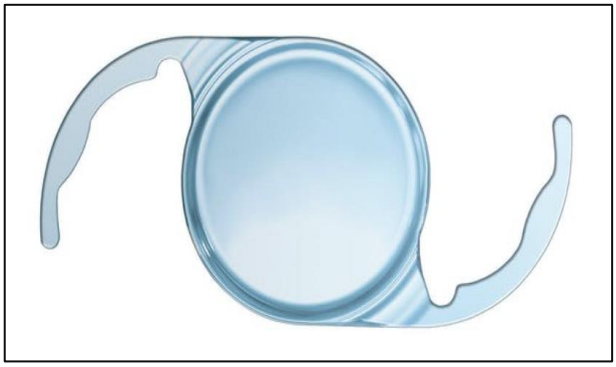


Fig 14: Monofocal intraocular lens

2. **Multifocal IOLs:** The introduction of bifocal and multifocal IOLs has effectively enabled near vision improvement without sacrificing distance vision. They are designed to accommodate both near and distant vision simultaneously. Clinically, three types of multifocal optics have proven effective in IOLs: refractive, diffractive and apodized-diffractive optics. Certain groups, such as professional night drivers, individuals with existing ocular conditions, those with significant preoperative astigmatism, and those

seeking complete spectacle independence with unrealistic expectations, may not be ideal candidates for multifocal IOL implantation. However, meticulous patient selection and precise biometry can yield excellent visual outcomes with reduced photic phenomena, decreased reliance on glasses and increased patient satisfaction. The most suitable candidates are those with bilaterally symmetric cataracts, minimal astigmatism and possess open-minded, adaptable personalities, understanding the necessity for postoperative visual adjustment and the potential occurrence of unwanted optical effects like halos and glare, as well as the potential need for laser treatment.

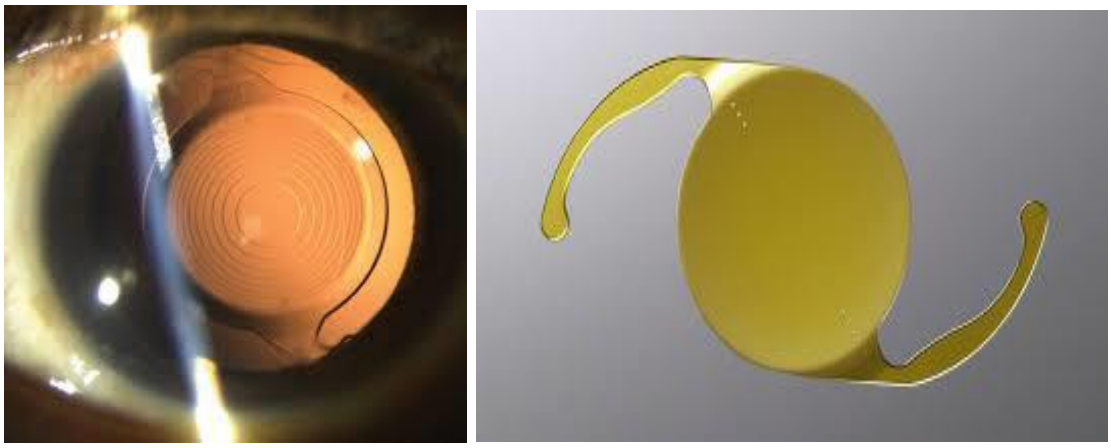


Fig 15 : Multifocal IOL

3. **Pseudo accommodative IOLs:** The apodized diffractive optic of this IOL delivers exceptional near vision while maintaining clear distance vision. It features an anterior conventional refractive surface for distance vision power and a posterior concentric diffractive plate, offering additional near viewing power ranging from +2.5 to +4.5 D.
4. **Accommodative IOLs: :** An accommodative IOL [FDA approved Crystalens AT-45 (manufactured by Bausch and Lomb)], is used for correcting aphakia and presbyopia. This intraocular lens is equipped with a biconvex optic measuring 4.5 mm (now available in 5.0 mm), crafted from third-generation silicone material known as 'BIOSIL'. Its flexible, hinged plate haptics enable adaptation in both position and shape, responding to accommodative efforts. They offer benefits such as reduced haloes and glare, as well as

good intermediate vision. However, they also have drawbacks, including individual variability in post-operative outcomes and poor near vision.

5. **Extended depth of focus IOLs:** Tecnis Symfony IOL offers an extended range of vision by providing an elongated focus area, unlike multifocal IOLs, which typically feature several distinct focus areas.

6. **Toric IOLs:**

   Pre-existing astigmatism can be managed through various methods such as corneal incisional surgery, laser procedures or the utilization of toric intraocular lenses (IOLs). While spectacles or contact lenses can correct astigmatism, they have drawbacks including patient dependency, cosmetic concerns, lifestyle limitations and costliness. The limitations are with each degree of rotation, approximately 3.3 % of the lens power is lost, potentially resulting in complete loss of cylindrical power with excessive rotation which may introduce additional astigmatism. Various models of toric IOLs are available today, such as the AcrySof Toric IOL, Rayner T-Flex IOL, and Staar Toric IOL.

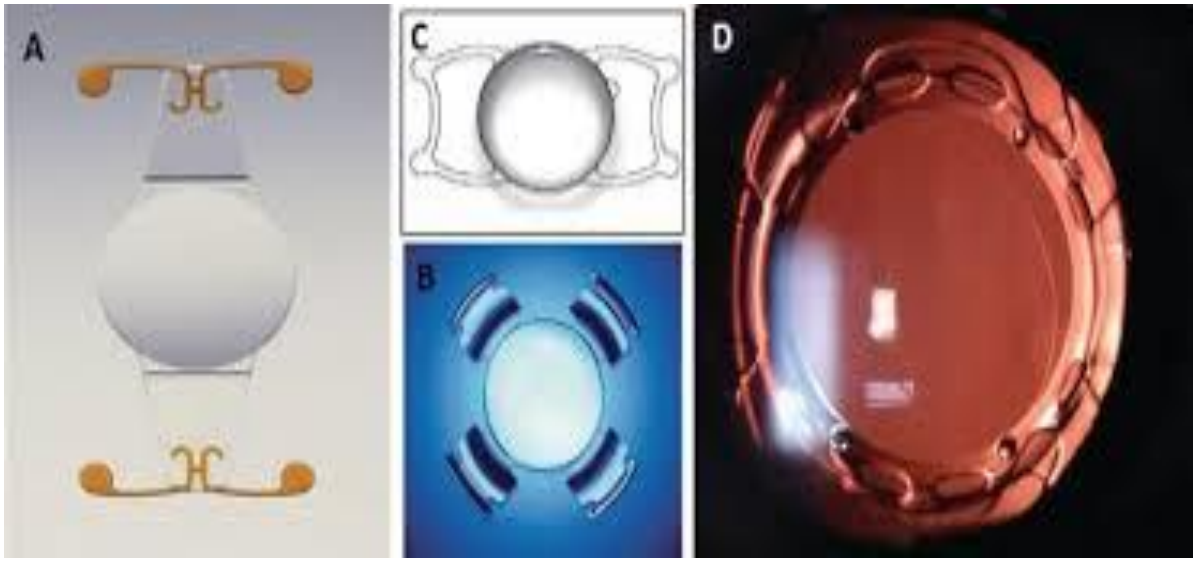


Fig 16: Accommodative IOL

Fig 17 : Extended depth of focus IOL

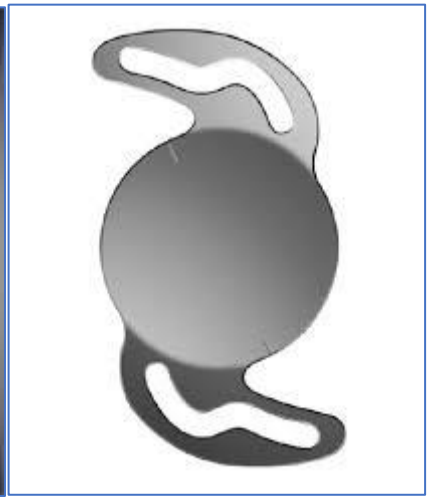


Fig 18 : Toric IOL

MAJOR ASPECTS OF IOL POWER CALCULATION

A. Ocular Biometry

B. Calculation formulas for determining IOL power

C. IOL power calculation

D. Optimization of IOL power

A. BIOMETRY

1. Axial length (AL) Measurement

a) Ultrasonic measurement of AL – done by applanation or immersion technique of which immersion technique is more accurate. A – Scan measures the time required for a sound pulse to travel from cornea to retina. In eyes > 25 mm – suspect staphyloma when multiple disparate readings are obtained and prefer B - Scan for such cases. A 1 mm error in axial length measurement causes a refractive error of 2.35 D in a 23.5 mm eye.

b) Optical measurement of axial length – This method utilizes partial coherence laser. The IOL Master measures the time taken for infrared light to travel to the retina. This non-contact method eliminates corneal compression artifacts.

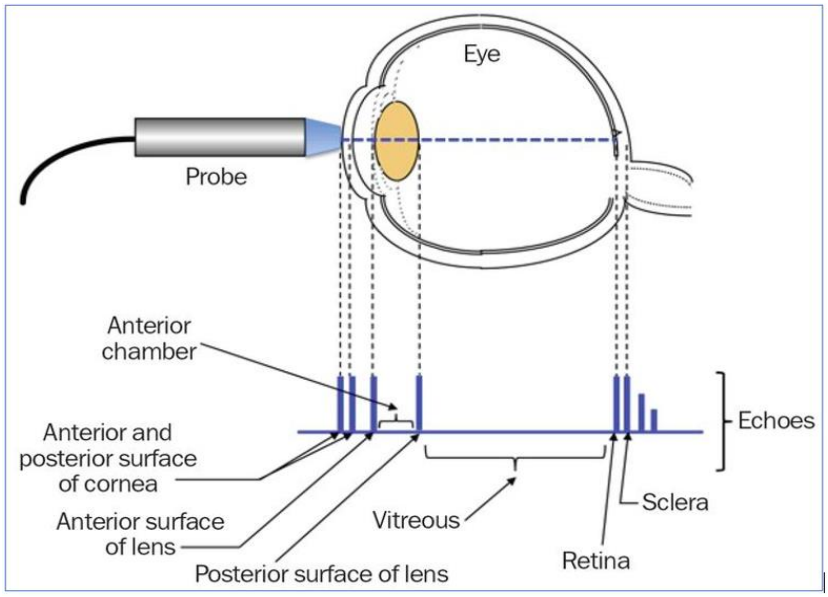


Fig 19 (a): Ultrasonic measurement of Axial Length

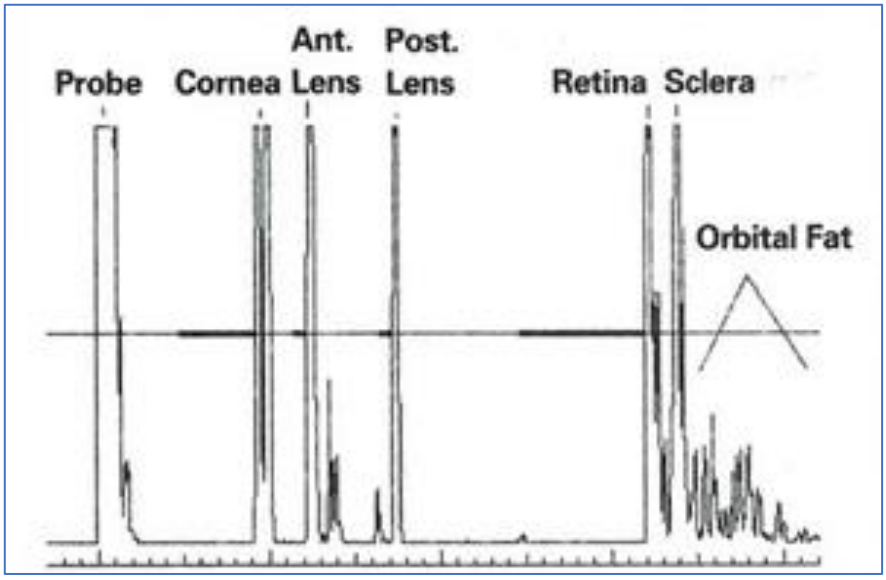


Fig 19 (b): Ultrasonic measurement of Axial Length

2. **Keratometry (K reading) –** always performed before tonometry**,** measures the vertical and horizontal corneal curvature and should be recalibrated after 20 cases for single observer. Measurement is repeated in the following situations:
    - Corneal curvature is below 40D or above 47D.
    - There is a difference in corneal cylinder of more than 1D between eyes.
    - The corneal cylinder shows poor correlation with the refraction cylinder.

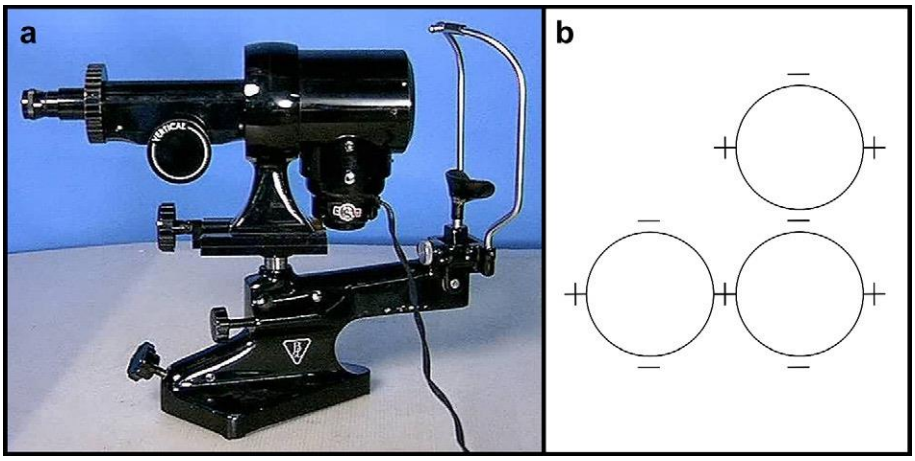


Fig 20: a) Bausch and Lomb keratometer b) Keratometric mire design

3. Effective IOL position

This refers to the location of the lens within the eye, specifically the distance between the cornea and the principal plane of the IOL. The previously used variable, anterior chamber depth (ACD), was deemed anatomically inaccurate for IOLs implanted "in the bag." Factors influencing Effective lens position (ELP) are:

- Anatomical factors – Axial length, corneal steepness, limbal white-to-white measurement, preoperative anterior chamber depth (ACD), and lens thickness (LT).
- IOL – related factors: Shape, length, flexibility, anterior angulation and material of IOL haptics.
- Surgeon related factors – Individual surgical technique of the surgeon can affect the effective lens position.
- Bag-to-sulcus shift – Posterior capsular rupture (PCR) or loss of anterior capsule integrity may necessitate placement of the IOL in the ciliary sulcus. This requires a deduction (0.50-0.75D) from the calculated IOL power.

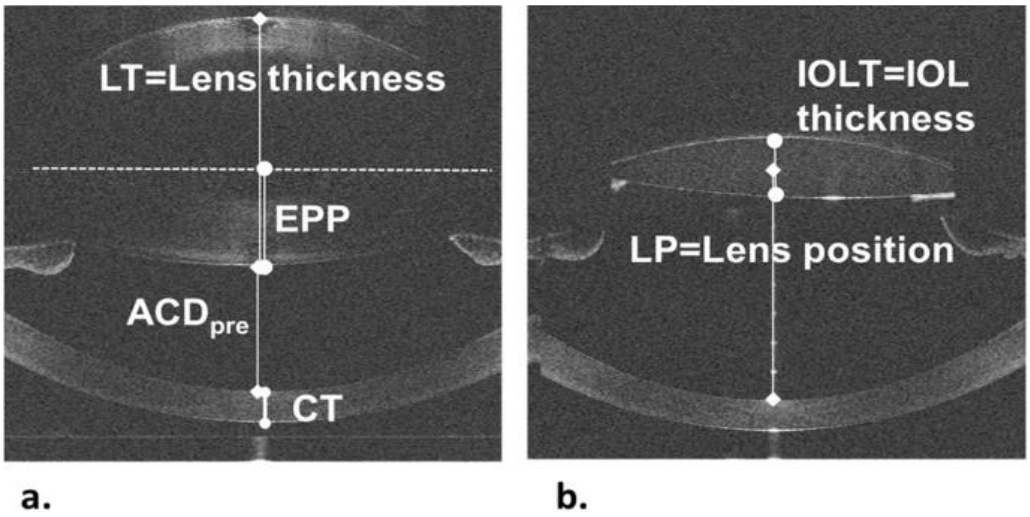


Fig 21: Raw optical coherence tomography images OD, (a) Preoperative measurement. (b) Postoperative measurement. ACD = anterior chamber depth, EPP = equatorial plane position, CT = corneal thickness.

