Dissertation on

"COMPARISON OF SHORT TERM CLINICAL RESULTS FOLLOWING IMPLANTATION OF ACRYLIC FOLDABLE INTRAOCULAR LENS AND POLYMETHYL METH ACRYLATE RIGID INTRAOCULAR LENS IN PATIENTS WITH DIABETES MELLITUS"

Submitted in partial fulfillment of requirements of

M. S. DEGREE

BRANCH – III (OPHTHALMOLOGY)

GOVT. RAJAJI HOSPITAL &

MADURAI MEDICAL COLLEGE

MADURAI

The Tamilnadu Dr. M. G. R. Medical University

CHENNAI, TAMIL NADU

APRIL 2015

Madurai-20, 23.09.2014

CERTIFICATE

This is to certify that this dissertation titled **"COMPARISON OF SHORT TERM CLINICAL RESULTS FOLLOWING IMPLANTATION OF ACRYLIC FOLDABLE INTRAOCULAR LENS AND POLYMETHYL METH ACRYLATE RIGID INTRAOCULAR LENS IN PATIENTS WITH DIABETES MELLITUS"** is a bonafide record of research work done by **Dr. P. SHARMILA,** Post Graduate Resident in the Department of Ophthalmology, Madurai Medical College, Madurai.

She has submitted this in partial fulfillment of the regulations laid down by "The Tamil Nadu Dr. M. G. R. Medical University" for award of Master of Surgery Degree, Branch III (Ophthalmology), under our guidance and supervision, during the academic years 2012 - 2015.

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CERTIFICATE FROM GUIDE

This is to certify that this dissertation entitled **"COMPARISON OF SHORT TERM CLINICAL RESULTS FOLLOWING IMPLANTATION OF ACRYLIC FOLDABLE INTRAOCULAR LENS AND POLYMETHYL METH ACRYLATE RIGID INTRAOCULAR LENS IN PATIENTS WITH DIABETES MELLITUS"** is a bonafide record of research work done by **Dr. P. SHARMILA,** Post Graduate Resident in Department of Ophthalmology, Madurai Medical College, Madurai.

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The Ethics Committee meeting of the Madurai Medical College, Madurai was held on 25th April 2014 at 10.00 Am to 12.00 Noon at Auditorium Hall at Govt. Rajaji Hospital, Madurai . The following members of the Ethical Committee have attended the meeting.

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Please note that the investigator should adhere the following: She/He should get a detailed informed consent from the patients/participants and maintain it confidentially.

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Chairman

To
The above Applicant
-thro. Head of the Department concerned

DECLARATION

I, **Dr. P. SHARMILA** solemnly declare that this dissertation titled **"COMPARISON OF SHORT TERM CLINICAL RESULTS FOLLOWING IMPLANTATION OF ACRYLIC FOLDABLE INTRAOCULAR LENS AND POLYMETHYL METH ACRYLATE RIGID INTRAOCULAR LENS IN PATIENTS WITH DIABETES MELLITUS"** was done by me.

I also declare that this bonafide work / a part of this work were not submitted by me / anyone else, for any award, for Degree / Diploma to any other University / Board either in India / abroad. This is submitted to The Tamilnadu Dr. M. G. R. Medical University, Chennai in partial fulfillment of the rules and regulation for the award of Master of Surgery Degree Branch -III (Ophthalmology) to be held in April 2015.

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PLACE : Madurai

DATE :

ACKNOWLEDGEMENT

My sincere thanks to **Capt. Dr. SANTHAKUMAR M. Sc (FM)., MD FM, PGDMLE., DNB(FM)** the Dean , Madurai Medical College, for allowing me to utilize the institutional facilities to do this dissertation.

I express my gratitude to **Dr. P. THIYAGARAJAN M.S, D.O.,** Professor and HOD of Ophthalmology, Government Rajaji Hospital and Madurai Medical College, Madurai, for permitting me to conduct and complete this study. I also owe my thanks to our Associate Professor **Dr. S. V. CHANDRAKUMAR M.S, D.O.,** for his support and encouragement to me in performing this study.

I thank **Dr. S. VADIVEL MURUGAN M.D (Gen. Med.)** Professor and HOD of Diabetology for permitting me to conduct this study in Diabetic patients.

I have great pleasure in thanking my beloved guide **Dr. N. PARVATHASUNDARI M.S, D.O.,** Senior Assistant Professor of Ophthalmology and all my **ASSISTANT PROFESSORS** for thier valuable guidance and encouragement throughout this study period.

I am grateful to the staff of department of Ophthalmology and Diabetology and my fellow post graduate colleagues for their valuable help throughout this study.

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PART- ONE

INTRODUCTION

Cataract is the most common cause of blindness worldwide and in our country also. In addition to the backlog, an additional 3.8 million people become blind each year because of cataract.

To improve the visual outcome, cataract surgery has evolved from couching in ancient times to modern day phacoemulsification and Manual Small Incision Cataract Surgery (MSICS).

Cataract surgery using current phaco techniques offers a number of attractive benefits to both the surgeon and the patient. The principle advantage is a smaller incision size, which decrease the amount of tissue injury, reduces the amount of post-operative pain and inflammation and provides more rapid refractive stabilization with less astigmatism than other procedures performed before. Hence this study is being done by using this technique.

Sir Harold Ridley first introduced IOL implantation in 1949.He was the first to successfully implant an IOL.

The Anterior chamber lenses which were once used were replaced with iris support lenses and later to today's modern posterior chamber lenses. There are a variety of modifications in materials, loops, optics and finish in all these lenses.

The modern cataract surgery has given good visual results, but this could deteriorate over times because of Posterior Capsule Opacification (PCO) which is the most frequent complication after cataract extraction which can occur in up to 50% of cases, resulting in poor light transmission and reduced visual acuity.

PCO can be treated by Nd: YAG (neodymium-doped yttrium aluminum garnet) laser capsulotomy, which, however, can cause adverse complications such as retinal detachment, endophthalmitis, intraocular pressure rise, cystoid macular edema, and damage to intraocular lens (IOL).

In developing countries, laser treatment is often not available. Moreover it is a financial burden to the patient. Posterior capsule opacification often disturbs fundus examination and optimal treatment by photocoagulation or vitrectomy in eyes with vitreo-retinal disorders. Socio-economic consequences are also enormous. Thus resolution of posterior capsule opacification is an urgent task in cataract surgery.

Lens epithelial cells (LECs) left behind in the capsular bag after cataract extraction is mainly responsible for the development of posterior capsule opacification.

The Intra Ocular lens materials that is used to make IOLs, also influences the development of Posterior Capsule Opacification. It can also cause some early post-operative complications like corneal edema, distorted pupil, irido corneal adhesions, iris capture, choroidal detachment, hyphema, cystoid macular edema, uveitis, fibrin reaction and late complications like lens deposits and posterior synechiae.

In modern cataract surgery it is essential to discuss the intraocular lens (IOL)'s of choice and their merits. Selecting the correct lens implant (size of optic, chemical material, foldable vs. non- foldable, mono vs. multifocal) may play a more important role in the patient’s final visual outcome and satisfaction than the specific technique used for phacoemulsification of the nucleus.

So recent work worldwide attempting to eliminate the development of PCO is focusing on several strategies. That includes:

- Improving surgical techniques
- Intraocular lens materials
- IOL design
- Using continuous curvilinear capsulorrhexis(CCC)
- Complete cortical clean up and in-the-bag fixation of intraocular lens.

Hence intraocular lens material is one of the influencing factors in the development of posterior capsule opacification (PCO), this study is being done to evaluate the development of posterior capsular opacification, after implantation of Acrylic foldable and rigid PMMA intraocular lens materials.

CATARACT AND DIABETES

CATARACT:

Cataract is one of the most common causes of low vision in the world. Etymologically, *cataracta* is a Latin word meaning “waterfall” (Water that runs down a waterfall appear to be white) used metaphorically to describe the pathology of ocular opacities.

A cataract is a clouding of the normally clear and transparent lens of the eye, which may prevent a clear image from forming on the retina. The risk of developing cataracts is multifactorial from UV radiation, smoking, alcohol, diet, diabetes, congenital, traumatic to old age.

Cataracts may be classified according to age of onset, morphology, grade of opacification, and maturity.

Age of onset

Cataracts may be congenital, juvenile or presenile, or age related (senile).

Morphology

Cataract morphology may be divided into fiber based (pattern relates to anatomical structure of the lens) or nonfiber based (a more

random distribution). Fiber-based cataracts may be divided into sutural (pattern relates to lens sutures) and non-sutural types.

Grading of cataract:

Grading systems have been designed that aim to quantify the degree of opacification. These vary from simple assessment by direct ophthalmoscopy to more sophisticated methods such as the **Lens Opacities Classification System III (LOCS III)**, where slit-lamp examination is compared to a standard set of photographs (separate set for nuclear, cortical, and posterior sub capsular).