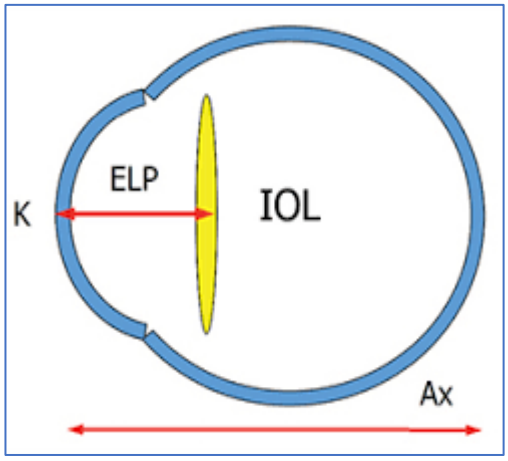


Fig 22: Diagrammatic representation of Effective IOL position

IOL CALCULATION FORMULAS

Since 1975, intraocular lens (IOL) power calculation has relied on precise measurements of corneal power and axial length (AL) of the eye. Prior to this, IOL power was determined solely based on clinical history, particularly the preoperative refractive error before the onset of cataracts.

The earliest IOL power calculation formulas, developed in the late 1970s and early 1980s, were either theoretical or based on regression analysis. Regression formulas gained popularity among surgeons, with the SRK formula emerging as one of the most successful and widely adopted.[22]

SRK FORMULA: P = A – 2.5L – 0.9K

- P – IOL power
- A – constant specific for each lens
- L – Axial Length in mm
- K – Average keratometry in diopters
- Optimal performance is achieved for eyes with axial lengths ranging from 22.0 to 24.5mm.

  Short eyes – too small value, long eyes – too large value.
- To accommodate eyes with varying axial lengths, the SRK II formula was developed. In this formula a correction factor is incorporated to increase lens power for shorter eyes and reduce it for longer eyes. By adjusting the A-constant across different axial length ranges, the SRK II formula is expressed as follows: **SRK II: P = A1 - 0.9 K - 2.5 L**.[23]

  A1 = A + 3 for L < 20 mm

  A1 = A + 2 for L is 20.00 - 20.99mm

  A1 = A + 1 for L is 21.00 - 21.99mm

  A1 = A for L is 22.0 - 24.5mm

  A1 = A - 0.5 for L is 24.5mm

The SRK/T formula, where "T" stands for theoretical, integrates the linear regression approach with a theoretical eye model. By incorporating nonlinear terms derived from

theoretical formulas alongside empirical regression techniques, it achieves improved accuracy. The SRK/T formula is particularly suited for longer axial lengths eyes exceeding 26.00 mm. This formula can utilize the same A constants as the original SRK formula or rely on anterior chamber depth (ACD) estimates, though it does not incorporate effective lens position (ELP) into its calculation.[24]

Holladay-1 formula:

The formula was derived from the geometric relationship of the anterior segment and has demonstrated superior outcomes for eyes with axial lengths ranging from 22.00 mm to 26.00 mm, surpassing those of other third-generation formulas

Hoffer-Q formula:

Achieved better outcomes for eyes < 22.00 mm compared to other third-generation formulas. Optimized using regression techniques for anterior chamber depth (ACD)

Holladay-II formula: More accurate as it can predict the position of the implants.

Olsen formula:

Includes K, AL, ACD and LT. It offers improved performance over third-generation formulas for eyes with an AL of 20.00-26.00 mm. Using exact ray tracing (calculates the path a light ray travels through an optical system), it better predicts ELP using the C-constant. The C-constant is a ratio that predicts the position of an intraocular lens (IOL) after in-the-bag implantation, based on preoperative anterior chamber depth (ACD) and lens thickness (LT). It quantifies how the empty capsular bag will encapsulate and stabilize the IOL.

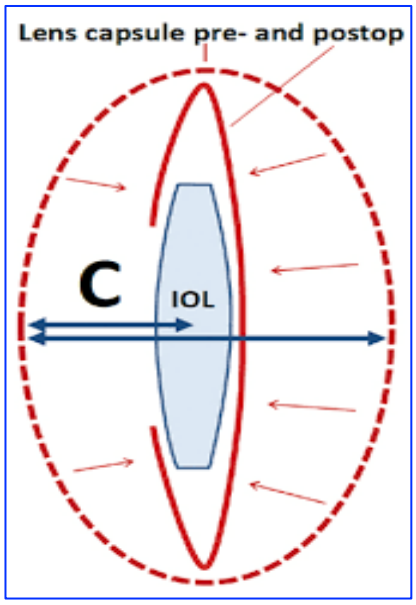


Fig 23: Encapsulation of the IOL by the capsular bag

Haigis formula:

This formula requires variables K, AL and ACD. It achieves excellent outcomes for eyes with axial lengths exceeding 28.00 mm. It suggests the use of three distinct constants to more accurately determine the effective lens position (ELP): a0, a1, and a2

NEWER IOL POWER CALCULATION FORMULAE

Barrett Universal II Formula:

Known as the universal formula, it applies universally across different lens styles and accommodates eyes with short, medium and exceptionally long axial lengths. It utilizes five variables — Axial Length, Keratometry, Anterior Chamber Depth, Lens Thickness and horizontal WTW corneal diameter—to calculate ELP alongside the A constant and desired postoperative refraction.

Hill-Radial Basis Function Formula:

Employs a sophisticated mathematical model known as an artificial neural network. Its advanced methodology includes a self-validating process utilizing pattern recognition driven by artificial intelligence.

Okulix Formula:

The ray tracing formula necessitates the measurement of the radius of curvature for both the anterior and posterior corneal surfaces, typically obtained using a corneal topographer. The IOL is characterized by this radii of curvature, its thickness and its refractive index.

CALCULATING BAG VS. SULCUS IOL POWER

The sophisticated techniques in IOL power calculation pose a lot of challenges in cases where traditional methods may not suffice. Factors like compromised capsular support may require alternative approaches such as choosing a sulcus IOL or an AC IOL.

In cases of capsular weakness the IOL is implanted in the ciliary sulcus instead of the desired capsular bag. This requires an IOL specifically designed for sulcus placement, typically a 3-piece IOL comprising both haptics and the optic that can be placed within the ciliary sulcus.

Alternatively, an optic capture through the capsulorrhexis, is employed by where the haptics remain in the sulcus and gently pushing the optic posteriorly through the capsulorrhexis, or vice versa. Adjustments in the power of the IOL is necessary to obtain the desired refractive outcome when altering ELP of the optic. If the optic resides within the plane of the sulcus, a power adjustment is warranted.

While suturing the haptics to the back of the iris, IOL power adjustment should correspond to the "in-the-bag" power calculation. This is due to the fact that sutures tend to be slightly looser than anticipated, and the optic is positioned more posteriorly compared to a standard sulcus IOL.

When both the haptics and the optic are positioned in the sulcus, the power calculation should be based on the sulcus IOL power because the optic is situated anterior to the anterior capsular rim within the sulcus. This adjustment varies according to the power of the original IOL and can be either precisely calculated or approximated. This adjustment is necessary

because as the optic is moved closer to the cornea, its "effective power" increases due to changes in the optical environment and the eye's anatomy.

The extent of this change depends on the "base power" of the intraocular lens, where a higher base power leads to a more pronounced difference. The initial step involves ensuring that the A-constant of the sulcus IOL model closely matches that of the original IOL.

THE RULE OF NINES FOR SULCUS IOL POWER

When positioned the IOL completely within the ciliary sulcus, the IOL is positioned 0.5 mm towards the cornea compared to placement within the capsular bag. Consequently, the A constant should be adjusted downward to approximately 0.80 diopters (D) in such instances. Given that lenses are available in half-diopter increments, the necessary adjustment when moving the lens forward into the sulcus is approximately half a diopter less for both 11D and 16D lenses, despite their inherent differences.

Typically, the IOL power of a sulcus-implanted IOL requires to be reduced by 0.50–1.00D to achieve an equivalent refractive outcome for an average eye. For larger, myopic eyes, the reduction required may be < 0.50D, whereas for smaller, hyperopic eyes, it could be as much as 1.50D. While the precise adjustment of IOL power can be calculated if the sulcus position is known, the **"Rule of 9s"** method offers a practical approximation.[16]

IOL Power for in the capsule placement (D)	IOL power for ciliary Sulcus (D)
0 to +9.0	No change
+9.5 to +18	Reduce by 0.50
+18.5 to +27	Reduce by 1.00
+27.5 or more	Reduce by 1.50
Haptics in sulcus and optic in bag	No change

Table 2: Rule of nines for sulcus IOL power calculation

Zonular laxity and post vitrectomy eyes

- In cases where zonular laxity is suspected, such as in pseudoexfoliation syndrome, the IOL optic may unexpectedly position itself further posteriorly in the eye. Loose zonules can result in the displacement of both the lens and iris diaphragm forward, resulting in a visibly shallow anterior chamber during the preoperative assessment.
- During cataract surgery, the replacement of the relatively heavy and thick cataractous lens with a thinner and lighter IOL can exacerbate this posterior positioning of the optic beyond the predicted preoperative ACD. Hence, augmenting the IOL power by 0.5 D can mitigate the risk of a postoperative hyperopia.
- Similarly, in post vitrectomy eyes for retinal conditions, the absence of an anterior hyaloid face can also contribute to the IOL optic sitting more posteriorly post-cataract surgery. Here too, adding 0.5 D to the IOL power is advantageous.

Long and short axial length

- The original SRK regression formula offered satisfactory outcomes for many patients, with average eye dimensions. However, it tended to falter with eyes deviating significantly from the norm in terms of length. Recognizing the need for enhanced precision, the SRK II formula was introduced, specifically to address the shorter and longer eyes.
- Recent techniques for these calculations include the Wang-Koch axial length modification refines results for myopic eyes, while formulas like the Holladay II and Haigis, integrating measured ACD, deliver accurate results for hyperopic eyes. Cutting-edge approaches like the Ladas Super Formula, accessible at www.IOLcalc.com, automate these adjustments seamlessly, eliminating the need for manual intervention.

Patient preference

We must integrate the patient's preferences into the decision-making regarding IOL power selection. Individuals with a myopic history typically prefer outcomes slightly leaning towards myopia when targeting plano. Conversely, certain hyperopic patients prioritize maintaining excellent distance vision and may not be greatly bothered by a slight hyperopic correction.

Selection of lens

Ideal options for positioning in the ciliary sulcus include either a single-piece PMMA lens or a three-piece IOL equipped with posteriorly angulated and slender looped haptics, which effectively push the optic away from the iris. The optic should feature a smooth surface with rounded edges and a minimum diameter of 6mm. The distance between the edges of the haptics across the optic should measure at least 13mm to ensure adequate tension on the sulcus and maintain centration of the IOL along the visual axis. The larger optic diameter allows for tolerance of minor decentration and enhances visualization of the peripheral retina.

1. **3-piece IOL options:** The acrylic IOL features a square anterior edge and an expansive 6.5mm optic, with broad 13mm haptics. In the ciliary sulcus, 3 piece acrylic IOLs like the AcrySof (model MA60AC, Alcon) are usually well-received and can be easily folded and injected through a 2.75-mm corneal incision. However, caution is necessary during insertion due to the thin haptics to minimize the chances of breakage. Additionally, the sharp-edged design of the optic may potentially cause irritation to the iris. Conversely, the 3-piece silicone IOL has a rounded anterior edge and longer 13.5mm haptics, ideal for larger eyes and has minimal risk of iris shafing. However, its quick injectability and susceptibility to opacification from silicone oil make it less favourable for vitrectomy cases. Given the risk of retinal detachment and potential silicone oil use in patients with

capsular trauma, acrylic IOLs are selected over silicone counterparts for ciliary sulcus implantation.

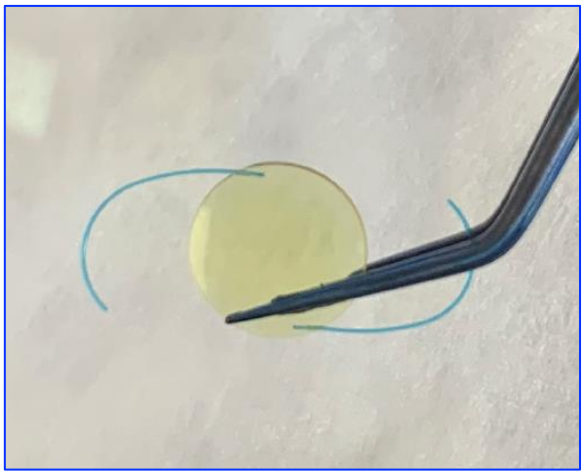


Fig 24: A three-piece IOL composed of an acrylic optic and PMMA haptics.

2. **1-piece IOL option:** One-piece PMMA IOLs have diminished in popularity as the primary IOL implant due to the necessity of large 6–7mm incisions for insertion. However, their slender haptic design are suitable for both capsular and sulcus placement. When positioned in the sulcus, these rigid, non-foldable lenses, characterized by their thin haptics, facilitate the displacement of the optic away from the iris.

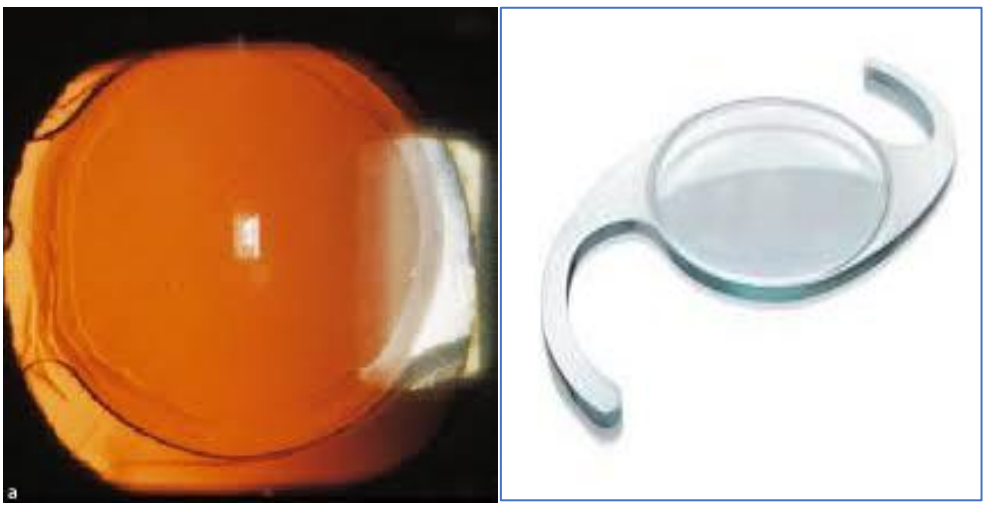


Fig 25: A Single piece intraocular lens

3. **Contraindicated IOL:** Single-piece foldable acrylic lenses are not recommended for placement in the ciliary sulcus due to several factors. Their square-edged optic design,

thick haptics, and rough side walls create friction along the lens edges. These lenses are typically sized for capsular fixation, making them undersized for sulcus placement. Even if optic capture is achieved, they lack sufficient posterior angulation, increasing the risk of anterior optic prolapse and potential pupillary capture. Furthermore, the adherent surface of acrylic IOLs and bulkier single-piece haptics can lead to iris chafing, elevating the risk of complications such as pigment dispersion syndrome, uveitis-glaucoma-hyphema (UGH) syndrome, and elevated intraocular pressure (IOP).

4. Technique

a) 3-piece foldable IOL entirely in the sulcus

- The primary consideration for sulcus IOL placement is to prevent vitreous prolapse.
- A bolus of viscoelastic injected through the posterior capsule break serves to stabilize the vitreous and establish a barrier. Dispersive viscoelastic is injected to create space between the iris and the anterior capsule.
- A bolus of viscoelastic injected through the posterior capsule break serves to stabilize the vitreous and create a barrier or tamponade effect. Dispersive viscoelastic is then injected to create space between the iris and the anterior capsule.
- The leading haptic is guided beneath the iris and into the sulcus, while the trailing haptic remains outside the eye or positioned over the iris until the leading haptic is correctly situated. The trailing haptic can then be maneuvered into the sulcus using forceps or rotated into position with a Kuglen hook.
- Careful removal of viscoelastic from the anterior chamber is crucial, recognizing that it is preferable to leave a small amount of viscoelastic in the eye than to risk vitreous prolapse. Dispersive OVD, if retained, is associated with fewer pressure fluctuations and provides better tissue coverage.

- In instances of weakened areas such as defects in the posterior capsule or compromised zonules, the haptic of the sulcus IOL should be positioned away from the affected region.
- Suture fixation of sulcus IOLs is uncommon except when there is evident instability due to zonular loss or insufficient anterior capsular support. While suturing the sulcus IOL in place behind the iris or sclera is an option, caution must be exercised as sutured lenses can potentially torque, leading to complications such as cystoid macular edema. Additionally, reports have indicated that a sutured one-piece lens may result in iris chafing and secondary pigment glaucoma, highlighting the importance of avoiding this approach

Fig 26 : 3 piece foldable IOL entirely in the sulcus

b) 3-piece foldable IOL with optic capture

- An intact capsulorrhexis of suitable dimensions facilitates optic capture through an anterior CCC ensuring IOL fixation and centration while reducing the risk of haptic and/or optic chafing against uveal tissues
- The capsulorrhexis should be well-centered, with an opening approximately 1.0–2.0 mm smaller than the optic diameter of the IOL.

- Following an anterior vitrectomy to clear prolapsed vitreous, an ophthalmic viscosurgical device is injected in both the anterior chamber and ciliary sulcus.
- Subsequently, the IOL is positioned in the ciliary sulcus, and the optic's edges are threaded through the capsulorrhexis with gentle pressure applied alternately on each side of the anterior surface of the IOL, 90 ^{0} away from the haptic-optic junctions. The haptics are retained within the sulcus.
- In cases of large anterior capsule tears extending to the equator, the IOL is positioned in the ciliary sulcus. The optic is then captured posteriorly through both the anterior and posterior capsule openings, while the haptics remain in the sulcus. This approach helps maintain IOL centration and prevents the formation of Elschnig's pearl opacification along the visual axis posterior to the IOL.
- This technique accommodates both one-piece PMMA IOLs and three-piece foldable IOLs for optic capture. This approach proves particularly advantageous when repositioning an IOL with an overall length suited for the capsular bag but not for the sulcus or when the haptics are deformed or compromised, they may no longer be appropriate for sulcus placement.

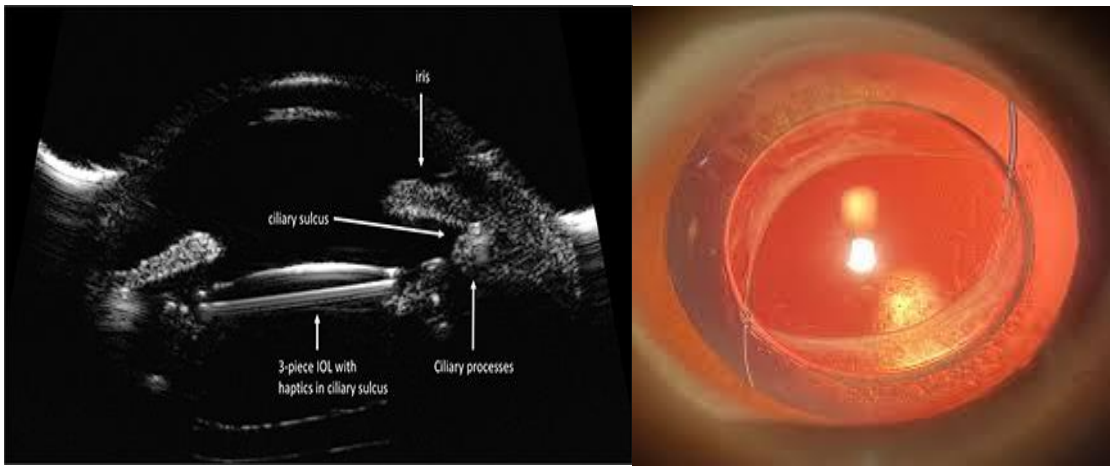


Fig 27: 3-piece IOL with haptics in ciliary sulcus

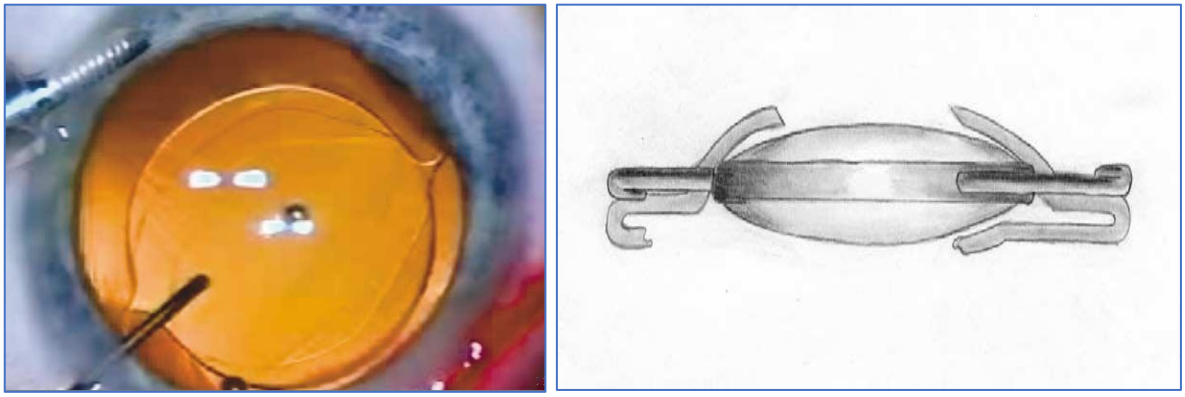


Fig 28 : Optic capture in anterior capsule – haptics retained in the ciliary groove while the IOL optic is captured posteriorly through the capsulotomy opening

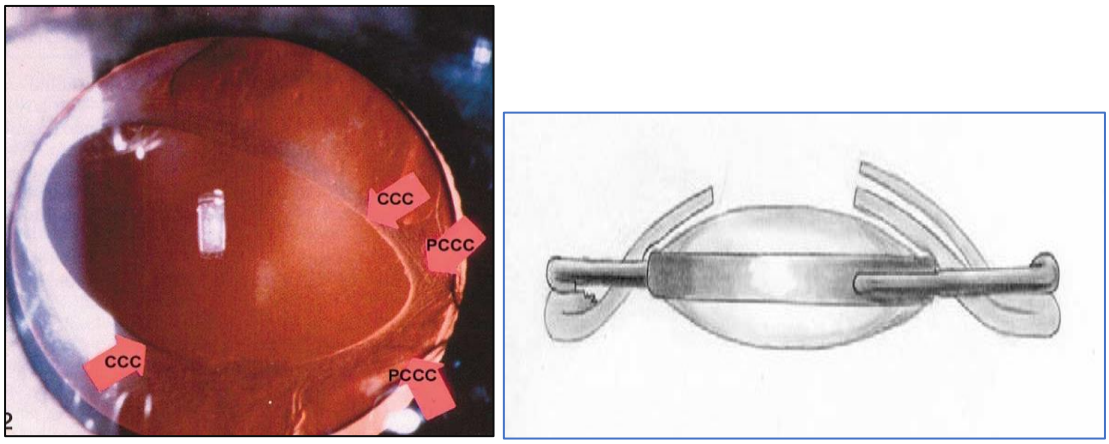


Fig 29 : Optic capture in posterior capsule – Haptics in the ciliary fossa and IOL optic captured through the posterior capsulotomy.

STRATEGIES FOR SUCCESS [17, 25]

A. Availability of appropriate lens

A single piece IOL is contraindicated for ciliary sulcus implantation. A 3 piece is ideal or plan for a ACIOL or for a secondary IOL implantation.

B. Practice beforehand with the preferred three-piece injector

- The three piece injector is loaded differently otherwise the haptics could be damaged.
- When inserting a three-piece IOL into the eye, because of firm haptics it offers a distinct sensation.

- It's crucial to ensure that the haptics avoid contact with the cornea to prevent scraping.
- Special care must be taken to avoid introducing the lens with the haptic directly into the posterior chamber, as this could potentially lead to sinking.

C. Counselling of patients.

Counselling the patients before and after the surgery is essential to explain about the complications happened during the surgery if any like PCR and the IOL placed in ciliary sulcus and give reassurance regarding the post operative visual outcome.

D. Adequate monitoring: Monitoring the patients with frequent follow up visits to watch for any post operative complications like IOL decentration and to manage them accordingly.

E. Using educational resources to improve surgical skills and knowledge.

F. Be prepared.

Be prepared for any complications that can happen while placing IOL in ciliary sulcus and we should be properly trained and prepared for managing them.

GUIDELINES FOR IMPLANTING AN IOL IN THE SULCUS[26-28]

Do's:

1. Ensure availability of either a three-piece acrylic or silicone IOL or a one-piece PMMA IOL, for potential implantation into the ciliary sulcus.
2. Consider adjusting the A-constant when transitioning from placing a one-piece IOL in the capsular bag to inserting a three-piece IOL into the ciliary sulcus.
3. Inject ample OVD to expand the gap and tamponade vitreous before introducing the IOL.
4. Enlarge the corneal incision to accommodate a larger cartridge for inserting a 3-piece IOL
5. Ensure proper cartridge selection and loading technique for the three-piece IOL to enable precise orientation.

Don’ts:

1. Do not place a one-piece acrylic IOL in the ciliary sulcus to prevent potential complications such as secondary pigmentary glaucoma and irreversible vision impairment.
2. Avoid inserting an IOL into the sulcus if there is insufficient anterior or posterior capsular support.
3. In situations where implanting the IOL in the ciliary sulcus is necessary, with appropriate preparation and technique, a favourable postoperative result can be achieved in most cases.

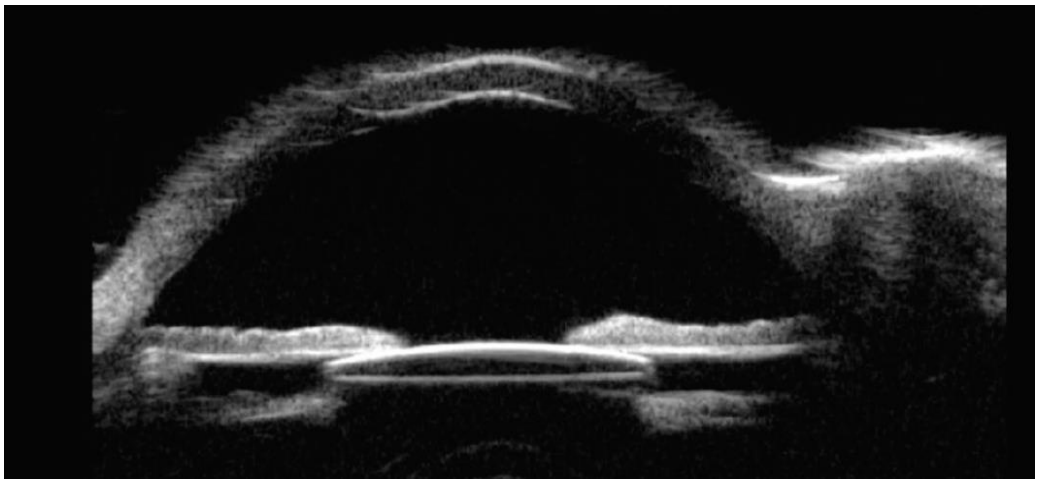


Fig 30: Ultrasound biomicroscopy shows a well-positioned IOL residing in the ciliary sulcus space, anterior to the remaining lens capsule and posterior to the iris.

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MATERIALS AND METHODS

MATERIALS AND METHODS

SOURCE OF DATA

This prospective interventional study was conducted on a minimum of 77 patients fulfilling the inclusion criteria in the Department of Ophthalmology, R. L. Jalappa Hospital and Research Centre, Kolar from September 2022 to December 2023, after obtaining ethical clearance from Institutional Ethical Committee **[No.SDUMC/KLR/IEC/ 314/2022-23, Dates 20/7/2022]** of Sri Devaraj Urs Medical College, **CTRI [CTRI/2022/12/048248, Dated 19/12/2022]** and written informed consent from the subjects.

STUDY DESIGN: Prospective interventional study

INCLUSION CRITERIA: All patients of either sex above 40 years of age with the following situations:

1. Capsule rupture: a) Anterior capsular tear without extension
    b) Anterior capsular tear extending to posterior capsule
    c) Posterior capsular tear with intact anterior capsule
2. Zonular dehiscence
3. Weak zonules in case of pseudoexfoliation
4. Uveitis
5. Traumatic subluxation of lens

EXCLUSION CRITERIA: Patients with history of the following:

1. Lack of Anterior Capsular Support

2. Patients on any topical IOP-lowering drugs like Timolol.
3. Patients with lacrimal gland and drainage disorder.
4. History of any ocular surface surgery or ocular trauma.
5. Thyroid disease patients.

METHOD OF COLLECTION OF DATA

After fulfilling the inclusion criteria each patient was assessed by detailed history and followed by clinical examination of the eyes as mentioned below:

1. Visual acuity assessment by using Snellen chart.
2. Slit lamp bio microscopy for evaluation of anterior segment.
3. Posterior segment evaluation done by indirect ophthalmoscopy and or +90D bio-microscopy.
4. Assessment of Intraocular pressure by Applanation Tonometer
5. Corneal curvature by Baush and Laumb keratometer
6. Axial length (AL), IOL power calculation by the SRK II (Sanders-Retzlaff-Kraff) formula and Spherical equivalent refraction (SER)
7. Gonioscopy with Goldmann three mirror. (to rule out Peripheral anterior synechiae, neovascularization)
8. Lacrimal syringing
9. Routine blood investigations, fasting sugar, postprandial blood sugar and HbA1c

TECHNIQUE

- The standard preoperative regime included topical flurbiprofen (0.03%) & Ciplox eyedrops (0.3%) 2 hours before surgery followed by pupillary dilatation using topical tropicamide (0.8%) & phenylephrine (5%).
- During the routine small incision cataract surgery, after identifying the PCR adequate anterior vitrectomy was performed to decrease the risk of vitreous prolapse and/or traction during IOL insertion.
- The state of the lens capsule bag was assessed and in patients with sufficient anterior capsule support, an Ophthalmic viscoelastic device was injected to tamponade vitreous and to create space between the iris and remaining anterior capsule.
- The incision was enlarged to accommodate the IOL. The power was reduced by 0.5 or 1D from the power calculated by the SRK II formula for in-the-bag implantation.
- A single piece PMMA IOL was introduced into the anterior chamber and the leading haptic is guided beneath the iris and into the sulcus, while the trailing haptic is left over the iris until the leading haptic is correctly positioned.
- The trailing haptic is gently maneuvered into the sulcus using sinsky hook or IOL dialer.
- Next the remaining OVD is carefully removed from the anterior chamber, taking care to prevent the vitreous prolapse.

Postoperatively all patients were instructed to instill steroid antibiotic [0.3% Moxifloxacin plus 0.1% dexamethasone] eye drops for 6 weeks in a tapering dose and followed up at day 1, day 7 and 1st month for the following examination:

1. Visual acuity (converted to log MAR)

2. Spherical Equivalent Refraction (D)

3. Any postoperative complication

The difference between actual and predicted postoperative SER was calculated for each patient and termed the "refractive shift."

SAMPLE SIZE CALCULATION

Was estimated based on the Mean actual refraction (SE) after sulcus IOL at postoperative period was -1.16 ± 0.47 from the study by *Rahul Dubey* et al.[29] At 5% alpha error and 80% power and Null hypothesis at 1 SE, sample size was 70 subjects. Considering 10% Nonresponse a sample size of **70 + 7 ≈ 77** subjects were included in the study.

Formula used for Sample size **(N) = $Z_{1-\alpha/2}^2$ SD^2 / d^2** [18]

$Z_{1-\alpha/2}$ = Is standard normal variate

(at 5% type 1error (P<0.05) it is 1.96 and at 1% type 1 error (P<0.01) it is 2.58).

SD = Standard deviation of variable. Value of standard deviation can be taken from previously done study or through pilot study.

d = Absolute error or precision

STATISTICAL ANALYSIS

Data was entered into Microsoft excel data sheet and was analysed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Continuous data was represented as mean and standard deviation. **Paired t test** is the test of significance for paired data such as pre op versus post op for quantitative data.

Graphical representation of data: MS Excel and MS word was used to obtain various types of graphs such as bar diagram, Pie diagram.

P value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

Statistical software: MS Excel**,** SPSS version 22 **(**IBM SPSS Statistics, Somers NY, USA) was used to analyse data.

RESULTS

RESULTS

Demographic data

A total of 77 patients were studied out of which males were 20 (26%) and females were 57 (74%).

Gender	Number	Percentage
Male	20	26
Female	57	74

Table 3: Distribution of subjects according to gender

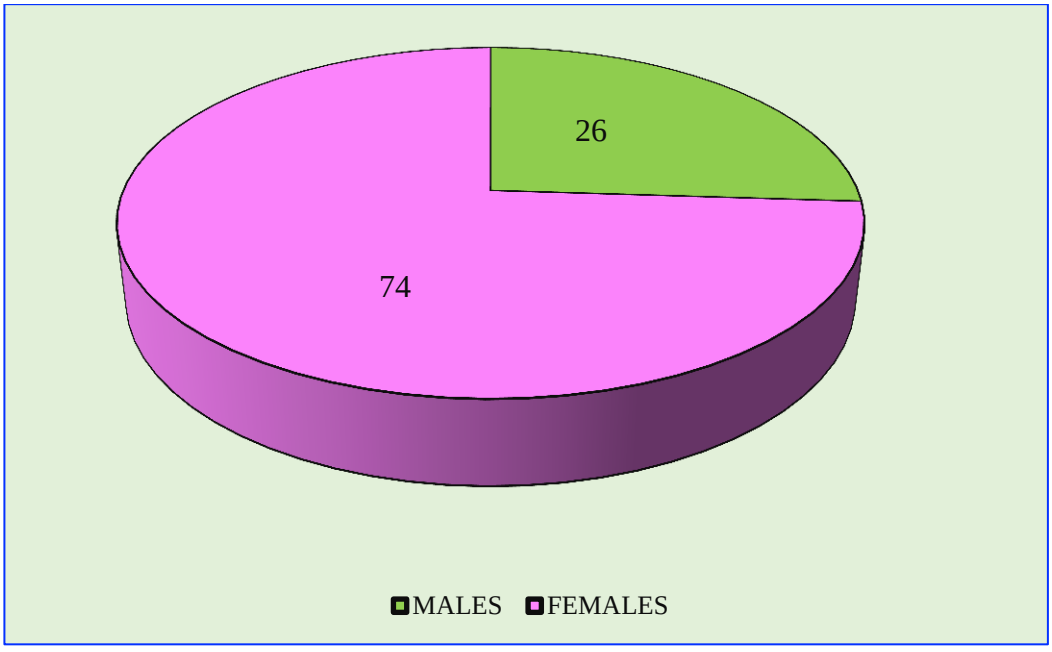

Fig 31: Distribution of subjects according to gender

Majority of the patients were in the age group of 51- 60 years 28 (36.4%), 21 (27.3%) in each of the age group 61- 70 years and > 70 years and 7 (9%) in the age group of 41- 50 years. The mean age of the study participants is 63.50 ± 10.445 (range: 41- 87).