Senile cataracts are a natural ageing process of the crystalline lens, and result from structural aberration of the proteins that account to one third of the lenses weight. One of the major proteins present within the lens is alpha crystalline, offering the lens its clarity and refractive power.

These proteins, some of which are insoluble, increase in size and molecular weight with age and can aggregate together and so the lens eventually loses transparency.

CATARACT IN DIABETIC PATIENTS:

Diabetes mellitus can affect the lens clarity, the refractive index and accommodative amplitude. There is a synergistic increase of aqueous

glucose concentration, (thereby the lenticular concentration) with an increase in serum glucose.

A considerable fraction of glucose is converted to sorbitol, by aldose reductase and is metabolized slowly by the lens and gets accumulated in lenticular cytoplasm thus increasing the osmotic pressure causing an influx of water, leading to hydrops of the lens fibers affecting the refractive power of the lens.

Transient refractive changes owing to large changes in their blood glucose level are not uncommon in uncontrolled diabetics. Acute myopic shifts may indicate undiagnosed or poorly controlled diabetes.

People with diabetes have decreased amplitude of accommodation and so presbyopia may set at an earlier age in patients with diabetes than in those without.

Acute *diabetic cataract*, or *snowflake cataract*, consists of bilateral, widespread sub capsular lens changes of sudden onset, evidently in young people with uncontrolled diabetes mellitus.

Multiple gray white sub capsular opacities that have a snowflake appearance are seen in the superficial anterior and posterior cortex where vacuoles and clefts are formed. Intumescence and maturity of the cortical cataract follow shortly thereafter.

Diabetic patients are prone to get lens changes as their counterparts who are free of the disease, except that they have it early. The frequency of cataract surgery is higher in diabetic eyes and diabetic patients require surgery at an earlier age. Diabetes mellitus is considered to be a risk factor for many complications; therefore the diabetic patient undergoing cataract surgery has a guarded prognosis.

Because of the increasing diabetic retinopathy, both in incidence and severity, we provide special emphasis to this, in considering cataract surgery in complex cases. Cataract and retinovascular complications often co-exist in diabetic patients presenting problems in determining the cause of decreased vision.

Cataract surgery can also result in rapid progression of diabetic retinopathy that may need treatment with photocoagulation. Rarely retinopathy can cause cataracts. An example would be prolonged vitreous cavity hemorrhage that results in a partial opacification of the lens. (Very high risk proliferative diabetic retinopathy)

Evaluating Diabetics Prior to Cataract Surgery:

Clinically significant macular edema (CSME) and less obvious macular changes in non-proliferative retinopathy may be the cause of decreased vision in addition to the cataract.

Detailed history when evaluating the cause of visual deterioration can target this issue. This can be helpful in deciding the prognosis of visual improvement after the procedure and in evaluating the role and impact of retinovascular disorders in impeding the betterness of vision post operatively and hence dilated fundus examination is mandatory.

Cataract surgery not only results in rapid progression of diabetic retinopathy, but also complicates the intra-operative and post-operative period.

Possible complications of cataract surgery in patients with Diabetes:

1. Delayed epithelization
2. Bleeding
3. Possible effect on diabetic retinopathy
4. Insufficient wound closure
5. Poor dilatation
6. Infection & iritis
7. Increased blood sugar caused by steroids
8. Rupture of the lens capsule
9. zonular dehiscence

Retained lenticular material ensures inflammation, further accelerating this process. It is important to maintain an intact posterior lens capsule, and as well, an easily dilatable pupil through which laser treatment of fundus can be performed.

Cataract surgery has become a safe procedure even for diabetics despite humpty of post-operative complications, due to improved surgical techniques.

Diabetics without retinopathy achieved visual results comparable to those of non-diabetic controls. The blood-aqueous as well as blood-retinal barrier damage in diabetic eyes are likely to pose an increased risk of PCO as such damage might stimulate LECs leading to a marked anterior capsule contraction, fibrosis and hence a higher rate of PCO.

Hence this study is being done to evaluate the development of posterior capsular opacification in diabetic patients.

DEVELOPMENT OF LENS

At 4mm embryo stage: The lens placode is formed from the surface ectoderm, which is in direct contact with the neural ectoderm, forming the optical vesicle, approximately at 27 days of gestation.

At 5mm embryo stage: At 29 days of gestation, the lens pit appears as an indentation, (infolding) the lens placode. This lens pit deepens and invigilates to form the lens vesicle.

At 9mm embryo stage: Further invagination of lens placode inside the optic cup and separation from the surface ectoderm occurs. After separation from the surface ectoderm the lens appears as a hollow sphere approximately 0.2mm in diameter, with a single layer of columnar cells outlining the wall. A basal wall envelops the vesicle and a thin basal lamina is synthesized that thickens to form the lens capsule.

10mm – 13mm embryo stage: The lens changes from circular to an oval-like shape.

The primary lens fibers make up the embryonic nucleus. The secondary lens fibers are laid down by the active equatorial cells of the anterior epithelium throughout life.

Between the 3rd and 8th month of gestation these fibers reach to both, the anterior and the posterior pole to form the **Foetal nucleus** which surrounds the **embryonic nucleus**. The fibers of the fetal nucleus meet at suture lines that appear as an erect **Y** anteriorly and an inverted **Y** posteriorly.

Secondary lens fibers laid down between the last month of gestation and puberty forms the **infantile nucleus**. The fibers formed after puberty constitutes the **Adult nucleus.** The most recent, superficial fibers form the **cortex.**

When a cell at the equator region slowly differentiates into a fiber it elongates with the anterior stretching towards the anterior epithelium and posterior towards the posterior wall. This process continues throughout life meaning the lens grows with age.

The zonules develop from the neuro ectoderm in the ciliary area between the 3rd and 5th month of gestation.

ANATOMY OF THE LENS

The crystalline lens is a transparent, symmetrically biconvex structure that functions to maintain its own transparency, by refracting the beam of light that traverses the eye and by aiding in accommodation.

- The lens is biconvex, with the posterior surface having the steeper curve.
- The *anterior* radius of curvature measures 8 to 14μm.
- The *posterior* surface radius of curvature measures 5 to 8μm.
- Poles-The centers of the anterior and posterior surfaces.
- The lens thickness is the distance from the anterior to posterior pole.
- The thickness of the unaccommodated lens is 3.5 to 5 mm and it increases 0.02 mm each year throughout life.
- The lens diameter is the nasal to temporal measurement and in the infant is 6.5 mm. The diameter reaches 9 mm during the teenage years and does not change significantly, although some report a small age-related increase in diameter.
- The equator is the largest circumference of the lens at a location between the two poles.

In the unaccommodated state, lens refractive power is + 20 diopters (D). The lens power increases in accommodation, with the maximum accommodative amplitude, + 14 D, reached between ages 8 and 12 years. Accommodative power decreases with age, approaching zero after 50 years.

Weight of the lens

Birth: 90 mg; Adult: 255 mg

The human lens has no vasculature or innervation after fetal development, and it depends entirely on the aqueous humor to meet both its anabolic and catabolic pathways. Lens lies posterior to the iris and anterior to the vitreous body.

It is maintained in position by the zonules of Zinn, the delicate, yet strong fibers that support and attach it to the Ciliary body. It mainly comprises of capsule, lens epithelium, cortex, and nucleus.

In the lens, anterior and posterior poles are joined by an imaginary line called the *optic axis,* which passes through them. *Meridians* are lines that pass from end to the other on the lens surface.

The Lens Capsule

- The capsule of the lens is an elastic basement membrane that envelops the entire lens. It is thickest on the anterior and posterior surfaces close to the equator measuring about 20 micron, and thinnest at the posterior pole measuring about 3 micron.
- The thick Basement membrane is formed by the lens epithelium anteriorly and by the superficial lens fibres posteriorly.

Zonular Fibers

Suspensory ligaments of the lens form the bridge between the lens and the ciliary body. These are composed of muco polysaccharides and glycoproteins. Its chemical nature permits enzymatic degradation.

Four broad subdivisions of zonular apparatus:

1. Pars orbicularis-part lying over the pars plana.
2. Zonular plexus-between the ciliary processes.
3. Zonular fork
4. Zonular limbs

The zonular fibers insert on the anterior, equatorial and posterior parts of the lens capsule. As the zonular fibers insert on the lens capsule a

narrow space is created around the equator which is called the canal of Hanover.

These zonular fibers insert, anteriorly 1.5 mm onto the anterior capsule and posteriorly 1.25 mm onto the posterior capsule.

The Lens Epithelium

Immediately behind the anterior lens capsule is a single layer of metabolically active epithelial cells. These cells are and carry out all normal cell activities, including the biosynthesis of nucleotides, protein, and lipid; adenosine triphosphate to meet the energy demands of the lens.

The epithelial cells are mitotic, with the greatest activity occurring in a ring around the anterior lens known as the *germinative zone* where the premitotic DNA synthesis occurs.

There is a cellular migration towards the equator, where differentiation into fibers takes place. As the epithelial cells migrate toward the bow region of the lens, they begin the process of terminal differentiation into lens fibers.

The most notable morphologic change occurs when the epithelial cells elongation for the formation of lens fiber cells. This change is associated with a tremendous increase in the intracellular protein mass in

the membranes of each fiber cell. At the same time, the cells lose organelles and the loss of these organelles is optically advantageous because light passing through the lens is no longer absorbed or scattered by these structures.

However, because these new lens fiber cells lack the metabolic functions previously carried out by the organelles, they are now dependent on glycolysis for production of energy.

Nucleus and Cortex

There is no cellular loss inside the lens but only as new fibers are laid down, there is crowding and compacting of the previously formed fibers, with the oldest layers at the center. The oldest of these, the *embryonic* and *fetal lens nuclei*, were produced in embryonic life and persist in the center of the lens. The cortex is formed by the outermost, newly laid lens fibers.

Lens sutures are formed by the inter digitations of apical cell processes *(anterior sutures)* and basal cell processes (*posterior sutures).* In addition to the **Y**-sutures located within the lens nucleus, multiple optical zones are visible by slit-lamp bio microscopy.

PHYSIOLOGY & BIOCHEMISTRY OF LENS

Throughout life human lens grows. Metabolism is chiefly anaerobic through the glycolytic pathway. Only 3%of the glucose utilization is aerobic, via Krebs cycle. Pentose shunt pathway is involved in RNA synthesis.

The lens capsule is normally under tension, so when cut or ruptured its edges roll out and then curl up. This property of elastic recoil is used during Nd: YAG-capsulotomy.

Water constitutes 65%of the lens weight. Proteins constitute 34%of the total weight of an adult lens.

ACCOMODATION

When an emmetropic eye is viewing a distant object, the ciliary muscle is relaxed, and the zonules are in a stretched configuration exerting tension on the lens capsule holding the lens in the unaccommodated state, such that the image lies on the retina.

When a near object is to be focused on the retina, an increase in the refractive power of the eye must occur. This increase in power is called accommodation and is accomplished by a change in lens shape brought about by contraction of the ciliary muscle the zonules are in a relaxed

configuration. Von Helmholtz is credited with determining that the following occur during accommodation:

1. Lens thickness increases anterior to posterior.

2. The lens thins along the equator.

3. Forward movement of the anterior lens surface and makes the anterior chamber shallower.

4. There is no change in the position of the posterior pole.

Transparency is a function of avascularity of lens, regular arrangement of fibers, and the short distance between components of differing indices relative to the light wavelength.

INTRAOCULAR LENSES

Intra ocular lenses are artificial lenses that are implanted inside the eye to compensate the refractive loss of lens removal during cataract surgery.

The evolution of intraocular lenses (IOLs)

Pre-IOL era: For those who underwent surgical removal of cataracts, adjusting to aphakia was a necessary side effect. Patients traded in their cataractous lenses for "Coke bottle bottom" spectacles.

SIDE EFFECTS OF THESE APHAKIC SPECTACLES:

- Causes a ring scotoma between 40 and 60 degrees
- Markedly constricted visual field
- Lack of stereopsis
- Spherical aberrations
- Problems of false orientation
- Difficulty with coordination

The 18th century Italian adventurer and paramour Casanova described in his memoirs a conversation he had in 1766 with an oculist named Tadni. Tadni purportedly showed Casanova a box of lenses he intended to

implant “under the cornea in the place of the crystalline lens.” It is unclear whether or not Tadni actually performed such a procedure.

Casaamata, the Court Eye Doctor of Dresden, around 1795, inserted a glass into an eye at the time of cataract surgery, and it immediately sank back toward the posterior pole.

Ridley Era

On 29 Nov 1949, Ridley carried out his first lens implantation on a 45-year-old woman, after he performed an ECCE. The IOL material consisted of poly methyl methacrylate (PMMA, Plexiglas), of diameter 8.32mm, 2.40mm thickness, weight in air was 112mg and power +24D.

During World War II Ridley treated pilots with perforated foreign body injuries to the eyes that had occurred through splinters of the Plexiglas domes in the cockpits. He learned that these splinters remained relatively inert in the internal eye. Ridley’s IOLs were sterilized by using 1%cetrimide solution. This cetrimide molecules were adherent to the IOL and later release, causing the inflammation.

Modifications of implantation techniques were introduced in the early 1950s by Parry, while Epstein used this time to modify lens designs. Apple coined the phase of the foremost IOL implantations which lasted from 1949 to the mid-1950s (Generation I) of the development of IOLs.

Baron and Strampelli Era :(1952-1962)

One of the most common complications of the Ridley's lens was its tendency to dislocate into the vitreous. Its frequency was 13%. So Baron, in France, considered a new implantation site: the anterior chamber, with fixation of the lens in the angle recess. The IOL was made of PMMA. Because of its steep anterior curve it caused endothelial cell loss, corneal decompensation, pseudo phakic bullous keratopathy, and corneal opacification. So he changed a huge convexo-concave design of IOL into Plano-convex design.

To 'humanize' IOL before implantation, Strampelli of Rome placed IOLs into the patient earlobes for 3 to 4 months. He has been credited with originating the anterior chamber IOL. Various modifications made by Dr. Peter Choyce and later by Dr. Charles Kelman.

Binkhorst Era

In the 1950s, Cornelious Binkhorst designed an iris fixated lenses, which had four closed loops, 2 in front and 2 behind, iris clip IOL, in an attempt to lower the complication rate of ACIOLs. For this, Epstein created a Maltese cross-shaped lenses, Worst used a suture or a metal clip for fixation.

Fyodorov, modified these IOL in 1964, by rotating the posterior loops so that they were 90 degrees to the anterior loops, lessened the likelihood of pupillary block. Because of its “antennae” appearance it was called the Fyodorov Sputnik lens. The lens weighed only 0.9mg in aqueous.

In 1969-Worst modified the iris clip IOL by adding either a suture or a metal clip(iris claw lens). Complications of these IOLs were pupillary distortion, iris chaffing, cystoid macular edema.

Mark and Kelman Era(1963-1990)

These are intermediate ACIOLs. It was made up of flexible loops with multiple point fixations. These IOLs were more stable with lesser complications.

Various designs:

Choice, Mark VIII, Mark XI, Flexible loop ACIOL, Kelman II lens, Kelman flexible tripod IOL, Kelman multiplex 4 point fixation lens.

Posterior chamber Era (1975-1990)

These were improved PCIOLs. First uni planar posterior chamber lens was implanted in 1975 by John Pierce. It had rigid tripod design.

In early 1977 Steven Shearing introduced a major design of PCIOL with an optic with two J shaped loops.

Modifications:

- William Simcoae-C looped PCIOL
- Eric Arnott-one piece PMMA PCIOL

Modern intraocular lens Era(1990-Present)

These are modern capsular lenses. The IOLs in these groups are:

- Rigid PMMA
- Soft foldable
- Multifocal IOL
- Phakic IOL
- Aspheric IOL
- Accommodative IOL
- Modern ACIOL
- Toric IOL

Characteristics of an ideal IOL

1. High optical quality
2. Light weight
3. High index of refraction
4. Durability
5. Ease of manufacture
6. Ease of sterilization
7. Lack of carcinogenicity
8. Lack of antigenicity
9. Lack of inflammatory reaction

Classification of IOLs

Based on the method of fixation

1. Anterior chamber IOLs.
2. Iris supported IOLs.
3. Posterior chamber IOLs:
    - In the bag or capsular fixated.
    - Sulcus fixated.

Based on the material used

- Rigid PMMA IOL
- Foldable IOL-Acrylic
- Silicone IOL

Based on the focusing ability

- Mono focal IOL
- Multifocal IOL
- Accommodative IOL

Based on interaction with water: (hydrophilic or hydrophobic)

Based on design: (one piece or three piece; spherical or toric; rounded or square-edged).

Recent: Drug delivered IOLs- releasing antimetabolites, steroids, and anti VEGF.

INTRAOCULAR LENS MATERIALS

1. PMMA (POLYMETHYLMETHACRYLATE) IOLs

- Methyl meth acrylate monomer forms the PMMA polymer.
- Monomer production starts with the reaction of acetone with hydrogen cyanide and then sulfuric acid. The resulting meth acrylamide sulfate is reacted with methanol to yield this monomer.
- Monomer excess or release from PMMA may be toxic to tissues. This monomer may repolymerize or dissolve in water so that it is unlikely to reach high concentration in ocular tissues. Release of this toxic monomer happens when the Nd-YAG laser energy levels higher than 5Mj is used for capsulotomy.
- **Various forms of PMMA**

-High molecular weight (2.5 to 3.0 million Daltons): lathe-cut or compression molded IOLs. Lower molecular weight (80,000 to 1, 40,000 Daltons): injection-molded.