Age (years)	Number	Percentage
41 – 50	7	9
51- 60	28	36.4
61 – 70	21	27.3
>70	21	27.3

Table 4: Distribution of subjects according to age group

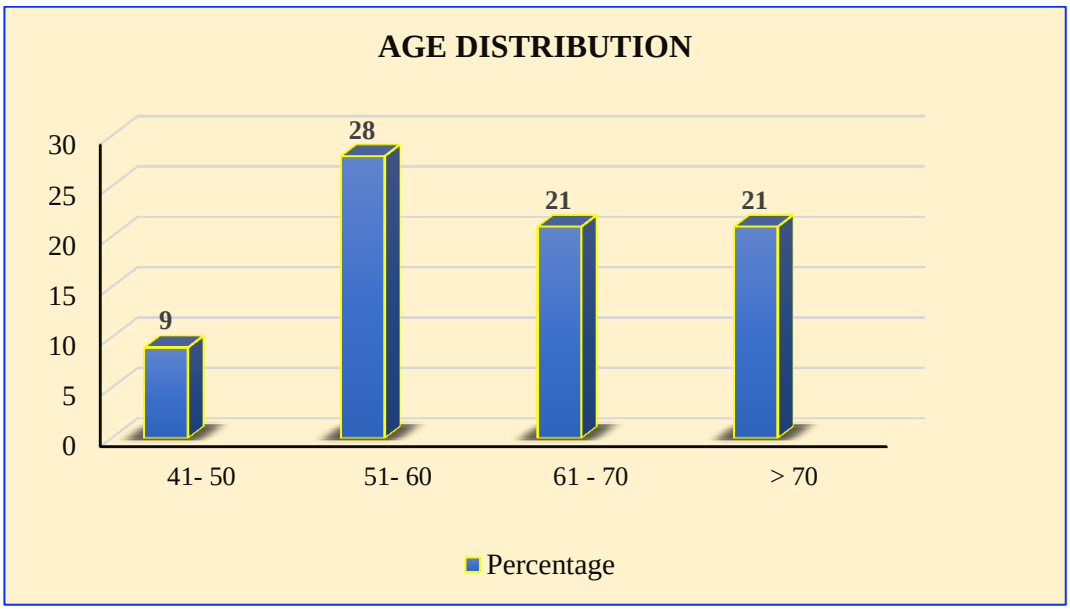

Fig 32: Distribution of subjects according to age group

Among the 77 patients , right eye was operated in 39 (50.6%) and left eye in 38 (49.4%) patients, the laterality distribution being almost equal.

Laterality	Number	Percentage
Right eye	39	50.6
Left eye	38	49.4

Table 5: Distribution of subjects according to laterality

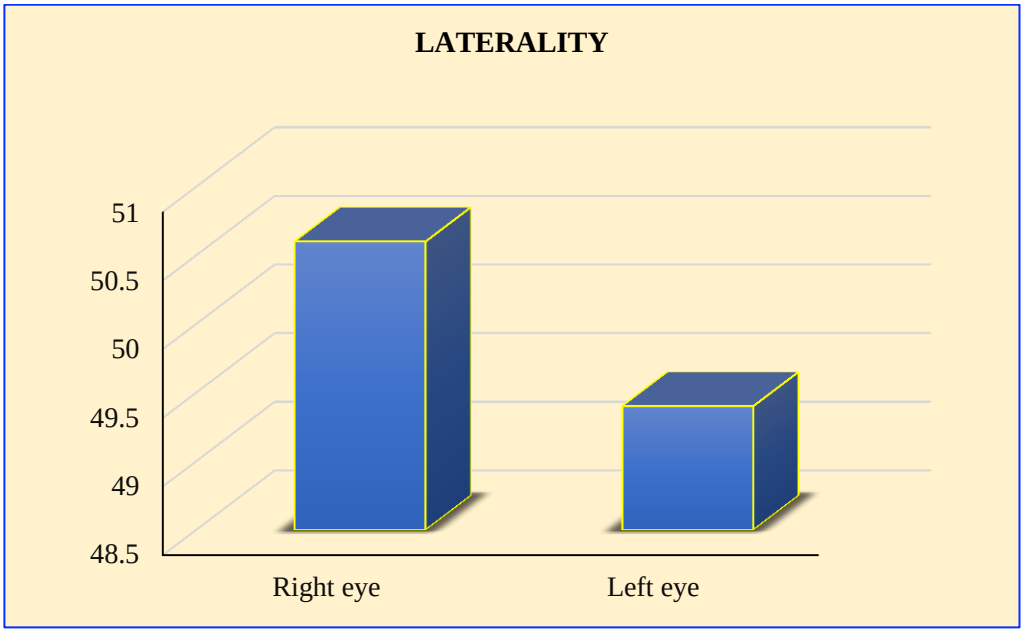

Fig 33: Distribution of subjects according to laterality

Risk factors for posterior capsular tear:

The most common risk factors observed were hypertension in 24 (31.16%), Diabetes mellitus in 22 (28.5%), mature cataract in 17 (22%) and pseudoexfoliation in 15 (19.48%) patients.

RISK FACTORS	N	%
Mature cataract	17	22
Pseudo exfoliation	15	19.48
Diabetes Mellitus	22	28.5
Hypertension	24	31.16

Table 6: Risk factors for PCR

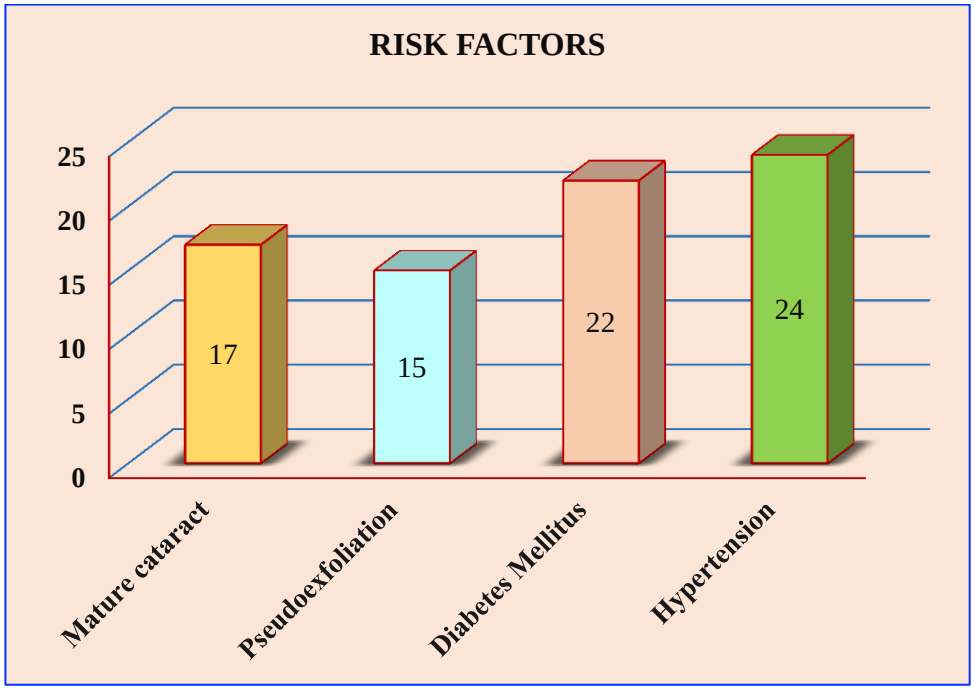

Fig 34: Risk factors for PCR

Stage in which posterior capsule rupture occurred:

Posterior capsule tear occurred in different stages during surgery. Maximum number of PCR occurred during the stage of cortical wash in 38 (49.4%) followed by stage of nucleus prolapse in 18 (23.4%), hydro dissection in 13 (16.9%), IOL placement in 5 (6.6%) and PC polishing in 3 (3.8%) of patients.

STAGE	N	%
Hydrodissection	13	16.9
Nucleus prolapse	18	23.4
Cortical wash	38	49.4
PC polishing	3	3.8
IOL placement	5	6.5

Table 7: Stage in which posterior capsule rupture occurred

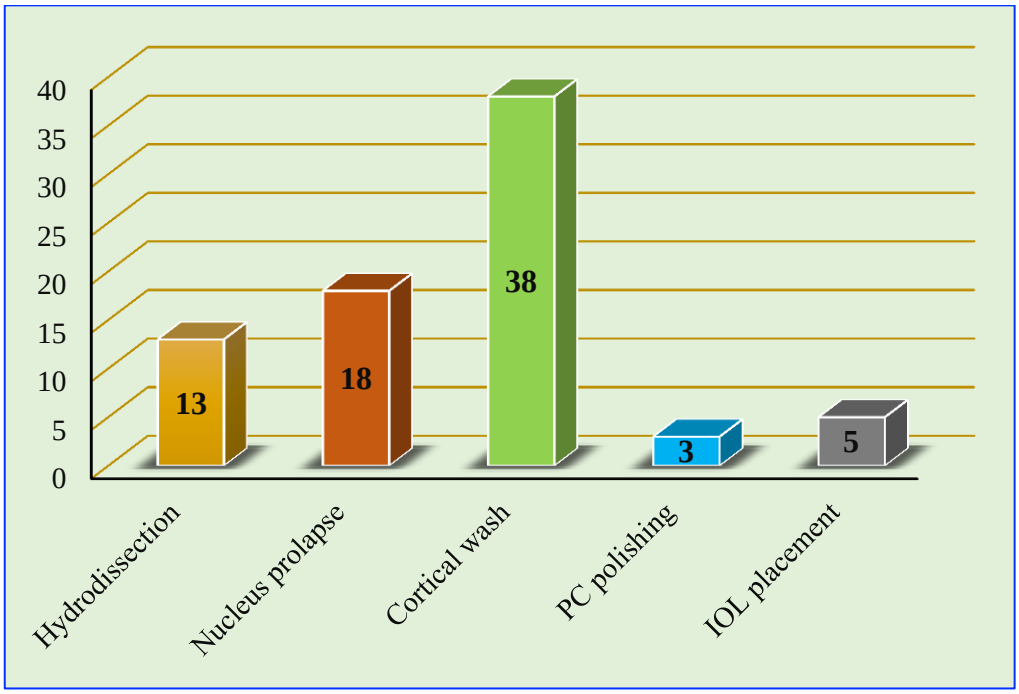

Fig 35: Stage in which Posterior Capsule rupture occurred

Visual acuity

This table compares the mean pre operative and post operative Best Corrected Visual Acuity (in Log MAR). There was a statistically significant difference between the mean preoperative (1.039 ± 0.745) and 1 month post operative visual acuity (0.189 ± 0.177) log MAR [P <0.001].

Visual acuity	Mean	SD	P value
Pre op	1.039	0.745	<0.001
Post op	0.346	0.269	
Post op 1 week	0.243	0.194	
Post op 1 month	0.189	0.177	

Table 8: Comparison of mean preoperative and postoperative visual acuity in log MAR

A statistically significant improvement was noted between the mean preoperative and postoperative visual acuity classified as per the WHO classification as well.

Visual Acuity	Log MAR	Pre operative	Post operative	P value
Good outcome	0 – 0.5	0	74	<0.001
Borderline outcome	0.6 – 1	2	3	<0.001
Poor outcome	<1	75	0	<0.001

Table 9: Comparison of preoperative versus postoperative visual acuity as per the WHO Guidelines

Good visual outcome of 0 – 0.5 log MAR was observed in 74 (96.1%) and borderline of 0.6 – 1 log MAR in 3 (3.9%) [P <0.001].

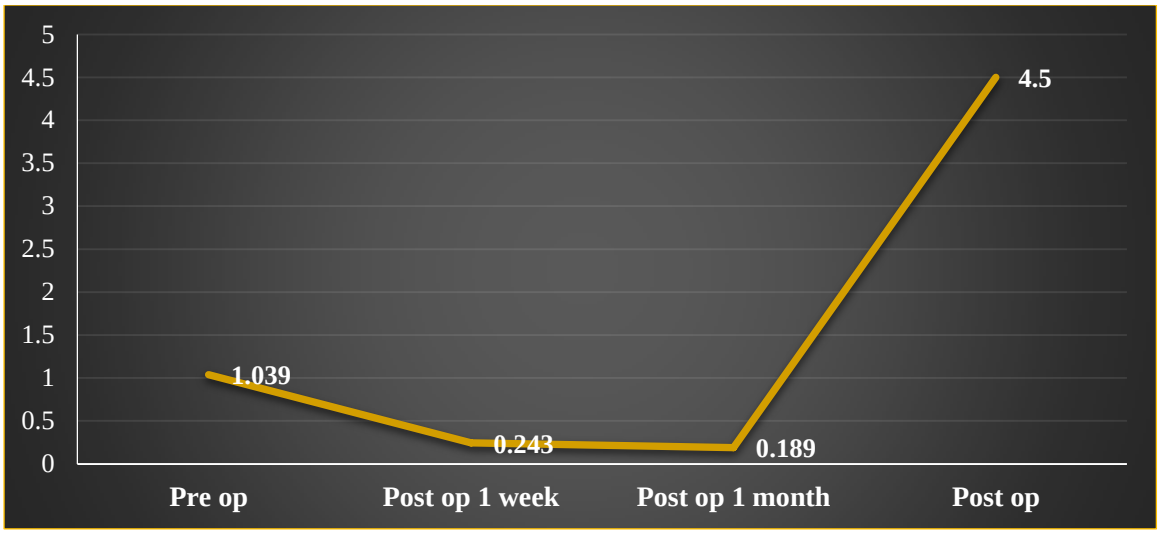

Fig 36: Preoperative versus postoperative visual acuity as per WHO Guidelines.

Spherical equivalent

The mean spherical equivalent predicted versus postoperative was 0.0108 ± 0.00977 and 0.0586 ± 0.17787 respectively, which was found to be statistically significant. [P <0.001].

Spherical equivalent refraction(D)	Mean	SD	Min	Max	P value
Post operative	0.0586	0.17787	0.75	1	<0.001
Predicted	0.0108	0.00977	0	0.03	

Table 10: Comparison of preoperative and postoperative spherical equivalent

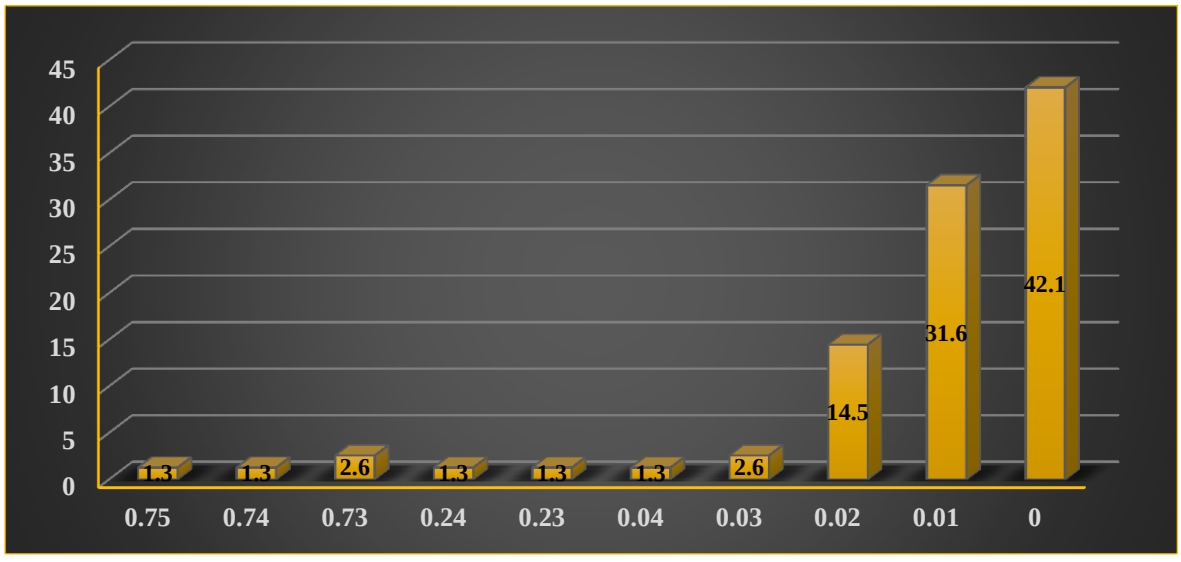

Fig 37: Cumulative distribution of spherical equivalent after IOL implantation in the sulcus

Intraocular lens power

The mean preoperative virtual power and the actual power of the IOL implanted is 21.50 ± 1.9596 (D) and 22.046 ± 1.9377 (D) respectively. A statistically significant difference was noted between the two. [P <0.001]

IOL Power (Diopter)	Mean	SD	Min	Max	P value
Virtual power	21.50	1.9596	15.5	26	<0.001
Actual power (sulcus implanted power)	22.046	1.9377	16	26.5	

Table 11: Difference in the Actual and Sulcus implanted IOL power

Postoperative complications:

The most common early postoperative complications noticed were striate keratopathy in 11 (14.5%) eyes followed by iritis in 8 (10.5%), IOL pigment dusting in 12 (15.8%) eyes and endothelial pigment dusting in 10 (13.2%) eyes. The late complications were Cystoid macular edema in 5(6.6%) patients, IOL decentration in 2 (2.6%) eyes and iris IOL contact in 2 (2.6%) eyes.