- It's a hard, transparent material; require larger incision for its insertion.
- Because of its light weight, durability, clarity it is most widely used.
- Refractive index is1.49.
- **Sterilization:** This material is durable, with a high resistance to aging and to changes in the climate. Cannot be autoclaved and is commonly sterilized by ethylene oxide gas sterilization. It is washed with Ringer Lactate solution before implantation.
- It is relatively inert and does not degrade within the eye or induce leukocyte chemo taxis. Careful polishing and surface coating with heparin will reduce the rate of inflammation.
- An eye with PMMA lens was more susceptible to retinal damage from UV radiation. To solve this problem additives ("UV chromophores") like benzotriazole and benophenones are added, which can absorb light up to 400nm.
- $<100^{o}$ Celsius- it is hard; $>140^{o}$ Celsius- it can melt.

- One piece lens-both optic and haptic is made up of same material, multi piece lens- optic and haptic is made up of different material.(eg:prolene).
- Optic size 4.5 to 7mm. Advantage of larger optic size-limited optical aberration, minimal pupillary capture and decentration
- Loop models- J, Y, and modified C loop with angulation 3 to 10^{o}.

Manufacturing Techniques

1. Lathe cutting
2. Compression molding + lathe cutting
3. Compression polymerization
4. Cast molding
5. Injection molding.

FOLDABLE INTRAOCULAR LENSES

6mm IOL can be inserted through a 3mm incision.

ACRYLIC POLYMERS

1. Hydrophobic acrylic polymers

This is the first IOL, implanted with square optic edge which is a co polymer of phenyl ethyl acrylate and phenyl ethyl methacrylate with

1.55-refractive index which folds easier because of its lower glass transition temperature (Tg-15.5 to 21.5^{o} Celsius) for PMMA it is-105^{o} Celsius with a water content of <1%.

2. **Hydrophilic acrylic polymer**

- Manufactured from poly hydroxyl ethyl meth acrylate (poly HEMA).
- Water content-38% with refractive index of 1.47.
- Should be kept cool until implantation.
- Ideal IOL for patient with inflammatory reaction and diabetic patients.

Advantages of acrylic IOLs: less chance of PCO, implanted through smaller size incision, less astigmatism, controlled unfolding, good laser resistance and biocompatibility.

Disadvantages: sticky surface can adhere to instruments, expensive, more chance of decentration.

Silicone Elastomers:

- Extensive cross linking and the high molecular weight reduce the biodegradability of the IOL.
- Because they are in molded form, no polishing is required.

- Has low index of refraction than PMMA.
- **Disadvantages**-due to the hydrophobic surface cellular reactions and surface deposits are common. IOL slippage and pitting is also common.

BIOCOMPATIBILITY

Foreign-Body Reaction

Definition of biocompatibility: "Biocompatibility is the capability of a prosthesis implanted in the body to exist in harmony with tissue without causing deleterious changes".

- Clinical measures of biocompatibility: Opacification of capsule, post-operative inflammation, and break down of blood-aqueous barrier, cellular reaction at the IOL optic and anterior capsule interface.
- Capsular biocompatibility- there should be minimal or no LEC proliferation over the posterior or anterior capsule.
- Uveal biocompatibility-direct contact of IOL with that of the uveal tissue should induce less inflammatory reaction.
-

INTRAOCULAR LENS DESIGNS

Aspheric lens

Generally the positive corneal asphericity is neutralized by negative asphericity of the young lens. But as the age advances the lens gain positive asphericity and it will add on to the corneal positive asphericity, gives rise to spherical aberrations at the plane of retina. Negative aspheric lenses are used to overcome this.

Multifocal Intraocular lenses

The loss of accommodation after cataract surgery can be quite significant. These IOL induced presbyopia has driven the development of bifocal and multifocal IOLs. Depending on the eye's gaze, one image is in focus at the retina and the second image is highly defocused.

Distant objects are placed in focus by the distance power of the lens and defocused by the near power. Near objects are focused by the near power of the lens and defocused by the distance power. Two types: refractive and diffractive.

Piggyback IOLs

These lenses can be placed primarily or the second lens placed secondarily over a previously implanted IOL. In the former, the anterior

IOL forces the posterior IOL more posteriorly a distance equal to the central thickness of the anterior lens. This causes the focal point of the posterior lens is moved farther behind the retina.

Secondary piggyback lenses can be calculated with the refraction formula:

Hyperopic: piggyback IOL=1.5xpost operative spherical equivalent refractive error. Myopic error: piggyback IOL=1.0xpost operative spherical equivalent refractive error.

Scleral supported IOL

Though placement of IOL in the capsular bag is the standard of care, situations arise where there is inadequate support for the IOL in the bag or in the sulcus; then scleral fixated IOLs are a viable option.

Placement of sutures:

- Ab interno- suturing techniques involved passing the needle from inside to outside the eye.
- Ab externo- technique involves passing the needle from outside to inside. During this technique, the anterior chamber can remain closed during needle passes. This avoids collapse of the ciliary

sulcus in the hypotonic eye, thus facilitating accurate suture placement.

HISTORY OF CATARACT SURGERY

The causes of cataract are multifactorial and vague, ranging from genetics and aging to environment, climate, diet, disease and trauma. The progressive clouding of the crystalline lens deprives the patient sight. Medicine's efforts to slow or halt this progression have failed.

It as was obvious even to the ancient Indian surgeon Sushruta, the answer to cataract lies in removing the obstruction to restore the passage of light onto the macula. Sushruta genius was simply to nudge the obstruction aside, a procedure called **couching**.

Intracapsular cataract extraction

It involved removal of the lens and capsular bag as a whole, with the refractive power of the now-absent lens provided externally by "Coke bottle" spectacles.

Ridley's innovation inspired surgeons to remove the opaque lens while leaving intact the capsular bag as a receptacle to hold his PMMA IOLs, and extra capsular cataract extraction was born.

Extra capsular cataract extraction (ECCE)'s pinnacle was the capsulotomy, removal of the anterior capsule to allow wholesale delivery

of the nucleus, to be replaced by a PMMA lens with known refractive qualities.

Refinement of ECCE technique led to extraction via smaller incisions that afforded stable intraocular pressure during surgery and sealed without sutures, a variation called **manual small-incision cataract surgery**. With SICS and low-cost IOLs, cataract surgery now penetrates even the world's poorest communities and millions are benefited with the best sight.

PHACOEMULSIFICATION

Phacoemulsification is undoubtedly the most superior method of cataract extraction credited to Charles Kelman applying targeted ultrasound and dubbed phacoemulsification. The incision-size benchmark now has dropped below 2mm. This sutureless surgery is responsible for increased patient expectations of post-operative vision, both in terms of acuity and quality.

The smaller the incision, the less the induced astigmatism and so foldable IOL's were introduced to aid in reducing the incision size. Apart from the size and the foldability, it is the material and design which are responsible for the desirable and not-so desirable characteristics of these foldable IOLs.

BASIC FEATURES

Three basic features of phaco machine: 1. Irrigation, 2. Aspiration, 3. Ultrasonic fragmentation. Correspondingly two hand pieces are used in phaco, the Irrigation aspiration hand piece and phaco or ultrasonic hand piece.

IRRIGATION-ASPIRATION HAND PIECE

- I - A hand piece has a silicone sleeve that fits snugly around the aspiration tip. Through this sleeve, irrigation is delivered. I - A tips differs from phaco tip, the sleeve may be turned to orient the irrigation port in any direction. In the silicone sleeve the irrigation ports should be perpendicular to the metallic aspiration port as this helps to direct the infusion fluid along the iris plane.
- This reduces iris flutter during the procedure. A variety of I-A tips are available; straight, 45^{o} or 90^{o} angulations; 0.2mm, 0.3mm, 0.7mm diameters. Most frequently used is the 0.3mm tip. During this procedure position 2 is the foot pedal position.

ULTRASONIC HAND PIECE

- Phaco emulsification surgery is entirely based on ultrasonic power, which is a function of acoustic vibrators that is incorporated into

the ultrasonic hand piece. Attached to this vibrator is a hollow titanium needle on the phaco tip.

- The acoustic vibrator is either a magneto restrictive or a piezoelectric device that converts electrical energy under the influence of an electrical signal. This vibrator oscillates longitudinally at a frequency between 30,000 - 60,000 Hz. The stroke amplitude of the linear movement is 3/1000 of an inch and the acceleration 80,000 - 2, 40,000 G.

PHACO TIP

The energy so produced along the ultrasonic hand piece is then transmitted into the phaco tip. It is made up of titanium and is hollow with the distal opening functioning as the aspiration port. It has various bevel angels from 0 degree - 60 degree.

ASPIRATION PUMPS

Three kinds of pumps are used to control aspiration and produce the negative suction pressure i.e. vacuum.

1. **Peristaltic pump**

In these pumps a pressure differential is created by compression of the aspiration tubing in a rotatory motion. When the rotational speed is

low; vacuum develops only when the aspiration port is occluded and it builds up to preset value in a stepladder pattern. By increasing the rotational speed, a linear buildup of vacuum occurs even without occlusion of the tip. It can thus be made to simulate venturi or diaphragmatic pump.

2. **Venturi pump**

It utilizes compressed gas to create inverse pressure. Generated vacuum is related to gas flow, which in turn is regulated by a variable valve. Vacuum build up occurs linearly in a consistent manner from zero to preset value. The buildup is almost instantaneous on pressing the foot pedal. Due to this, there is an increased risk of iris trauma and posterior capsular rents, which makes these pumps unsafe, particularly for beginners.

3. **Diaphragmatic pumps**

It uses a flexible membrane with in a cassette to generate vacuum. Buildup of vacuum is more linear and it reaches the preset level even without occlusion. This makes it unsafe. Without having to mechanically approach, the lens material can be aspirated.

FOOT PEDAL

The position indicator shows the mode of operation in which the instrument is functioning on depressing the foot pedal in a linear manner.

Position 1: Only Irrigation solution is flowing.

Position 2: Irrigation/Aspiration occurs simultaneously.

Position 3: Irrigation, Aspiration and Fragmentation take place simultaneously.

MECHANISM OF ACTION OF PHACO

Factors involved include

1. A mechanical impact of tip against the lens.
2. An acoustic wave transmitted through fluid in front of tip.
3. Cavitation:

In response to pressure changes at the phaco tip, there is formation of gas bubbles which arises from the solution; these bubbles can expand and contract. These bubbles implosion causes localized intense heat (7204'c temp and shock wave of 75,000psi) resulting in emulsification of lens material. Transient cavitation of pulsed ultrasound delivery is more efficient than the Continuous cavitation produced by continuous ultrasound.

4. There is an impact of fluid and lens particles being pushed forward in front of tip.

PHACO PARAMETERS

1. **Ultrasonic power**

   It is usually about 50% to 70%.If the lens is soft it is decreased to about 30% and if it is hard, power is increased to 80%.

2. **Effective phacotime**

   It is a total phacotime at 100% phaco power. Effective phacotime is very significant as less effective phacotime indicates proportionately less energy delivered to the eye there by reducing the side effects of phaco power.

3. **Phacopower**

   It is the ability of the phaco hand piece to cut or emulsify cataract. Phacopower is directly related to stroke length, frequency and efficiency of hand piece.

   It is nothing but the ability of the phaco needle to vibrate and cavitate the adjacent lens material. It is noted as a linear percentage of the maximum stroke length of the needle capability.

When the foot pedal is depressed to position 3, Phaco power is produced.

4. **Stroke length**

Stroke length is the distance by which the titanium phacotip moves to and fro. It is the most important factor in deciding the phaco power. Changing the phacopower setting of the machines can alter the stroke length.

5. **Frequency**

How fast the phaco needle moves back and forth during phacoemulsification. The frequency of ultrasonic hand piece is between 27,000hertz (Hz) and 60,000Hz.

OTHER PARAMETERS

6. **Tuning**

The method used to match the optimum driving frequency of the ultrasonic board within the console with the phaco handpiece operating frequency in a specific medium (e.g., Balanced Salt Solution).

7. Chatter

- Chatter occurs when the vacuum is overcome by the ultrasonic stroke. This causes the nuclear fragments to be repelled by the ultrasonic tip until the vacuum reaches high enough levels to neutralize the ultrasonic tip's repulsive energy and once again attracts the material.
- Phaco power reduction will diminish chatter by decreasing the stroke length of the tip excursion, thereby reducing forces that push the fragment away from the tip.

8. Duty cycle

It is the period when phaco power is being delivered during pulsed phacoemulsification. The duty cycle is said to be 50%, if the time of “power on” equals the time of “power off”.

9. Fluidics

The bottle height is usually set between 80 to 100cm, with regard to Vacuum and AFR. ***TOO HIGH BOTTLE WILL RESULT IN: Zonular stress, Miosis, repeated iris-lens fluctuation.***

10. Inflow

Introduction of Balanced Salt Solution into the eye via tubing and hand piece is done by depressing the foot pedal to position 1.It mainly dependent on gravity.

11. Outflow

Size of incision, diameter of phaco tip, and sleeve diameter, type of the pump used and, tubing diameter influence the outflow

12. Load

It is nothing but how much mass of nuclear material in contact with the phaco tip. To obtain this, the system and the ultrasonic tip should maintain constant stroke length or power. The system must be able to adapt to changing conditions, since the load is constantly changing. The cutting efficiency will be compromised, if the system cannot do this.

13. Piezoelectric crystal

It is a type of transducer used in ultrasonic hand pieces. It transforms electrical energy into mechanical energy. Linear motion is generated when the electrical energy supplied by the console.

TERMINOLOGY

1. **Vacuum**

   It is nothing but the negative pressure, created in the tubing, and is measured in mmHg.

2. **Aspiration**

   The withdrawal of fluid and lens material from the eye; produced by depressing the foot pedal to position 2 and continuing in position 3.

3. **Aspiration flow rate (AFR)**

   The flow of fluid through the tubing, measured in milliliters per minute (20-36ml/min is commonly used in most phaco machines). In a peristaltic system, the flow is determined by the speed of the pump. Other factors influencing flow include compliance, venting, and tubing size.

4. **Followability**

   It is the function of AFR. Followability is nothing but tendency for structures within the anterior chamber to move towards the phaco tip.

5. **Occlusion**

It is an obstruction of the aspiration port or aspiration tubing. Vacuum builds, when lens material occludes the tip and is maintained, until the material is evacuated.

6. **Rise time**

It is the rate at which vacuum builds once the aspiration port has been occluded. The faster the aspiration flow rate, the faster the rise time.

7. **Surge**

- A phenomenon that occurs when vacuum has built up due to an occlusion and the occlusion is suddenly broken, leading to the fluid in the higher-pressure (positive) anterior chamber tending to rush into the lower-pressure (negative) phaco tip.
- If the negative surge exceeds the inflow capability of the irrigation line, fluctuations in anterior chamber depth may occur and iris or posterior capsule may be drawn into the tip.
- Changes made in phaco machine in order to limit surge include the following: higher fluid inflow, lower vacuum, low-compliance tubing of thinner diameter, a smaller tip, coiled aspiration tubing,

and occlusion mode software. In addition, improvements in software allow automatic modification of aspiration and flow.

SURGICAL STEPS IN PHACOEMULSIFICATION

Exposure of the globe

During surgery, the eyelids are usually held apart by using a lid speculum. When selecting the speculum, the surgeon should make sure that it will accommodate the phaco handpiece and other instruments.

A bridle suture may be placed to help position the globe. The bridle suture is especially helpful for stabilizing the globe and exposing the bulbar conjunctiva to create a conjunctival flap.

Paracentesis

A 15 degree sharp blade is used to create a small paracentesis, placed approximately 2 or 3 clock hours away from the site where an incision will be made for the phaco handpiece. A straight entry plane is made parallel to the iris and to the left for a right handed surgeon, to the right for a left handed surgeon. Then visco elastics are instilled to protect intraocular structures and allow more control during creation of the phaco incision.

Scleral tunnel incisions

The superiorly placed scleral tunnel incision with an internal corneal lip is frequently used by beginning phaco surgeons. Small, posteriorly placed superior stepped scleral tunnel incisions reduce the incidence of both early and late surgically induced astigmatism.

Foldable IOLs can be inserted through incisions of 2.75 - 3.20 mm, whereas all poly methyl methacrylate (PMMA) IOLs require openings slightly larger than the diameter of the optic.

The keratome is inserted in the tunnel until it reaches the clear cornea beyond the vascular arcade. The heel of the keratome is elevated, and the tip of the keratome is pointed posteriorly, aiming toward the center of the lens and creating a dimple in the peripheral cornea. The keratome is then slowly advanced in this posterior direction, creating an internal corneal lip as it enters the anterior chamber.

Creating a clear-corneal cataract Incision

For phacoemulsification, the use of clear-corneal incisions has become very common nowadays for many reasons: they are easy to construct, provide good access to the cataract, seal well and induce very minimal astigmatism.

In a typical phacoemulsification, two incisions are created in the following manner:

- The main incision is created on the dominant (usually right) hand side.
- Paracentesis is created on the non-dominant (usually left) hand side.
- These incisions are typically placed approximately 60 to 90 degrees apart.
- The main incision can be made at the steep axis to reduce astigmatism at this meridian.

However, all of these incisions should have longer tunnel lengths to allow better sealing of the incision and less induction of astigmatism.

When the tunnel length is shorter.it creates more astigmatic flattening at that meridian and they do not seal nearly as well. Also there is less “oar-lock” effect; the more posterior entrance into the anterior chamber will give rise to iris prolapse through the incision.

At the end of the surgery the intra-ocular pressure exerts an outward force and pushes the inner part of the incision and keeps

the corneal layers tightly sealed. Long tunnel length will help to prevent any incisional leakage.