COMPLICATIONS	NUMBER	PERCENTAGE
Striate keratopathy	11	14.5
Iritis	8	10.5
Endothelial dusting	10	13.2
IOL pigment dusting	12	15.8
IOL decentration	2	2.6
Iris IOL Contact	2	2.6
Cystoid macular edema	5	6.6

Table 12: Distribution of postoperative complications

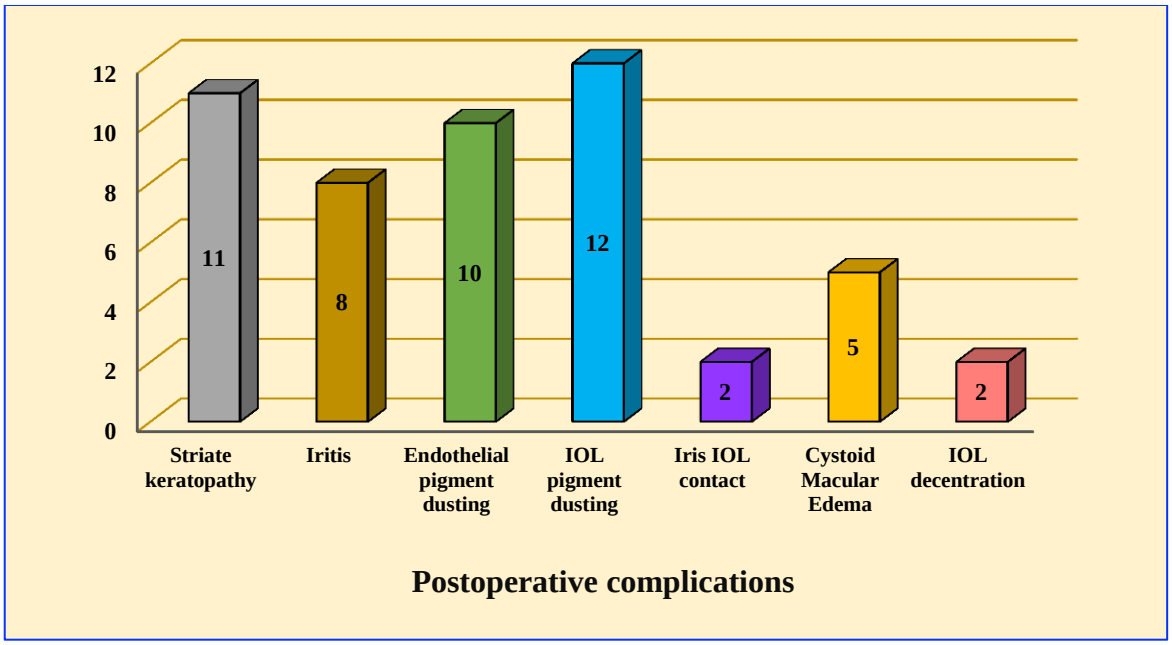

Fig 38: Distribution of postoperative complications

All the early complications resolved with postoperative medications over a period of 2 weeks. Iritis resolved within 3-7 days in all the cases. Mild IOL tilt observed in 2 cases (2.6%) did not affect the visual outcome significantly.

DISCUSSION

DISCUSSION

This prospective interventional study comprising of 77 patients undergoing manual small incision cataract surgery in the Department of Ophthalmology, R. L. Jalappa Hospital and Research Centre, Kolar from September 2022 to December 2023, were evaluated for the refractive outcome and intra operative and post operative complications after IOL implantation in the ciliary sulcus for visual rehabilitation.

Out of 77 patients, a female preponderance of 57 (74%) were observed than the 20 (26%) males. [Table 3]. This was similar to a study by Dubey R who evaluated 61.1 % females and 38.9% males.[29] This was not the same in other studies where male dominance was noted. [30-32][Table 13]

STUDIES	MALE		FEMALE		Age (years)
	N	%	N	%	
Present study (77), 2024	20	26	57	74	63.50 ± 10.445
Yoon EG (33), 2023[32]	22	66.7	11	33.3	61.0
Bhaskaran J (33), 2022[31]	20	60.6	13	39.4	75.21 ± 5.74
Dubey R (36), 2012[29]	14	38.9	22	61.1	77.9 ± 6.4
Y.C. Huang (11), 2013[30]	11	68.75	5	31.25	45.6 ± 25.0

Table 13: Comparison of Age and gender distribution in the present and other studies

Among these, 28 (36.4%) were in the age group of 51- 60 years, 21 (27.3%) patients each in age group range of 61- 70 years and > 70 years and 7 (9%) patients were in the age group of 41- 50 years. The mean age in years was 63.50 ± 10.445. [Table 4].

In this study, 39 patients had received surgery on the right eye and 38 patients on the left eye as seen in most of the other studies.[33,34][Table 14]

LATERALITY	RIGHT EYE		LEFT EYE	
	Number	Percentage	Number	Percentage
Present study (77), 2024	39	50.6	38	49.4
Yoon EG (33), 2023[32]	13	39.4	20	60.6
Sugiura. T (146), 2022[33]	75	51.4	71	48.6
Mohebbi M (24), 2017[34]	12	50	12	50
Chang DF (30), 2009[17]	19	63.3	11	36.7

Table 14: Comparison of Laterality among other studies

The most common risk factors observed were hypertension in 24 (31.16%), Diabetes mellitus in 22 (28.5%), mature cataract in 17 (22%) and pseudoexfoliation in 15 (19.48%) patients.

The study done by **Huang Y C** had Marfan syndrome with lens subluxation, lens dislocation, traumatic cataract and complications of a cataract surgery resulting in an inadequate posterior capsule support.[30]

The risk factors noted by **Dubey R** was similar to our study showing mean age of 77.9 $\pm$ 6.4 years, axial length of > 25mm in 8.3, Pseudoexfoliation in 31.6%, Diabetes mellitus in 55.5%, Systemic hypertension in 27.7% and operating surgeon being Consultant in 6 cases and 10 cases done by senior trainee , 20 cases by junior trainee out of 36 PCR cases.[29]

Sugiura. T and colleagues conducted a retrospective, interventional study on Long-term outcomes of trans sclerally sutured intraocular lens fixed in ciliary sulcus , comparing it to a control group of standard cataract surgery . The risk factors in their study was IOL dislocation post cataract extraction (38.4%), inability to place IOL as a result of complications during cataract surgery (27.4%), IOL and lens removal by vitreous surgery

(7.5%), trauma (8.2%), aphakia post cataract surgery in children (3.4%), subluxated lens because of Marfan syndrome (2.7%) and subluxated lens due to unknown cause (0.7%).[33]

In **Yoon EG et al** study the causes of ciliary sulcus IOL implantation were 22 eyes (33.8%) with PC rupture, 15 eyes (23.1%) having dislocated IOLs, 14 eyes (21.5%) having zonulopathy, 9 aphakic eyes (13.8%), 3 eyes (4.6%) with radial tear and 2 eyes (3.1%) with calcified intraocular lens.[32]

During cataract surgery, posterior capsule tear can happen in different stages. Maximum number of PCR occurred during the stage of cortical wash in 38 (49.4%) followed by stage of nucleus prolapse in 18 (23.4%), hydro dissection in 13 (16.9%), IOL placement in 5 (6.6%) and PC polishing in 3 (3.8%) patients.

Zhao J noted that in 8 (72.7%) patients posterior capsular rupture occurred at the stage of nucleus removal and 3 (27.3%) patients during the stage of irrigation/aspiration. Additionally, vitreous prolapse was observed in 10 out of the 11 affected patients.[18]

A similar study on 13 eyes by **Renieri G** observed that posterior capsule rupture happened in various stages of cataract surgery, Phacoemulsification in 3 (23.1%), Cortical wash in 7 (53.8%), PC polishing in 2 (15.4%) and IOL placement in 1(7.7%).[35]

Mean Visual acuity (log MAR)	Present study (2024)	Bhaskaran J (2022)[31]	Sugiura T (2022)[33]	Buccuzzi et al (2022)[36]
Mean preoperative	1.039 $\pm$ 0.745	1.40 $\pm$ 0.92	0.30 $\pm$ 0.45	0.49 $\pm$ 0.19
Mean postoperative	0.189 $\pm$ 0.177	0.38 $\pm$ 0.26	0.15 $\pm$ 0.43	0.19 $\pm$ 0.10
P Value	p<0.001	<0.001	p<0.01	<0.0001

Table 15: Comparison of visual acuity with other studies

The mean postoperative visual acuity on the first day was 0.346 $\pm$ 0.269, on the 1st week was 0.243 $\pm$ 0.194 and on the 1st month was 0.189 $\pm$ 0.177 log MAR. It was concluded that there is a statistically significant difference between mean preoperative (1.039 ± 0.745) log MAR

and 1 month post operative visual outcome at 1st day, 1 week and after 1 month [P <0.001]. The results obtained were compared to other similar studies.[31,33,36]

Also most of our patients had good visual outcome falling in the good outcome category of WHO's Classification, 74 (96.1%) patients had good visual outcome of log MAR (0 - 0.5) and 3 (3.9%) patients had borderline visual outcome of log MAR (0.6 – 1).

A retrospective, comparative observational study done by **Zhao et al** in which secondary ciliary sulcus IOL implantation was performed on 21 eyes of 14 children with paediatric cataract, the visual outcome at last visit was found to be 20/50 or better in overall 85% of patients.[37]

The observed visual acuities of patients in **Mohebbi M et al** study was 6/6 (12), 6/9 (5), 20/30 (3), 6/12 (1), 6/18 (1), 6/36 (1), and CF 3m (1) patient.[34]

Bhaskaran J conducted a retrospective study over a 5 year period between 2017 and 2022 on 35 eyes of 35 patients with age more than 50 years with dense cataracts and pseudoexfoliation with zonulopathy. A statistically significant difference between the mean preoperative and postoperative visual acuity of 1.40 ± 0.92 and 0.38 $\pm$ 0.26 Log MAR respectively on ciliary sulcus implantation of a three-piece IOL.[31]

Sugiura T conducted a retrospective, comparative, interventional case series which included 146 eyes of 142 patients who were aphakic with deficient capsular support, dislocated IOLs and subluxated crystalline lenses who had undergone transscleral suture fixation of intraocular lenses in the ciliary sulcus with a minimum follow-up period of 12 months. They reported the mean refractive error to be −0.712±0.749 Diopters (D), which was significantly more myopic than the preoperative target refraction ($p<0.01$) and the spherical equivalent of the normal controls ($p<0.01$).[33]

Mean Spherical equivalent (D)	Present study (2024)	Gundersen KG (2022)[38]	Huang YC (2013)[30]	Dubey R (2012)[29]
Postoperative error	0.0586 ± 0.17787	– 0.15 ± 0.44	–2.01 ± 1.04	– 1.16 ± 0.47
Predicted error	0.0108 ± 0.00977	– 0.18 ± 0.88	– 0.35 ± 0.62	– 0.45 ± 0.23
P Value	p<0.001	p < 0.001	p < 0.001	p < 0.05

Table 16: Comparison of mean spherical equivalent with other studies

The mean pre operative predicted and postoperative spherical equivalent was 0.0108 ± 0.00977 and 0.0586 ± 0.17787 respectively, which was found to be statistically significant. [P <0.001].

Huang YC included 18 eyes with sulcus suture-fixated PC IOLs in his study were the mean predicted refraction, calculated using the SRK-T formula, was -0.35 ± 0.62 D and the mean postoperative spherical equivalent was +2.01 ± 1.04 D. Seventeen eyes experienced myopic shifts, while one eye had a hyperopic shift. The difference between postoperative spherical equivalent and predicted refraction was -1.66 ± 0.97 D. When using the Hoffer-Q and Holladay-1 formulas, the differences between postoperative spherical equivalent and predicted refraction were -1.90 ± 1.20 D and -1.70 ± 1.10 D, respectively.

Simple linear regression analysis indicated that the SRK-T formula outperformed the others in predicting outcomes for sulcus suture-fixated PC IOLs.[30]

Gundersen KG enrolled 16 subjects (32 eyes) whose postoperative mean refraction spherical equivalent (MRSE) at 3 months was −0.16 ± 0.30 D (range −0.875 to +0.50 D) with a residual cylinder of 0.29 ± 0.27 D (range 0.0 to 1.0 D). Thirty of 32 eyes (94%) had an MRSE < 0.50 D of Plano and 28 of 32 eyes (88%) had a residual cylinder of 0.50 D or less. Twenty-six eyes (81%) met both criteria. They did not find any statistically significant difference in the MRSE (p = 0.57) or the refractive cylinder (p = 0.31) between eyes

undergoing simultaneous surgery, although the number of eyes in each sample size in this stratification may be too small to be meaningful.[38]

Mean IOL power (D)	Present study (2024)	Dubey R (2012)[29]	Suto C (2003)[28]
Virtual power	21.50 ± 1.9596	23.36 ± 1.45	23.26 ± 2.09
Actual power	22.046 ± 1.9377	22.55 ± 1.35	22.15 ± 1.94
P Value	<0.001	<0.05	<0.0001

IOL – Intraocular lens, D – Diopter

Table 17: Comparison of virtual and actual IOL power with other studies

When an intraocular lens (IOL) is positioned entirely within the ciliary sulcus, it sits approximately 0.5 mm anterior compared to its placement within the capsular bag. Consequently, the A constant should be adjusted by approximately 0.80 Diopter (D) to account for this shift. Given that IOL powers are typically available in half-diopter increments, both an 11D and a 16D lens require a similar adjustment when moved forward into the sulcus, albeit slightly less than half a diopter.

The power of an IOL placed in the sulcus often needs to be decreased by 0.50–1.00 D to achieve the same refractive outcome for an average eye. Larger myopic eyes may require a smaller reduction, typically less than 0.50 D, whereas smaller hyperopic eyes may necessitate a reduction of up to 1.50 D.[39] The exact adjustment can be calculated based on the precise sulcus position, although a practical estimation using the "rule of 9s" method is generally sufficient. [Table 2]

In cases where the anterior capsular rim remains intact with a well-centered capsulorrhexis, placing the haptics in the ciliary sulcus and pushing the optic posteriorly to secure it behind the capsulorrhexis provides enhanced stability with minimal impact on lens power calculations.[40]

The most common early postoperative complications noticed were striate keratopathy in 11 (14.5%) eyes followed by iritis in 8 (10.5%), IOL pigment dusting in 12 (15.8%) eyes and endothelial pigment dusting in 10 (13.2%) eyes. The late complications were Cystoid macular edema in 5(6.6%) patients, IOL decentration in 2 (2.6%) eyes and iris IOL contact in 2 (2.6%) eyes.

Most of the complications noted were transient that resolved with postoperative medications instilled over 6 weeks in a tapering dose. These complications had not affected the final visual outcome.

Acrylic IOLs are favored over silicone IOLs due to the increased risk of retinal detachment and potential requirement for silicone oil in patients with capsular trauma.[41]

One-piece PMMA IOLs have diminished in popularity as the primary choice for IOL implants due to the necessity of a large 6–7mm incision for insertion. However, their slim haptic design enables compatibility with both capsular and sulcus placement. When positioned in the sulcus, these rigid, non-foldable lenses with thin haptics effectively move the optic away from the iris. Most of the cases in the present study involved single– piece PMMA IOLs implanted in the sulcus compared to other studies where a three – piece IOL was preferred.

"It has been reported that the most serious complications associated with placing IOLs in the ciliary sulcus often stem from inappropriate IOL selection. Specifically, patients who receive single-piece acrylic (SPA) IOL implants in the ciliary sulcus may experience secondary pigment dispersion (83%), elevated intraocular pressure(33%), leading to secondary pigmentary glaucoma, intraocular haemorrhage (23%) and iris transillumination defects (80%)" .[26, 41-43]

Analysis of studies in which IOLs were explanted due to pigment dispersion syndrome revealed the predominant histological finding of pigment granules on the anterior surface of the IOLs—more pronounced on the peripheral optic and haptic-optic junction.

These findings are indicative of posterior iris chafing attributed to the optic and the relatively thick, flexible haptics , characterized by squared corners and unpolished side walls.[17] Iris chafing contributes to iris transillumination defects, while secondary pigment dispersion can lead to the formation of Krukenberg spindle and hyperpigmentation of the trabecular meshwork.[44]

Despite increasing reports of postoperative complications associated with sulcus placement of Single piece acrylic IOLs , their use remains controversial. However, two studies conducted at the same center by Taskapili et al. supported the implantation of a single-piece acrylic IOL in the sulcus backing the findings of the present study. These studies suggest that this approach preserves the advantages of small-incision cataract surgery , yielding good postoperative visual outcomes with few complications or instances of IOL decentration.[45,46]

CONCLUSION

CONCLUSION

This study demonstrates that implanting a single-piece intraocular lens (IOL) implantation in ciliary sulcus was well tolerated by patients. The postoperative visual outcomes were positive, with minimal treatable complications observed and the IOLs remaining well-positioned and well-tolerated in the sulcus.

Despite the fact that IOLs specifically designed for placement in the capsular bag should not be typically placed in the ciliary sulcus (except for reduction in the power by 0.5 to 1 D), no safety concerns were identified, as evidenced by the absence of elevated intraocular pressure or chronic uveitis during follow-up examinations of these patients.