The temporal approach clear (or "near clear") technique has the following advantages

- It avoids dissection of Tenon's capsule and of conjunctiva, which decreases the risk of bleeding (e.g. in patients on anticoagulants).
- Offers better accessibility, enables better working place, because brow obstruction is eliminated with a temporal approach.
- The globe being parallel to the axis of the microscope, the red glow is better appreciated from the temporal side providing better visibility.
- Spares the superior conjunctiva for subsequent surgery (e.g. glaucoma filtering procedures, or aqueous shunt surgery)
- Avoids the need for a traction suture.
- A lesser against the rule drift is present, as compared to superior approach.

Disadvantages of temporal clear corneal incision

- Need for the surgeon to adapt to a different surgical position.

- Lack of forehead support for the surgeon's hands.
- Development of corneal striae intraoperatively if incision extends too far anteriorly, with reduced visualization need to enlarge the incision for use of nonfoldable I0Ls.
- Difficulty in converting to a manual expression ECCE technique.
- Proximity of instruments to the corneal endothelium during surgery.
- Possible corneal thermal burns.

4. Capsulorrhexis Creation

To access the cataract nucleus, the evolution of capsulorrhexis began with the use of a irrigating cystitome which makes multiple punctures in the anterior lens capsule to create an opening(can opener anterior capsulotomy) was performed initially.

But it causes unstable capsular bag and predisposes to a higher complication rate. Today, the preferred method is creation of the continuous curvilinear capsulorrhexis (CCC).

The ideal capsulorrhexis should have the following characteristic features:

- It should be well-centered, round opening of the anterior capsule with a diameter of about 5mm.
- This gives sufficient access to the nuclear material, and at the end of the surgery it allows secure placement of a posterior chamber IOL within the capsular bag.
- The optic diameter of the typical IOL is about 6mm and our 5mm capsulorrhexis is therefore able to cover the entire edge of the optic and hold it securely in position after the end of surgery.
- Before doing capsulorrhexis, the anterior chamber should be well formed with viscoelastic and the anterior lens capsule is flattened, for greater control and prevents run-off and radialization of the capsulorrhexis.

Step 1: By using a bent 26 gauge needle, a cystitome, single puncture is made in the central part of the anterior lens capsule. This can also be done with the tips of the capsulorrhexis forceps.

To facilitate creation of a capsulorrhexis with an exact 5mm diameter every time, the capsulorrhexis forceps are marked with two lines, at 2.5mm and at 5mm.This 2.5mm mark delineates the

radius of our intended capsulorrhexis, when the sharp tips of the forceps are poked into the centre of the anterior lens capsule.

Step 2: To propagate the tearing of the capsulorrhexis, it is important to keep the torn capsule folded over. This allows the tear to proceed in a more controlled manner.

Step 3: We will notice that half way through the rhexis, the 2.5mm hash mark of the forceps tip should be in the exact center of the anterior capsule, and the 5mm hash mark should be at the outer edge of the capsulorrhexis, as we proceed to tear the circular capsulorrhexis. This will give the clue that we are tearing the proper size capsulorrhexis.

If capsulorrhexis radializes, we have to stop the rhexis and inject more cohesive viscoelastic, and try to bring it centrally once again. If it extends too far radial and out to the zonules, we can finish the rhexis by going in the opposite direction with the capsulorrhexis forceps, or by using the bent needle cystitome to place a series of punctures in the intended areas.

Because it is a complete circle, the capsulorrhexis usually provides a high degree of strength and stability to the capsular bag and keeps the

IOL secured centrally. This assures a consistent post-operative refractive outcome.

Hydro dissection:

- Following capsulorrhexis, gentle injection of irrigating fluid, or hydro dissection, is performed to separate the peripheral cortex from the underlying posterior lens capsule.
- In addition to loosening the lens nucleus/cortex complex, this also facilitates nuclear rotation during phacoemulsification and hydrates the peripheral cortex, making it easier to aspirate after nucleus removal.
- A bent, blunt-tipped 25 - to 30-gauge cannula or flattened hydro dissection cannula attached to a 3-5-mL syringe is placed under the anterior capsule flap. While carefully lifting the capsular flap, the BSS is injected in a radial direction. Gentle posterior pressure centrally on the nucleus will express posterior fluid and prevent fluid pressure from rupturing the posterior capsule.
- Gentle irrigation should continue until the surgeon sees a wave of fluid moving under the nucleus and across the red reflex. In mature cataracts or in cases without a red reflex, careful hydro dissection is done, until nuclear rotation can be performed. Irrigation in the

sub incisional area may require a right -angled or J -shaped hydro dissection cannula.

- Hydro dissection is riskier after a can-opener capsulotomy has been performed, with zonules that are weakened, or in a patient who has posterior polar cataracts.

Hydro delineation

Some surgeons also inject BSS into the substance of the nucleus to hydro delineate, or separate, the various layers of the nucleus after hydro dissection.

This technique separates the harder central endonucleus from the softer outer epinucleus, which can remain behind to act as a cushion to protect the underlying posterior capsule from inadvertent trauma during nucleus removal. In less brunescent cataracts, a fluid wave can be seen to separate the endo nucleus from the epinucleus and produce the "golden ring" sign. This method is not effective in white or densely brunescent nuclei.

Phaco fracture technique (divide and conquer / nucleofractis)

In this technique a deep central linear groove or trough is sculpted in the nucleus, with continuous ultrasound used for sculpting. The groove must be deep enough to allow subsequent cracking.

Clues for adequate groove depth

- Smoothing of the striations in the groove,
- Brightening of the red reflex in the groove, and
- Sculpting to a depth of 2-3 phaco tip diameters.

The nuclear cracking is done to divide the nucleus into 2 pieces, or the deeply grooved nucleus can be rotated to create troughs to divide each half into quadrants. The phaco tip and second instrument are inserted into each groove and spread apart, with a cross action or parallel action, thereby achieving the complete separation of the pieces.

This piece is engaged by the phaco tip, and after attaining adequate vacuum, the nuclear quadrant is pulled toward the center of the capsular bag and emulsified. Each quadrant is sequentially removed in the same manner.

Phaco chop (Nagahara's technique)

- After completing capsulorrhexis and hydro dissection, the phaco emulsification tip is placed in the eye, burying it in the nucleus as far as superiorly as possible. Next modified lens hook is placed through the side port incision and poked down into the nucleus.

- Then it is pulled towards the phaco tip, ripping a narrow groove in the nucleus as it cuts its way towards the chopping block there by the nucleus is chopped into two pieces.
- The nucleus is rotated 90^{o} orienting, the original chop horizontally, and by the same method inferior half of the nucleus is chopped. These 4 quarters are then emulsified.
- Advantages- reduced phaco time and emulsification power.

Stop and chop technique

- Koch and katzen suggested opening up some space in the middle of the cataract by using standard sculpting technique and then chopping the rest.
- The nucleus is nudged into two halves and from then the nucleus is removed with chop technique.

Other techniques

1. Phaco sweep

2. Chip and flip technique.

Cortex Removal:

- Normally, the epinucleus will be extruded from the capsular bag as a solid mass and will come to be centre of the pupillary space. In

this position, the irrigating spoon is inserted under a portion of the epinucleus, and with the pressure of the chamber maintainer and intermittent additional injection of fluid through the irrigating spoon; the epinucleus is expulsed from the anterior chamber.

- The cortex can be aspirated with 21-gauge cannula; however maximal control is obtained with the side-port 23-gauge cannula on the 5ml syringe.
- With the anterior chamber maintainer running and the bottle elevated slightly, the straight, side ported aspirating cannula is inserted through the stab puncture.
- The tip reaches into the capsular bag, coming into contact with the fibrous residual cortex, which is pulled from the peripheral capsular bag into the pupillary aperture and aspirated. Each fragment is stripped from the periphery toward the centre.
- Our aim is to remove a few large sheets of cortex material instead of pulling many small strips of cortex. This allows for safer and more efficient cortical clean-up and is less likely to result in residual cortical matter in the capsular bag.

IOL Insertion

- The three main IOL classifications for insertion are: rigid IOLs, foldable IOLs, and injectable IOLs. Each is inserted differently.

- Rigid IOLs are typically made of poly methyl methacrylate (PMMA) which is a well-tolerated, non-flexible plastic. These IOLs tend to be single piece, due to their rigid nature, they require a larger incision for their insertion, typically 0.5mm greater than the size of the. Most 6.0mm optic PMMA IOLs can be inserted through a 6.5mm incision.
- This larger size incision should not routinely be made in the cornea; rather, a scleral tunnel incision should be created, which will cause a long-term astigmatic effect, which can often be lessened by proper closure with sutures. In modern practices, due to the large incision size, the PMMA IOLs tend to be used rarely.
- Foldable IOLs are made of acrylic or silicone, which are designed to be folded in half, and held with forceps, and then placed within the eye. This allows an IOL with an optic size of 6.0mm can be inserted through an incision of about 3.0-3.5mm or even less, which can be safely made in the cornea. It has only a mild astigmatic effect. Once the IOL is inserted within the eye, the forceps are opened, the IOL is released, and the forceps can be removed.
- During insertion, the injector system allows the IOL to be completely shielded from contacting the ocular surface, and it

allows for smaller incisions of less than 3.0mm, and sometimes even less than 2.0mm.

- Once the IOL is injected into bag, it opens up and resumes its full size and shape, and the injector is removed from the incision. These smaller incisions have the least astigmatic effect with best sealing effect.
- **The technique for inserting all IOLs:** First the leading haptic is placed into the capsular bag, followed by the optic, and then finally the trailing haptic is also placed. The normal configuration is with the haptics in the same orientation as the letter "Z", not in the "S" formation, seen post operatively.
- Once the IOL is completely within the capsular bag, it can be gently rotated with the help of the second instrument (IOL dialer) to ensure that it is well-positioned. In some situations, such as compromised posterior capsule, the IOL is intentionally placed within the ciliary sulcus –the space between the posterior surface of the iris and the anterior lens capsule.
- For the long-term stability of the IOL, the 6.omm optic should be covered on its 360 degree by the edge of the typical 5.00mm capsulorrhexis.

- Using high flow and high vacuum, the remaining viscoelastic that is sequestered behind the IOL optic, is aspirated. Finally the anterior chamber can be filled with balanced salt solution, and the incisions can be sealed.

POSTERIOR CAPSULAR OPACIFICATION [PCO]

PCO is of main concern to ophthalmologists worldwide for its medical, social, and economic implications.

Many preventive factors and surgical techniques were attempted to decrease the PCO development, but there is still no procedure for its complete eradication.

Fortunately, posterior capsule opacification is amenable *to* treatment by means of Nd: YAG posterior capsulotomy.

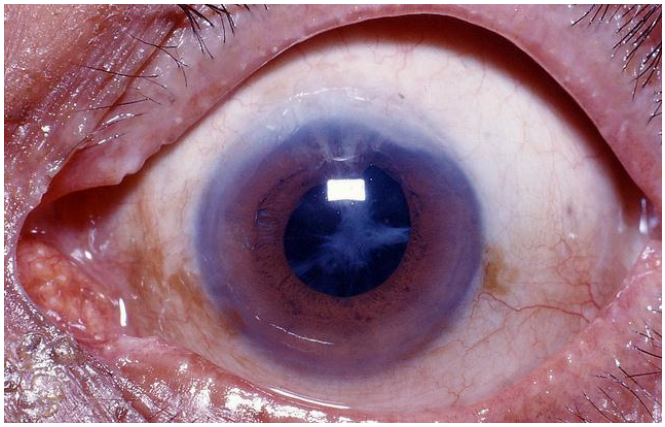
Capsular opacification stems from the continued viability of lens epithelial cells remaining after removal of the nucleus and cortex. These cells proliferate in several patterns.

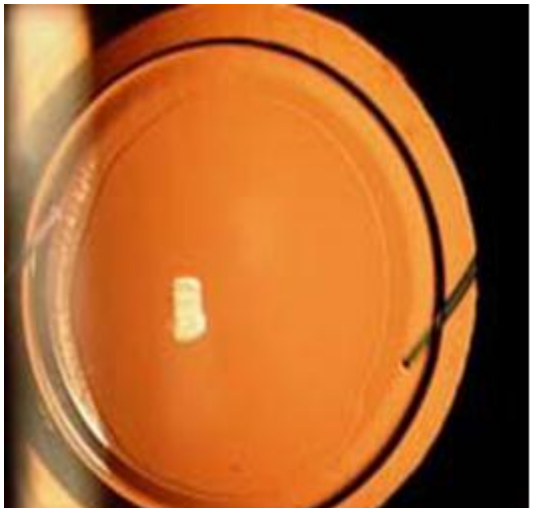
PATHOGENESIS

Where the edges of the anterior capsule adhere to the posterior capsule, a closed space will be reestablished consisting of nucleated bladder cells ***(Wedl cells)*****,** resulting in a Soemmering *ring*. If the epithelial cells migrate outward, *Elschnig pearls*, which resemble fish eggs, are formed on the posterior capsule.

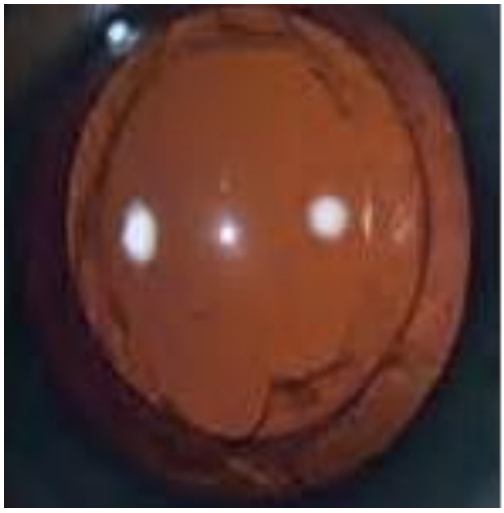
These pearls can fill the pupil or remain hidden behind the iris. Histopathology shows that each "fish egg" is a nucleated bladder cell,

PATIENT WITH THICK CENTRAL PCO



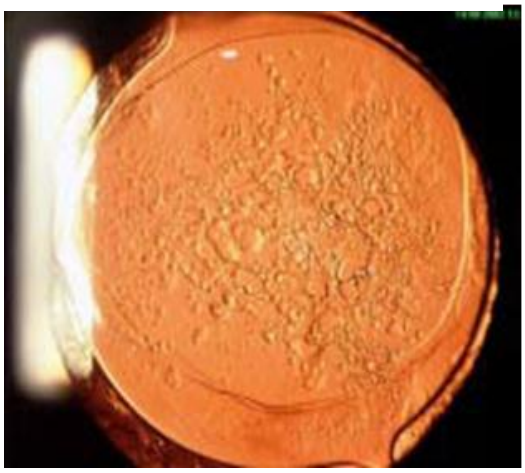


GRADE 0 PCO



GRADE 2 PCO

GRADE 3 PCO



GRADE 4 PCO

identical to those proliferating within the capsule of a Soemmering ring but lying outside the capsule and usually lacking a basement membrane.

If the epithelial cells migrate across the anterior or posterior capsule, they may cause capsular wrinkling and opacification. Significantly, the lens epithelial cells are capable of undergoing metaplasia with conversion to myofibroblasts.

A matrix of fibrous and basement membrane collagen can be produced by these cells, and contraction of this collagen matrix will cause wrinkles in the posterior capsule, with resultant distortion of vision and glare.

PREVENTION OF POSTERIOR CAPSULAR OPACIFICATION

SURGICAL FACTORS IN THE PREVENTION OF PCO

Hydro dissection-Enhanced cortical clean up

This step is very important and underrated. In this technique the edge of the anterior capsule is slightly tented up by the tip of the cannula and the flow of the fluid toward the capsule will efficiently separate the cortex from the capsule.

In the bag IOL fixation:

IOL-optic barrier effect is mainly achieved in continuous curvilinear capsulorrhexis and not that much in can opener technique.

Capsulorrhexis size

PCO is less when the anterior capsule is in 360^{o} contact with the optic. Small CCC promotes tight fit of the capsule around the optic, thus maximizing the contact between the optic and the posterior capsule. Capsular contraction after surgery also results in increased contact pressure which will prevent the LEC migration.

Many clinical studies have shown that PCO is reduced if the anterior capsulorrhexis lies completely on the anterior IOL surface. This compresses the IOL against the posterior capsule producing a mechanical barrier to LEC migration.

Biocompatible IOL(IOL material)

IOL materials are said to be more biocompatible, when they have the capacity to inhibit the stimulation of cellular proliferation.

Poly acrylic IOLs, having tacky surface, will create a bio adhesion between the IOL optic and the anterior capsule.

There is no space for the epithelial cells to migrate between the IOL optic and the posterior capsule. Moreover capsulorrhexis edge is more stable over the anterior surface of poly acrylic than PMMA or silicone IOL.

Contact between the IOL optic and the posterior capsule

To obtain the tight fit between the IOL the posterior capsule, the optic/haptic angulation should displace the IOL optic posteriorly.

Stickiness of the IOL optic material to that of the posterior capsule prevents epithelial cell migration, contributing to the so called "No space, no cells" concept.

IOL optic geometry

Nowadays most of the IOLs are with biconvex design so that the posterior convex surface will create the barrier effect between the IOL optic and the posterior surface and prevent the LEC migration.

Sharp optic edge in prevention of PCO

The sharp edge of IOL creates sharp bend and complex folds in the posterior capsule, will induce contact inhibition of LECs migrating on the posterior capsule. This bend formation is earlier in Acrylic and silicone IOLs and delayed in PMMA IOL. Sharp bend created by Acrylic IOL is superior when compared to other IOLs.

Types of capsular bend

1. Parallel, 2. Y shaped 3. Right angled, and 4.Wrapping. Among these, the right angle type was common configuration.

PCO- leads to reduction in the sharpness of vision by posing a direct obscuration of the visual axis. Its time of onset is of broad spectrum, varying from months to years after the surgery.