Placement of an intraocular lens in the ciliary sulcus is often necessitated when capsular placement is not feasible, rather than being a preferred choice.Selecting the appropriate IOL, having a thorough understanding of ciliary sulcus anatomy and employing precise surgical techniques are crucial for optimizing outcomes and reducing complications in such cases.

SUMMARY

SUMMARY

Although cataract surgery is a safe and effective means of restoring vision, posterior capsular rupture remains an inevitable complication that still occurs in patients who undergo cataract surgery, despite advancements in technology

In the present study, 77 cataract patients attending R.L. JALAPPA hospital and Research Centre, attached to Sri Devraj Urs Medical College, Tamaka, Kolar were included. The average age group of these patients was 63.50 $\pm$ 10.445 years with slightly female preponderance.

Maximum number of PCR occurred during the stage of cortical wash in 38 (49.4%) followed by stage of nucleus prolapse in 18 (23.4%), hydro dissection in 13 (16.9%), IOL placement in 5 (6.6%) and PC polishing in 3 (3.8%) of patients.

There was a statistically significant difference between the mean preoperative (1.039 ± 0.745) and 1 month post operative BCVA (0.189 ± 0.177) log MAR [P <0.001]. Good visual outcome of 0 – 0.5 log MAR was observed in 74 (96.1%) and borderline of 0.6 – 1 log MAR in 3 (3.9%).

Similarly the mean pre operative predicted and postoperative spherical equivalent was 0.0108 ± 0.00977 and 0.0586 ± 0.17787 respectively and the mean preoperative virtual power and the actual power of the IOL implanted is 21.50 $\pm$ 1.9596 (D) and 22.046 $\pm$ 1.9377 (D) respectively.

The most common early postoperative complications were striate keratopathy in 11 (14.5%), iritis in 8 (10.5%), IOL pigment dusting in 12 (15.8%) and endothelial pigment dusting in 10 (13.2%) eyes. The late complications were Cystoid macular edema in 5(6.6%), IOL decentration in 2 (2.6%) and iris IOL contact in 2 (2.6%) eyes.

In conclusion the lack of serious complications and favorable visual outcome noted in this study suggest that ciliary sulcus fixation of posterior chamber intraocular lens was found to be safe and effective alternate method for visual rehabilitation.

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ANNEXURES

ANNEXURE I - CASE PROFORMA

Name:	Case No:
Age:	Date:
Sex:	1P No:
Occupation:	DOS:
Address:	

Chief complaints:

Past history:

DM / HTN / BA / Epilepsy

Family history:

Personal history:

Appetite – Sleep – Bowel –

Diet – Habits – Bladder –

GPE:

Pallor / Edema /Icterus / Cyanosis / Clubbing / Lymphadenopathy

Vital signs:

a. Pulse – c) RR –

b. BP – d) Temp –

Systemic examination:

a. CVS – c. RS –

b. PA – d. CNS –

OCULAR EXAMINATION		
	RE	**LE**
1. Head Posture **2. Ocular Posture** **3. Facial Symmetry**		
4. Ocular Movements		
5. Visual Acuity a) Distant b) Near		
6. Anterior Segment		
7. Fundus (IDO & Slit Lamp +90D)		
8. B Scan		
9. Keratometry K1 K2		
10. Axial length		
11. Intraocular lens power		
12. Predicted Spherical equivalent refraction		
13. Intraocular pressure		
14. Lab Investigations a. RBS b. ECG c. Blood urea d. Serum Creatinine		
15. Intraoperative Complications		

Postoperative VA	**1 day**	**1 week**	**1 month**
Distant Vision UDVA CDVA			
Near Vision UNVA CNVA			
Spherical equivalent refraction			
Refractive shift			

Postoperative complications	**Day 1**	**1 Week**	**1 Month**
a. Striae Keratopathy b. Hyphema c. Iritis d. Increased IOP e. Posterior synechiae f. Cystoid macular edema g. IOL tilt / decentration h. Persistent corneal edema			

ANNEXURE - II

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, TAMAKA, KOLAR - 563101.

INFORMED CONSENT FORM

Case no:

IP no:

TITLE: "REFRACTIVE OUTCOME OF CILIARY SULCUS IMPLANTED INTRAOCULAR LENSES"

I, the undersigned, agree to participate in this study and authorize the collection and disclosure of personal information as outlined in this consent form.

I understand the purpose of this study, the risks and benefits of the technique and the confidential nature of the information that will be collected and disclosed during the study. The information collected will be used only for research.

I have had the opportunity to ask questions regarding the various aspects of this study and my questions have been answered to my satisfaction.

I understand that I remain free to withdraw the participation from this study at any time and this will not change the future care.

Participation in this study does not involve any financial burden to me.

Name	Signature	Date	Time
Patient:			
Witness:			
Primary Investigator/ Doctor:			

ANNEXURE II

ಶ್ರೀ ದೇವರಾಜ್ ಅರಸ್ ಉನ್ನತ ಶಿಕ್ಷಣ ಮತ್ತು ಸಂಶೋಧನಾ ಸಂಸ್ಥೆ, ಟಮಕ, ಕೋಲಾರ - 563101.

ತಿಳಿವಳಿಕೆ ಸಮ್ಮತಿ ನಮೂನೆ

ಶೀರ್ಷಿಕೆ: "ಸಿಲಿಯರಿ ಸಲ್ಕಸ್ ಇಂಪ್ಲಾಂಟೆಡ್ ಇಂಟ್ರಾಕ್ಯುಲರ್ ಲೆನ್ಸ್‌ಗಳ ವಕ್ರೀಭವನದ ಫಲಿತಾಂಶ"ಈ ಸಂಶೋಧನೆಗೆ

ರೋಗಿಯ ಗುರುತಿನ ಸಂಖ್ಯೆ:

ಐಪಿ ಸಂಖ್ಯೆ:

ಅಂಗೀಕರಿಸಿದ ನಾನು, ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಪಾಲ್ಗೊಳ್ಳಲು ಒಪ್ಪುತ್ತೇನೆ ಮತ್ತು ಈ ಸಮ್ಮತಿಯ ರೂಪದಲ್ಲಿ ವಿವರಿಸಿರುವಂತೆ ನನ್ನ ವೈಯಕ್ತಿಕ ಮಾಹಿತಿಯ ಸಂಗ್ರಹಣೆ ಮತ್ತು ಬಹಿರಂಗಪಡಿಸುವಿಕೆಯನ್ನು ದೃಢೀಕರಿಸುತ್ತೇನೆ.

ನಾನು ಈ ಅಧ್ಯಯನದ ಉದ್ದೇಶ, ತಂತ್ರಗಳ ಅಪಾಯಗಳು ಮತ್ತು ಪ್ರಯೋಜನಗಳನ್ನು ಮತ್ತು ಅಧ್ಯಯನದಲ್ಲಿಸಂಗ್ರಹಿಸಿದ ಮತ್ತು ಬಹಿರಂಗಪಡಿಸುವ ಮಾಹಿತಿಯ ಗೌಪ್ಯತೆಗೆ ನಾನು ಅರ್ಥಮಾಡಿಕೊಂಡಿದ್ದೇನೆ.

ಸಂಗ್ರಹಿಸಿದ ಮಾಹಿತಿಯನ್ನು ಸಂಶೋಧನೆಗೆ ಮಾತ್ರ ಬಳಸಲಾಗುತ್ತದೆ.

ಈ ಅಧ್ಯಯನದ ವಿವಿಧ ಅಂಶಗಳನ್ನು ಕುರಿತು ಪ್ರಶ್ನೆಗಳನ್ನು ಕೇಳಲು ನನಗೆ ಅವಕಾಶವಿದೆ ಮತ್ತು ನನ್ನ ತೃಪ್ತಿಗೆ ನನ್ನ ಪ್ರಶ್ನೆಗಳಿಗೆ ಉತ್ತರ ನೀಡಲಾಗಿದೆ.

ಈ ಸಂಶೋಧನೆಯಿಂದ ಹೊರಬರುವ ಮಾಹಿತಿಯನ್ನು ವೈದ್ಯರು ಯಾವುದೇ ಜರ್ನಲ್ನಲ್ಲಿ ಅಥವಾ ಕಾನ್ಫೆರೆನ್ಸ್ನಲ್ಲಿ ಪ್ರಕಟಿಸಲು ಅನುಮತಿ ಸೂಚಿಸಿರುತ್ತೇನೆ

ನಾನು ಈ ಅಧ್ಯಯನದಿಂದ ಯಾವುದೇ ಸಮಯದಲ್ಲಿ ಹಿಂತೆಗೆದುಕೊಳ್ಳಲು ಮುಕ್ತವಾಗಿರುತ್ತೇನೆ ಮತ್ತು ಇದು ನನ್ನ ಮುಂದಿನ ಕಾಳಜಿಯನ್ನು ಬದಲಿಸುವುದಿಲ್ಲ ಎಂದು ನಾನು ಅರ್ಥಮಾಡಿಕೊಂಡಿದ್ದೇನೆ.

ಈ ಸಂಶೋಧನಾ ಯೋಜನೆಯ ಭಾಗವಹಿಸುವಿಕೆ ನನಗೆ ಯಾವುದೇ ಹಣಕಾಸಿನ ಹೊರೆ ಒಳಗೊಂಡಿರುವುದಿಲ್ಲ.

ಹೆಸರು	ಸಹಿ	ದಿನಾಂಕ	ಸಮಯ
ರೋಗಿಯ:			
ಸಾಕ್ಷಿ 1:			
ಸಾಕ್ಷಿ 2:			
ಪ್ರಾಥಮಿಕ ತನಿಖೆದಾರ / ಡಾಕ್ಟರ್:			

ANNEXURE - III

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, TAMAKA, KOLAR - 563101.

PATIENT INFORMATION SHEET

TITLE: "REFRACTIVE OUTCOME OF CILIARY SULCUS IMPLANTED INTRAOCULAR LENSES"

This information is to help you understand the purpose of the study titled "**Refractive outcome of Ciliary Sulcus implanted intraocular lenses**". As you're invited to take part voluntarily in this research study, it is important that you read and understand the purpose, procedure, benefits and discomforts of the study.

Senile cataracts develop in the elderly due to the ageing process. It develops slowly to cause loss of vision, and can render the person completely blind if it is left untreated. Cataracts usually affect both eyes, but they will generally develop in one eye before the other.

Absolutely no risks are associated with the various investigations to be done which are Random Blood Sugar, Fasting Blood Sugar, Post Prandial Blood Sugar, Keratometry, biometry, ECG, lacrimal syringing, Direct & Indirect ophthalmology

After undergoing standard investigations protocol for cataract surgery the pupil will be dilated with 0.8% tropicamide & 5% / 10% phenylephrine drops along with flurbiprofen eye drops. Under local anesthesia the cataract will be removed and an artificial lens will be implanted inside the eye for restoring vision.

The following complications maybe seen during surgery which will be managed medically/ surgically. They are hemorrhage, posterior capsule rupture (1.92%), nucleus drop (0.68%), zonular dialysis (0.8%), wound leakage, uveitis, secondary glaucoma, cystoid macular edema (12%), endophthalmitis (0.01%– 0.3%) & posterior capsular opacification (<5% –50%). As the surgery is done under local anesthesia the risk to life is less than 0.5%. If required patient will be referred to higher Centre for further management under appropriate guidance.

After surgery you will receive antibiotic steroid eye drops which has to be instilled hourly for two days, followed by tapering dose for 6 weeks along with Flurbiprofen eye drops 0.03% TID for 4 weeks. Free spectacles will be issued 4 weeks after the surgery.

The purpose of this study is to find the difference in the vision after cataract surgery when the lens is positioned outside instead of the lens bag.

There is no compulsion to participate in this study, and will not change the final outcome of your eye condition. You may refuse to take part in the study or you may stop your participation in the study at any time, without a penalty or loss of any benefits to which you were otherwise entitled before taking part in this study. However, patients in the future may benefit as a result of knowledge gained from this study.

CONFIDENTIALITY

Your medical information will be kept confidential by the study doctor and staff and will not be made publicly available. All information collected from you will be strictly confidential and will not be disclosed to any outsider except if it is required by the law. The information collected will be used only for research. This information will not reveal your identity and the original records may be reviewed by your doctor or ethics review board. This study seeks ethical committee approval and will be started only after their formal approval.

For further information,/clarification please contact the below mentioned resident at Sri Devaraj Urs Academy of Higher Education and Research, Tamaka, Kolar – 563101.

DOCTOR'S DETAILS:

DR. LEKSHMY, MBBS, (MS)
3rd Year Resident
Department of Ophthalmology,
SDUMC, Kolar – 563101
Contact no:9496197305
Mail ID: lekshmyaravind21@gmail.com

ANNEXURE III

ಶ್ರೀ ದೇವರಾಜ್ ಅರಸ್ ಉನ್ನತ ಶಿಕ್ಷಣ ಮತ್ತು ಸಂಶೋಧನಾ ಸಂಸ್ಥೆ, ಟಮಕ, ಕೋಲಾರ - 563101.

ಶೀರ್ಷಿಕೆ: "ಸಿಲಿಯರಿ ಸಲ್ಕಸ್ ಇಂಪ್ಲಾಂಟೆಡ್ ಇಂಟ್ರಾಕ್ಯುಲರ್ ಲೆನ್ಸ್‌ಗಳ ವಕ್ರೀಭವನದ ಫಲಿತಾಂಶ"

"ಸಿಲಿಯರಿ ಸಲ್ಕಸ್ ಅಳವಡಿಸಿದ ಇಂಟ್ರಾಕ್ಯುಲರ್ ಲೆನ್ಸ್‌ಗಳೊಂದಿಗೆ ವಕ್ರೀಕಾರಕ ಫಲಿತಾಂಶ" ಎಂಬ ಶೀರ್ಷಿಕೆಯ ಅಧ್ಯಯನದ ಉದ್ದೇಶವನ್ನು ಅರ್ಥಮಾಡಿಕೊಳ್ಳಲು ಈ ಮಾಹಿತಿಯು ನಿಮಗೆ ಸಹಾಯ ಮಾಡುತ್ತದೆ. ಈ ಸಂಶೋಧನಾ ಅಧ್ಯಯನದಲ್ಲಿ ಸ್ವಯಂಪ್ರೇರಣೆಯಿಂದ ಪಾಲ್ಗೊಳ್ಳಲು ನಿಮ್ಮನ್ನು ಆಹ್ವಾನಿಸಲಾಗಿದೆ, ನೀವು ಅಧ್ಯಯನದ ಉದ್ದೇಶ, ಕಾರ್ಯವಿಧಾನ, ಪ್ರಯೋಜನಗಳು ಮತ್ತು ಅನಾನುಕೂಲಗಳನ್ನು ಓದುವುದು ಮತ್ತು ಅರ್ಥಮಾಡಿಕೊಳ್ಳುವುದು ಮುಖ್ಯವಾಗಿದೆ.

ವಯಸ್ಸಾದ ಪ್ರಕ್ರಿಯೆಯಿಂದಾಗಿ ವಯಸ್ಸಾದವರಲ್ಲಿ ವಯಸ್ಸಾದ ಕಣ್ಣಿನ ಪೊರೆಗಳು ಬೆಳೆಯುತ್ತವೆ. ದೃಷ್ಟಿ ಕಳೆದುಕೊಳ್ಳಲು ಇದು ನಿಧಾನವಾಗಿ ಬೆಳವಣಿಗೆಯಾಗುತ್ತದೆ ಮತ್ತು ಚಿಕಿತ್ಸೆ ನೀಡದೆ ಬಿಟ್ಟರೆ ವ್ಯಕ್ತಿಯನ್ನು ಸಂಪೂರ್ಣವಾಗಿ ಕುರುಡನನ್ನಾಗಿ ಮಾಡಬಹುದು. ಕಣ್ಣಿನ ಪೊರೆಗಳು ಸಾಮಾನ್ಯವಾಗಿ ಎರಡೂ ಕಣ್ಣುಗಳ ಮೇಲೆ ಪರಿಣಾಮ ಬೀರುತ್ತವೆ, ಆದರೆ ಅವು ಸಾಮಾನ್ಯವಾಗಿ ಒಂದು ಕಣ್ಣಿನಲ್ಲಿ ಇನ್ನೊಂದಕ್ಕಿಂತ ಮೊದಲು ಬೆಳೆಯುತ್ತವೆ.

ರಾಂಡಮ್ ಬ್ಲಡ್ ಶುಗರ್, ಫಾಸ್ಟಿಂಗ್ ಬ್ಲಡ್ ಶುಗರ್, ಪ್ರಂಡಿಯಲ್ ಬ್ಲಡ್ ಶುಗರ್, ಕೆರಾಟೋಮೆಟ್ರಿ, ಬಯೋಮೆಟ್ರಿ, ಇಸಿಜಿ, ಲ್ಯಾಕ್ರಿಮಲ್ ಸಿರಿಂಗಿಂಗ್, ಡೈರೆಕ್ಟ್ ಮತ್ತು ಪರೋಕ್ಷ ನೇತ್ರವಿಜ್ಞಾನದ ವಿವಿಧ ತನಿಖೆಗಳೊಂದಿಗೆ ಸಂಪೂರ್ಣವಾಗಿ ಯಾವುದೇ ಅಪಾಯಗಳು ಸಂಬಂಧಿಸಿಲ್ಲ.

ಕಣ್ಣಿನ ಪೊರೆ ಶಸ್ತ್ರಚಿಕಿತ್ಸೆಗಾಗಿ ಪ್ರಮಾಣಿತ ತನಿಖೆಯ ಪ್ರೋಟೋಕಾಲ್‌ಗೆ ಒಳಗಾದ ನಂತರ, ಶಿಷ್ಯನನ್ನು 0.8% ಟ್ರೋಪಿಕಮೈಡ್ ಮತ್ತು 5% / 10% ಫಿನೈಲ್ಫ್ರಿನ್ ಹನಿಗಳೊಂದಿಗೆ ಫ್ಲರ್ಬಿಪ್ರೊಫೇನ್ ಕಣ್ಣಿನ ಹನಿಗಳೊಂದಿಗೆ ಹಿಗ್ಗಿಸಲಾಗುತ್ತದೆ. ಸ್ಥಳೀಯ ಅರಿವಳಿಕೆ ಅಡಿಯಲ್ಲಿ ಕಣ್ಣಿನ ಪೊರೆ ತೆಗೆದುಹಾಕಲಾಗುತ್ತದೆ ಮತ್ತು ದೃಷ್ಟಿ ಪುನಃಸ್ಥಾಪಿಸಲು ಕಣ್ಣಿನೊಳಗೆ ಕೃತಕ ಮಸೂರವನ್ನು ಅಳವಡಿಸಲಾಗುತ್ತದೆ.

ಶಸ್ತ್ರಚಿಕಿತ್ಸೆಯ ಸಮಯದಲ್ಲಿ ಕೆಳಗಿನ ತೊಡಕುಗಳು ಕಂಡುಬರಬಹುದು, ಇದನ್ನು ವೈದ್ಯಕೀಯವಾಗಿ / ಶಸ್ತ್ರಚಿಕಿತ್ಸಕವಾಗಿ ನಿರ್ವಹಿಸಲಾಗುತ್ತದೆ. ಅವುಗಳೆಂದರೆ ಹೆಮರೇಜ್, ಹಿಂಭಾಗದ ಕ್ಯಾಪ್ಸುಲ್ ಛಿದ್ರ (1.92%), ನ್ಯೂಕ್ಲಿಯಸ್ ಡ್ರಾಪ್ (0.68%), ಝೋನ್ಯುಲರ್ ಡಯಾಲಿಸಿಸ್ (0.8%), ಗಾಯದ ಸೋರಿಕೆ, ಯುವೆಟಿಸ್, ಸೆಕೆಂಡರಿ ಗ್ಲುಕೋಮಾ, ಸಿಸ್ಟಾಯ್ಡ್ ಮ್ಯಾಕ್ಯುಲರ್ ಎಡಿಮಾ (12%), ಎಂಡೋಫ್ಥಾಲ್ಮಿಟಿಸ್ (0.01%)– 0.3 & ಹಿಂಭಾಗದ ಕ್ಯಾಪ್ಸುಲರ್ ಅಪಾರದರ್ಶಕತೆ (<5% -50%). ಸ್ಥಳೀಯ ಅರಿವಳಿಕೆ ಅಡಿಯಲ್ಲಿ ಶಸ್ತ್ರಚಿಕಿತ್ಸೆ ಮಾಡುವುದರಿಂದ ಜೀವಕ್ಕೆ ಅಪಾಯವು 0.5% ಕ್ಕಿಂತ ಕಡಿಮೆ ಇರುತ್ತದೆ. ಅಗತ್ಯವಿದ್ದರೆ ರೋಗಿಯನ್ನು ಸೂಕ್ತ ಮಾರ್ಗದರ್ಶನದಲ್ಲಿ ಹೆಚ್ಚಿನ ನಿರ್ವಹಣೆಗಾಗಿ ಉನ್ನತ ಕೇಂದ್ರಕ್ಕೆ ಉಲ್ಲೇಖಿಸಲಾಗುತ್ತದೆ.

ಶಸ್ತ್ರಚಿಕಿತ್ಸೆಯ ನಂತರ ನೀವು ಆಂಟಿಬಯೋಟಿಕ್ ಸ್ಟೆರಾಯ್ಡ್ ಕಣ್ಣಿನ ಹನಿಗಳನ್ನು ಸ್ವೀಕರಿಸುತ್ತೀರಿ, ಇದನ್ನು ಎರಡು ದಿನಗಳವರೆಗೆ ಗಂಟೆಗೊಮ್ಮೆ ಹಾಕಬೇಕು, ನಂತರ 6 ವಾರಗಳವರೆಗೆ ಡೋಸ್ ಟೇಪರಿಂಗ್ ಜೊತೆಗೆ ಫ್ಲರ್ಬಿಪ್ರೊಫೇನ್ ಐ ಡ್ರಾಪ್ಸ್ 0.03% ಟಿಐಡಿ 4 ವಾರಗಳವರೆಗೆ. ಶಸ್ತ್ರಚಿಕಿತ್ಸೆಯ ನಂತರ 4 ವಾರಗಳ ನಂತರ ಉಚಿತ ಕನ್ನಡಕವನ್ನು ನೀಡಲಾಗುತ್ತದೆ.

ಕಣ್ಣಿನ ಪೊರೆ ಶಸ್ತ್ರಚಿಕಿತ್ಸೆಯ ನಂತರ ಲೆನ್ಸ್ ಬ್ಯಾಗ್ ಬದಲಿಗೆ ಮಸೂರವನ್ನು ಹೊರಗೆ ಇರಿಸಿದಾಗ ದೃಷ್ಟಿಯಲ್ಲಿ ವ್ಯತ್ಯಾಸವನ್ನು ಕಂಡುಹಿಡಿಯುವುದು ಈ ಅಧ್ಯಯನದ ಉದ್ದೇಶವಾಗಿದೆ.

ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಲು ಯಾವುದೇ ಒತ್ತಾಯವಿಲ್ಲ ಮತ್ತು ನಿಮ್ಮ ಕಣ್ಣಿನ ಸ್ಥಿತಿಯ ಅಂತಿಮ ಫಲಿತಾಂಶವನ್ನು ಬದಲಾಯಿಸುವುದಿಲ್ಲ. ನೀವು ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಲು ನಿರಾಕರಿಸಬಹುದು ಅಥವಾ ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಪಾಲ್ಗೊಳ್ಳುವ ಮೊದಲು ನೀವು ಅರ್ಹರಾಗಿದ್ದ ಯಾವುದೇ ಪ್ರಯೋಜನಗಳ ದಂಡ ಅಥವಾ ನಷ್ಟವಿಲ್ಲದೆ ಯಾವುದೇ ಸಮಯದಲ್ಲಿ ಅಧ್ಯಯನದಲ್ಲಿ ನಿಮ್ಮ ಭಾಗವಹಿಸುವಿಕೆಯನ್ನು ನಿಲ್ಲಿಸಬಹುದು. ಆದಾಗ್ಯೂ, ಈ ಅಧ್ಯಯನದಿಂದ ಪಡೆದ ಜ್ಞಾನದ ಪರಿಣಾಮವಾಗಿ ಭವಿಷ್ಯದಲ್ಲಿ ರೋಗಿಗಳು ಪ್ರಯೋಜನ ಪಡೆಯಬಹುದು.

ಗೌಪ್ಯತೆ

ನಿಮ್ಮ ವೈದ್ಯಕೀಯ ಮಾಹಿತಿಯನ್ನು ಅಧ್ಯಯನ ವೈದ್ಯರು ಮತ್ತು ಸಿಬ್ಬಂದಿ ಗೌಪ್ಯವಾಗಿಡುತ್ತಾರೆ ಮತ್ತು ಸಾರ್ವಜನಿಕವಾಗಿ ಲಭ್ಯವಾಗುವಂತೆ ಮಾಡಲಾಗುವುದಿಲ್ಲ. ನಿಮ್ಮಿಂದ ಸಂಗ್ರಹಿಸಲಾದ ಎಲ್ಲಾ ಮಾಹಿತಿಯು ಕಟ್ಟುನಿಟ್ಟಾಗಿ ಗೌಪ್ಯವಾಗಿರುತ್ತದೆ ಮತ್ತು ಕಾನೂನಿನ ಅಗತ್ಯವಿದ್ದಲ್ಲಿ ಹೊರತುಪಡಿಸಿ ಯಾವುದೇ ಹೊರಗಿನವರಿಗೆ ಬಹಿರಂಗಪಡಿಸಲಾಗುವುದಿಲ್ಲ. ಸಂಗ್ರಹಿಸಿದ ಮಾಹಿತಿಯನ್ನು ಸಂಶೋಧನೆಗೆ ಮಾತ್ರ ಬಳಸಲಾಗುತ್ತದೆ. ಈ ಮಾಹಿತಿಯು ನಿಮ್ಮ ಗುರುತನ್ನು ಬಹಿರಂಗಪಡಿಸುವುದಿಲ್ಲ ಮತ್ತು ಮೂಲ ದಾಖಲೆಗಳನ್ನು ನಿಮ್ಮ ವೈದ್ಯರು ಅಥವಾ ನೈತಿಕ ಪರಿಶೀಲನಾ ಮಂಡಳಿಯು ಪರಿಶೀಲಿಸಬಹುದು. ಈ ಅಧ್ಯಯನವು ನೈತಿಕ ಸಮಿತಿಯ ಅನುಮೋದನೆಯನ್ನು ಬಯಸುತ್ತದೆ ಮತ್ತು ಅವರ ಔಪಚಾರಿಕ ಅನುಮೋದನೆಯ ನಂತರವೇ ಪ್ರಾರಂಭಿಸಲಾಗುವುದು.

ಹೆಚ್ಚಿನ ಮಾಹಿತಿಗಾಗಿ,/ಸ್ಪಷ್ಟೀಕರಣಕ್ಕಾಗಿ ದಯವಿಟ್ಟು ಕೆಳಗೆ ನಮೂದಿಸಿದ ನಿವಾಸಿಗಳನ್ನು ಶ್ರೀ ದೇವರಾಜ್ ಅರ್ಸ್ ಅಕಾಡೆಮಿ ಆಫ್ ಹೈಯರ್ ಎಜುಕೇಶನ್ ಅಂಡ್ ರಿಸರ್ಚ್, ತಮಕ, ಕೋಲಾರ - 563101 ನಲ್ಲಿ ಸಂಪರ್ಕಿಸಿ.

ಹೆಚ್ಚಿನ ಮಾಹಿತಿಗಾಗಿ ಸಂಪರ್ಕಿಸಿ

ಡಾ. ಲಕ್ಷ್ಮಿ. ಎಂ ಎಸ್

ಎಸ್ ಡಿ ಯು ಎಮ್ ಸಿ.

ಟಮಕ, ಕೋಲಾರ

ಸಂಪರ್ಕ ಸಂಖ್ಯೆ: 9496197305

lekshmyaravind21@gmail.com

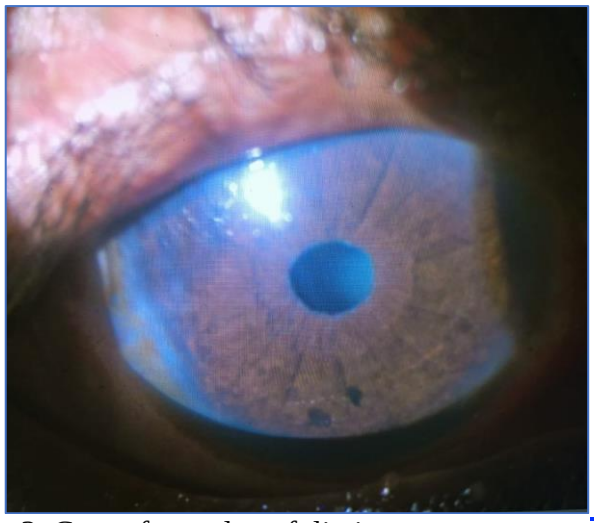
GANT CHART FOR RESEARCH PROJECT PROCESS THROUGH 3 YEAR QUARTERS

Activities	Year 1 (2022)				Year 2 (2023)				Year 3 (2024)	
	1	2	3	4	5	6	7	8	9	10
Define research question										
Literature review										
Protocol preparation										
Refine protocol with supervisor										
Submit protocol ethics approval										
Await study approval										
Data collection										
Finalization of data collection										
Data analysis										
Dissertation and Paper preparation										
Refine dissertation with guide										
Submit article for publication										
Submit dissertation										

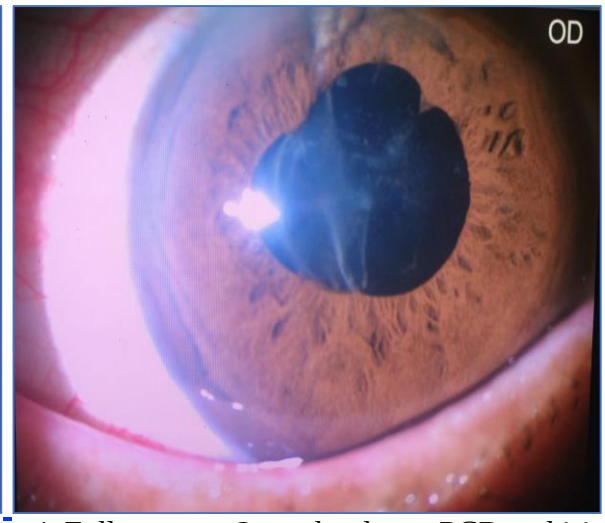
PHOTOGRAPHS

1. Autorefractometry

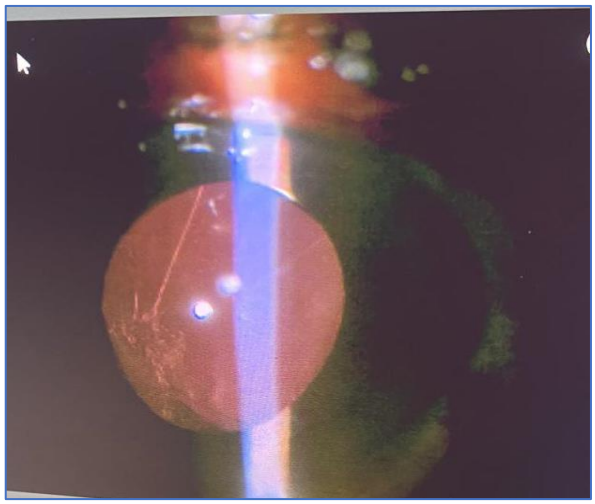
2. A Scan Biometry



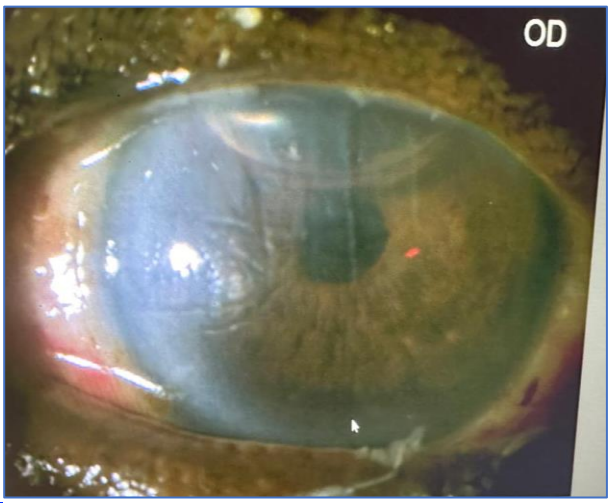
3. Case of pseudo exfoliation



4. Follow-up at 2-weeks shows PCR and iris pigments on IOL



5. Follow-up at 1 week shows PCR



6. Striate Keratopathy

KEY TO MASTER CHART

AL – Axial Length

BCVA – Best corrected visual acuity

CME – Cystoid macular edema

D – Diopter

DM – Diabetes mellitus

HTN – Hypertension

IOL – Intraocular lens

K1 – Vertical corneal curvature

K2 – Horizontal corneal curvature

Log MAR – log of minimal angle of resolution

NS – Nuclear Sclerosis

PC – Posterior capsule

PCR – Posterior capsular rupture

PSC – Posterior Subcapsular Cataract

PXF – Pseudoexfoliation

SE – Spherical equivalent

VA – Visual acuity

MASTERCHART

SL NO	UHID NO	Age	Gender	Eye	Preop VA LogMAR	AL (mm)	K1	K2	Virtual IOL (D)	Actual IOL (D)	Diff	Predicted SE (D)	Postop SD (D)	Diff	STAGE IN WHICH PC RUPTURE				RISK FACTORS FOR PCR					POSTOP BCVA (log			Postop IOP (mmHg)	POSTOPERATIVE COMPLICATION												REMARKS
															Hydrodissection	Nucleus prolapse	Cortical wash	PC polishing	Surgeon	AL > 25mm	PXF	DM	HTN	1 Day	1 week	1 month		Striae keratopathy	Iritis	Secondary glaucoma	IOL decentration	CME	Pigment dispersion	Iris transillumination defects	Endothelial pigment dusting	IOL pigment dusting	IOL decentration	IOL tilt	Iris IOL contact	
1	185997	40	F	RE	0.01	22.23	45	46	21.5	21	0.5	0	0.03	0.03	YES	NO	NO	NO	Consultant	NO	NO	NO	NO	0.2	0.2	0	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
2	178226	64	F	RE	1.8	21.59	45.25	45.5	24.5	24	0.5	0.02	0.05	0.03	YES	NO	NO	NO	Resident	NO	NO	NO	NO	1	1	0.2	14	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
3	178227	65	M	LE	1.8	23.03	43.25	45	20.5	20	0.5	0.02	0.02	0	NO	YES	NO	NO	Resident	NO	NO	NO	YES	0.3	0.2	0.2	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
4	200803	78	F	RE	0.01	23.32	44.25	44.75	20	20	0.5	0	0.02	0.02	NO	YES	NO	NO	Resident	NO	NO	YES	NO	1	0.6	0.5	20	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
5	200805	56	F	RE	1.3	22.19	43.5	45	24	23.5	0.5	0.02	0.75	0.73	NO	NO	YES	NO	Resident	NO	NO	NO	YES	0.6	0.5	0.2	14	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
6	200781	58	F	LE	0.01	22.33	46.75	47.75	20.5	20	0.5	0.01	0.25	0.24	NO	YES	NO	NO	Resident	NO	NO	YES	NO	0.3	0.3	0.2	16	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	
7	204912	65	F	LE	1.3	21.85	44.25	45	24.5	24	0.5	0	0.75	0.75	NO	YES	NO	NO	Resident	NO	NO	NO	NO	0.8	0.6	0.5	14	NO	NO	NO	NO	NO	NO	NO	YES	YES	NO	NO	NO	
8	203488	73	M	RE	0.0016	22.39	43.59	45	23.5	23	0.5	0.01	0.5	0.04	NO	NO	YES	NO	Resident	NO	NO	NO	NO	0.5	0.3	0.2	18	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
9	208425	53	F	RE	0.001	23.33	43.5	44.75	20.5	20	0.5	0.01	0.75	0.74	YES	NO	NO	NO	Resident	NO	NO	NO	NO	0.3	0.3	0.2	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
10	208432	60	F	LE	0.001	23.13	44.5	45.25	20.5	20	0.5	0.02	0.25	0.23	NO	NO	YES	NO	Consultant	NO	NO	NO	YES	0.2	0.2	0	14	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
11	208436	60	F	LE	1.3	22.5	45.75	46.5	21	20.5	0.5	0.02	0.01	0.01	NO	NO	YES	NO	Resident	NO	NO	NO	NO	0.3	0.3	0.3	12	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	
12	188236	87	M	LE	0.0016	23	42.75	42.5	20.5	20	0.5	0.01	0	0.01	NO	NO	YES	NO	Consultant	NO	NO	NO	NO	0.2	0.2	0.2	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
13	258161	70	F	LE	0.01	22.44	43	43.75	20	19.5	0.5	0	0	0	NO	NO	YES	NO	Resident	NO	NO	NO	YES	0	0	0	18	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
14	261017	60	F	LE	1.8	23.42	43	44	20	19.5	0.5	0	0.02	0.02	NO	NO	YES	NO	Resident	NO	YES	NO	NO	0.3	0.3	0	16	NO	NO	NO	NO	NO	NO	NO	YES	YES	NO	NO	NO	
15	247233	74	M	RE	0.01	21.74	46.25	47	23.5	23	0.5	0	0	0	NO	NO	YES	NO	Resident	NO	YES	NO	NO	0.2	0.2	0	18	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
16	248264	64	F	RE	1.5	23.46	44.6	45	18	17.5	0.5	0	0	0	NO	YES	NO	NO	Resident	NO	YES	NO	NO	0.8	0.5	0	16	YES	NO	NO	NO	NO	NO	NO	YES	YES	NO	NO	NO	
17	260113	70	F	LE	1.5	23.35	43.25	44	22	21.5	0.5	0.03	0.01	0.02	NO	NO	YES	NO	Resident	NO	NO	NO	NO	0.3	0.3	0.2	12	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	
18	250235	79	M	RE	0.01	22.04	45.5	45.75	20	19.5	0.5	0.02	0	0.02	YES	NO	NO	NO	Resident	NO	NO	YES	NO	0.2	0.2	0.2	14	NO	NO	NO	NO	NO	NO	NO	YES	NO	YES	NO	NO	
19	246365	70	M	LE	1.8	23.23	43.75	44	22	21.5	0.5	0	0	0	NO	NO	YES	NO	Resident	NO	NO	NO	YES	0.3	0.3	0.3	18	NO	NO	NO	NO	NO	YES	NO	YES	NO	NO	NO	NO	
20	229810	65	F	LE	1.8	23.83	44.75	45	19.5	19	0.5	0.03	0.02	0.01	NO	NO	YES	NO	Consultant	NO	YES	NO	NO	0.3	0.3	0.3	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
21	216963	67	F	LE	1.8	21.16	47.35	48.25	23.5	23	0.5	0.02	0.75	0.73	NO	NO	YES	NO	Resident	NO	NO	NO	NO	0.5	0.2	0.2	16	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	
22	216912	65	M	LE	1.2	23.12	43.35	44.35	19.5	19	0.5	0.02	0.02	0	NO	YES	NO	NO	Resident	NO	YES	YES	NO	0.6	0.2	0.2	14	NO	NO	NO	NO	NO	NO	YES	NO	YES	YES	NO	NO	
23	265600	63	M	RE	0.001	22.46	45	43	22	21.5	0.5	0.02	0	0.02	YES	NO	NO	NO	Resident	NO	YES	NO	NO	0.6	0.5	0.2	12	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
24	265623	72	F	LE	1.5	21.88	47	47.5	22	21.5	0.5	0	0	0	NO	NO	YES	NO	Consultant	NO	NO	YES	YES	0	0	0	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
25	265603	73	F	LE	0.001	23.52	43.5	44.75	19.5	19	0.5	0.02	0.01	0.01	NO	NO	YES	NO	Resident	NO	NO	YES	YES	0.5	0.3	0.2	18	YES	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	
26	270106	57	F	LE	1.5	21.75	45	45.75	25	24.5	0.5	0	0	0	NO	NO	YES	NO	Resident	NO	NO	NO	NO	1	0.6	0.6	20	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
27	273389	67	M	RE	0.01	24.38	44.75	45.75	21	20.5	0.5	0.03	0.01	0.02	NO	NO	YES	NO	Resident	NO	NO	YES	YES	0.3	0.2	0.2	14	NO	YES	NO	YES	NO	NO	NO	NO	NO	YES	NO	NO	
28	275840	78	F	LE	1.3	21.69	45.25	45.75	24.5	24	0.5	0	0	0	NO	YES	NO	NO	Resident	NO	YES	NO	NO	0.2	0	0	12	NO	NO	NO	NO	NO	NO	NO	YES	YES	NO	NO	NO	
29	248264	60	F	RE	1.8	22.7	44.75	45.75	20	19.5	0.5	0.03	0.01	0.02	NO	NO	YES	NO	Resident	NO	NO	YES	YES	0.5	0.2	0.3	18	NO	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	
30	261947	64	M	LE	0.001	22.34	43	44	22	21.5	0.5	0.02	0.01	0.01	NO	NO	NO	NO	Resident	NO	NO	YES	YES	0.3	0.2	0.3	12	NO	NO	NO	YES	NO	NO	NO	NO	NO	YES	NO	NO	
31	286811	80	M	RE	0.01	22.86	42.75	43.75	22.5	22	0.5	0.01	0.01	0	NO	YES	NO	NO	Resident	NO	YES	NO	NO	0.6	0.2	0.2	14	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
32	3E+06	60	F	LE	1.8	22.66	43	43.75	20	19.5	0.5	0	0	0	NO	YES	NO	NO	Resident	NO	NO	NO	NO	0.3	0.3	0.2	12	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO	
33	280809	55	F	LE	1.8	23.93	43.75	44	21.5	21	0.5	0.01	0	0.01	NO	YES	NO	NO	Resident	NO	NO	NO	YES	0.6	0.5	0.3	18	NO	YES	NO	YES	NO	NO	NO	YES	YES	YES	NO	NO	
34	275851	71	F	RE	0.001	21.94	46	46.75	23.5	23	0.5	0	0	0	YES	NO	NO	NO	Resident	YES	NO	NO	NO	0	0	0	16	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	
35	267357	49	F	LE	1.8	21.45	47.75	49.25	22	21.5	0.5	0.02	0.01	0.01	YES	NO	NO	NO	Resident	NO	NO	YES	NO	0.5	0.3	0.3	12	NO	YES	NO	NO	YES	NO	NO	YES	NO	NO	NO	NO	
36	267374	82	M	RE	1.8	22.97	42.75	44.75	22	19.5	0.5	0.02	0.01	0.01	YES	NO	NO	NO	Consultant	NO	YES	NO	NO	0.8	0.2	0.3	16	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
37	289828	58	F	LE	1.5	22.07	44	44.25	24.5	24	0.5	0.01	0	0.01	NO	NO	NO	NO	Resident	NO	NO	NO	NO	0.5	0.2	0.2	14	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	
38	292231	73	F	RE	1.5	23.47	43.5	43.75	21	20.5	0.5	0.02	0.01	0.01	NO	YES	NO	NO	Resident	NO	YES	NO	NO	0.8	0.2	0.2	20	YES	NO	NO	YES	YES	NO	NO	NO	NO	YES	NO	NO	
39	285256	60	M	RE	1.3	22.2	44.75	45.5	23	22.5	0.5	0	0	0	NO	NO	YES	NO	Consultant	NO	NO	NO	YES	0.2	0.2	0	14	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
40	289821	63	M	LE	1.5	22.5	43.75	44	23.5	23	0.5	0.03	0.01	0.02	NO	NO	YES	NO	Consultant	NO	YES	NO	NO	0.2	0.2	0.2	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
41	58719	60	F	LE	1.8	21.96	46.25	47.75	22	19.5	0.5	0	0	0	NO	NO	YES	NO	Resident	NO	NO	YES	YES	0.3	0.3	0.2	14	NO	YES	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	
42	294889	75	M	LE	1.5	21.92	45.75	46.25	23	22.5	0.5	0.02	0	0.02	NO	NO	NO	NO	Resident	NO	NO	YES	YES	0	0	0	12	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
43	311625	81	M	LE	1.5	22.76	45	45.95	20.5	20	0.5	0.01	0	0.01	NO	NO	YES	NO	Resident	NO	NO	NO	NO	0.2	0.2	0.2	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
44	315847	68	F	LE	1.5	22.33	45.25	46.25	22	21.5	0.5	0.02	0.01	0.01	NO	NO	NO	NO	Resident	NO	NO	NO	NO	0.2	0.2	0.2	14	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	

45	297887	53	M	RE	0.8	22.85	43.75	45	21.5	21	0.5	0.01	0	0.01	NO	YES	NO	NO	Consultant	NO	NO	NO	YES	0	0	0	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
46	297877	70	F	RE	1.8	24.14	44.5	46.75	16	15.5	0.5	0.01	0.02	0.01	NO	NO	YES	NO	Consultant	NO	NO	NO	NO	0	0	0	12	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
47	328952	55	F	LE	1.8	23.54	42.5	42.75	21.5	21	0.5	0.01	0.01	0	NO	NO	YES	NO	Resident	NO	NO	YES	YES	0.3	0.3	0.2	13	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	
48	348159	77	F	LE	1.5	21.9	45	46.5	24	23.5	0.5	0.01	0.01	0	NO	NO	YES	NO	Resident	NO	NO	NO	NO	0.2	0.2	0.2	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
49	345052	50	F	RE	1.8	21.05	47.75	48.25	24	23.5	0.5	0	0	0	NO	NO	YES	NO	Resident	NO	NO	NO	NO	0.2	0.2	0	12	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
50	339105	59	F	RE	0.01	23.14	44	45	20.5	20	0.5	0	0	0	YES	NO	NO	NO	Consultant	NO	YES	NO	NO	0.3	0.2	0	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
51	344514	43	F	RE	0.01	21.91	44.75	45.5	24	23.5	0.5	0.02	0.01	0.01	YES	NO	NO	NO	Consultant	NO	NO	NO	NO	0.2	0	0	14	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
52	344309	72	F	RE	1.3	21.79	45.75	46.5	23.5	23	0.5	0.02	0	0.02	NO	YES	NO	NO	Resident	NO	YES	YES	YES	0.8	0.8	0.8	18	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	YES	
53	324523	60	F	RE	0.8	22.6	43.75	44	23	22.5	0.5	0.02	0.01	0.01	NO	YES	NO	NO	Resident	NO	NO	NO	NO	0.3	0.3	0.3	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	YES	
54	324031	52	F	LE	1.5	21.83	48	48.75	19.5	19	0.5	0	0	0	NO	NO	NO	NO	Resident	NO	NO	NO	NO	0	0	0	14	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
55	324036	50	F	LE	0.001	24.19	41.75	42.75	20	19.5	0.5	0.01	0.01	0	NO	NO	YES	NO	Consultant	NO	NO	YES	NO	0.2	0	0	12	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
56	342910	55	F	RE	1.5	23.25	41.25	41.75	23.5	23	0.5	0	0	0	NO	NO	YES	NO	Resident	NO	NO	NO	NO	0.2	0	0	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
57	350349	57	M	LE	1.5	22.76	44.25	45	21.5	21	0.5	0.01	0	0.01	NO	YES	NO	NO	Resident	NO	NO	YES	NO	0.3	0.3	0.3	18	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO	NO	
58	358529	52	F	LE	1.5	22.43	43.75	44.5	23.5	23	0.5	0.02	0.01	0.01	NO	NO	NO	NO	Resident	NO	NO	NO	YES	0.3	0.2	0.2	12	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
59	328926	54	F	RE	0.001	20.63	47.5	48	26.5	26	0.5	0.01	0.01	0	NO	YES	NO	NO	Resident	NO	NO	NO	NO	0.2	0.2	0.2	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
60	342211	75	M	LE	1.5	22.96	43.25	44	21	20.5	0.5	0	0	0	YES	NO	NO	NO	Resident	NO	NO	YES	YES	0.5	0.3	0.3	18	NO	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
61	344514	43	F	RE	0.001	21.91	44.75	45.5	24	23.5	0.5	0	0	0	NO	NO	YES	NO	Consultant	NO	NO	NO	NO	0	0	0	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
63	361236	63	F	RE	1.5	23.19	44.75	45.75	19.5	19	0.5	0.02	0.01	0.01	YES	NO	NO	NO	Resident	NO	NO	NO	NO	0.3	0.2	0.2	14	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
64	361245	35	F	RE	0.0016	22.81	43.75	44.5	22	21.5	0.5	0.01	0	0.01	NO	NO	YES	NO	Resident	NO	NO	NO	NO	0.3	0.2	0.2	12	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
65	348993	75	F	LE	0.001	21.89	46	47.5	22.5	22	0.5	0.02	0	0.02	NO	NO	YES	NO	Resident	NO	NO	YES	YES	0.8	0.8	0.8	14	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
66	324239	58	M	RE	0.8	22.51	44.25	45.25	22.5	22	0.5	0	0	0	NO	NO	YES	NO	Resident	NO	NO	NO	NO	0	0	0	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
67	361112	80	F	LE	1.8	22.68	44	45.25	22	21.5	0.5	0.01	0	0.01	NO	NO	NO	NO	Resident	NO	NO	NO	NO	0.3	0.3	0.3	18	NO	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
68	324031	52	F	LE	1.5	22.91	46	46.75	19.5	19	0.5	0	0	0	NO	NO	YES	NO	Resident	NO	NO	YES	NO	0	0	0	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
69	344309	72	F	RE	1.3	21.79	45.75	46.5	23.5	23	0.5	0	0	0	NO	NO	YES	NO	Resident	NO	NO	NO	NO	0	0	0	14	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
70	308511	55	F	RE	1.8	22.27	43.25	44.75	24	23.5	0.5	0.02	0.01	0.01	NO	YES	NO	NO	Consultant	NO	YES	NO	YES	0.8	0.5	0.5	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
71	359730	60	F	RE	1.5	21.59	44.5	45.5	25.5	25	0.5	0	0	0	NO	NO	YES	NO	Resident	NO	YES	YES	NO	0.3	0.3	0.3	14	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
71	358886	64	F	RE	0.8	21.67	46.5	47.25	23	22.5	0.5	0	0	0	NO	NO	YES	NO	Resident	NO	NO	NO	NO	0	0	0	12	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
73	361214	60	F	RE	1.2	22.18	42.5	43.25	25	24.5	0.5	0.01	0.02	0.01	YES	NO	NO	NO	Resident	NO	NO	NO	NO	0.3	0.2	0.2	14	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
74	334891	76	F	RE	1.8	23.04	44.75	45.25	20.5	20	0.5	0.02	0.01	0.01	NO	NO	YES	NO	Resident	NO	NO	YES	YES	0.5	0.3	0.3	12	NO	NO	NO	NO	YES	NO	NO	NO	NO	YES	NO	NO	
75	333357	64	F	RE	0.001	20.9	46.25	47	25.5	25	0.5	0.01	0.01	0	NO	YES	NO	NO	Resident	NO	NO	YES	NO	0.8	0.8	0.5	16	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
76	317706	60	F	RE	1.8	21.76	45.5	46	24	23.5	0.5	0	0	0	NO	NO	YES	NO	Resident	NO	NO	NO	NO	0.2	0.2	0.2	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
77	342916	63	F	RE	1.5	22.7	43.75	44.75	22.5	22	0.5	0	0	0	NO	NO	YES	NO	Resident	NO	NO	NO	NO	0	0	0	16	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	