PCO is more common with:

Younger patients (older the patient, the lower will be the incidence of PCO), post - extracapsular cataract extraction , some designs of IOL, glaucoma, pseudo exfoliation, retinitis pigmentosa, high myopia and Ocular inflammation.

GRADING OFPOSTERIOR CAPSULAR OPACIFICATION:

- Grade-0:Nil
- Grade-1:PCO not reaching IOL edge
- Grade-2:PCO just within the IOL edge
- Grade-3:PCO well inside the IOL edge but not involving the visual axis
- Grade-4:PCO obscuring the visual axis

TREATMENT OF POSTERIOR CAPSULAR OPACIFICATION

The Nd: YAG Capsulotomy

Use of the Nd: YAG laser has now become the procedure of choice for treating secondary opacification of the posterior capsule or contraction of the anterior capsule, although a discission knife can be used. It is used through an ab externo corneal incision to open an opacified capsule in special cases.

Indications for Nd: YAG capsulotomy

- Faint best corrected visual acuity, opacities on distant direct ophthalmoscopy.
- Obscuration of the fundus view in screening and treatment for diabetic retinopathy.
- Monocular diplopia or glare caused by posterior capsule wrinkling
- Encroachment of a partially opened posterior capsule into the visual axis
- Capsular phimosis requiring relaxing incisions.

Contraindications to Nd: YAG capsulotomy

- Inadequate visualization of the posterior capsule.

- An uncooperative patient who is unable to hold fixation during the procedure (may be addressed by the use of a contact lens or retro bulbar anesthesia in some of these patients).

Procedure

Nd: YAG laser discission is usually painless and is performed as an outpatient procedure.

The Nd: YAG laser has a wavelength of 1064 nm.

- The pulse energy threshold for puncture of the posterior capsule is generally 0.8-2.0 with either Q-switched (5- 30 ns pulse length) or mode-locked (30-200 ps pulse length) systems.
- Use the lowest effective energy output setting (higher energy levels in areas of dense fibrosis).
- The posterior capsule is best visualized through an undilated pupil and landmarks are marked so that one can pinpoint the location of the visual axis because center of the visual axis is the ideal site for the opening, 3-4 mm in diameter.
- Openings of larger diameters may be required for more complete visualization of the fundus in some cases (dilatation is helpful in producing a larger opening but the visual axis may not be assessed clearly)

- A high -plus-power anterior segment laser lens, used with topical anesthesia, improves ocular stability and enlarges the cone angle of the beam, reducing the depth of focus.
- The smaller-focus diameter facilitates the laser pulse puncture of the capsule, and damage to the structures is minimal.
- The position of the bio microscope may be adjusted, or the patient can shift fIxation slightly if there is any obscuration to the field of focus

Pitfalls

IOL dislocation

Occasional reports of IOL dislocation into the vitreous cavity mostly seen with silicone plate haptic lenses. The risk is reduced by constructing the capsulotomy in a spiraling circular pattern, rather than in a cruciate pattern, with less likely radial extension.

Vitreous rupture

The anterior vitreous face may remain intact with less energy output. A rupture in the anterior vitreous face is kept a check by the presence of a PCIOL, although vitreous strands occasionally migrate around the lens through the pupil but it can be damaged by laser capsulotomy, but the threshold for lens damage

appears to be lower for silicone than for other materials. The laser pulse should be focused just behind the posterior capsule, but pulses too far behind the IOL will be ineffective.

The safest approach is to focus the laser beam slightly behind the posterior surface of the capsule for the initial application and then move subsequent applications anteriorly until the desired puncture is achieved. Also search for sites where the capsule might have dropped more posterior to the IOL, because these sites can be treated more safely.

Anterior capsular retraction

In cases of this condition, multiple relaxing incisions of the fibrotic ring are applied. This relieves the contracting force and creates a larger optical opening. Cycloplegic and anti - inflammatory drugs are not routinely necessary.

Preoperative and postoperative application of topical apraclonidine hydrochloride or brimonidine tartrate is recommended to prevent postoperative IOP elevation.

Pitting of IOL

This condition occurs with the poorly focused laser beam, still a few laser marks on the IOL does not impair ocular tolerance of the IOL.

Cystoid macular edema

It is an occasional complication and may develop months after capsulotomy. It is less common when capsulotomy is delayed for 6 months or more after cataract surgery.

Rhegmetogenous retinal detachment

It is rare, except in high myopes and may occur several months after capsulotomy.

Intraocular pressure elevation

The pattern is mild and transient and is usually innocuous. However, elevation above precapsulotomy levels is a hallmark for patients with established glaucoma or those that manifest significant ocular hypertension within hours of the capsulotomy.

Mechanism of raise of IOP

- Clogging of the trabecular meshwork by the inflammatory cells will reduce the aqueous drainage.
- Trabeculitis
- Pupillary block caused by vitreous

Chronic endophthalmitis

It is due to sudden release of sequestered organisms into the vitreous, but is very rare. Besides, Nd: YAG laser capsulotomy does not magnify the scope of visualization of the peripheral retina

and increases the cost of cataract treatment thus providing a scope of developing new ways to prevent the formation of PCO that include modifications in design and material of the lens, surgical techniques, and other approaches.

Anterior capsular opacification [ACO]/anterior capsule fibrosis

As compared with PCO, ACO usually occurs as early as 1 month after cataract surgery. Post-operative ACO is composed of fibroblast-like cells, which was transformed from LECs and collagen.

Miyake et al found that the hydrophilic lenses had less inflammatory reaction and slower ACO formation, which was mainly due to its contact angle of water and oil.

PART- TWO

AIMS AND OBJECTIVES

1. To compare the incidence of posterior capsular opacification after implantation of Acrylic Foldable Intraocular lenses and poly methyl methacrylate (PMMA) Rigid intraocular lenses (IOLs).

2. To compare the post-operative visual outcome when using foldable Acrylic IOL with PMMA IOL.

MATERIALS AND METHODS

STUDY DESIGN: This is a prospective, comparative study.

This study is to be conducted among 100 patients with Type 1 and Type 2 diabetes mellitus attended as outpatient and inpatient in the ward with pre-operative, intra and post-operative post prandial random blood sugar (PPBS) < 140mg/dl at Ophthalmology Department of Government Rajaji Hospital, Madurai.

Subjects shall be evaluated for entry into the study if they are 40 years of age or older. Subjects believed to fulfill all eligibility criteria, and none of the exclusion criteria, will be invited to participate in the study.

STUDY PERIOD: 6 Months (April 2014 to September 2014)

FINANCIAL SUPPORT: Nil

ETHICAL COMMITTEE CLEARANCE: Obtained.

SELECTION OF STUDY SUBJECTS

A total of 100 patients attending the Out Patient units and in the wards of Ophthalmology Department, Government Rajaji Hospital, Madurai who satisfy the inclusion criteria were selected.

INCLUSION CRITERIA

1. Patient with age group 40-70 years with uncomplicated senile cataract.
2. Eligible cataracts in diabetics without retinal change & with PPBS < 140mg/dl.
3. By using phacoemulsification technique.
4. All surgeries were performed by a single surgeon.
5. By using continuous curvilinear capsulorrhexis technique.
6. PCIOL placement in the capsular bag.
7. Patients with well dilated pupil.

EXCLUSION CRITERIA

1. History of previous ocular diseases.
2. History of previous intra ocular surgery.
3. History of previous intraocular inflammation, corneal pathologies.
4. History of glaucoma.
5. Significant posterior segment pathology on examination (which preclude post-operative visual outcome).

6. Intra and immediate post-operative surgical complications such as zonular dehiscence, failure to place the IOL, CCC rim tear, incomplete cortical clean up, PC rupture, vitreous loss, PCO noted at the time of surgery, prolapse of iris, post-operative AC reaction, and striate keratopathy of severe type.

7. Congenital cataract.

8. History of ocular trauma.

9. Traumatic cataract.

10. Patient with dilated pupil size of<6mm, pseudo exfoliation syndrome

11. History of long term anti-inflammatory treatment.

The patients underwent a complete ocular examination pre-operatively and were carefully selected to exclude any ocular disease other than the presence of cataract.

Pre-operative ocular examination including

- Visual acuity, both unaided as well as aided using spectacle or pin hole was checked with snellen's visual acuity chart.

- The anterior segment evaluation was done using the slit lamp. Particular attention was paid for the presence of signs of inflammation.
- After pupillary dilatation, the cataract was assessed and graded. A thorough posterior segment evaluation was done.
- Keratometry was done using Bausch and Lomb keratometer. Axial length was measured with 'A' scan unit and the IOL power was calculated using SRK II formula.
- IOP was measured using a schiotz indentation tonometer.
- Patency of lacrimal passages was checked using lacrimal sac syringing.
- Diabetics were taken up for surgery only if PPBS was less than 140 mg /dl (under control).
- All patients received one hourly 6 times topical antibiotic (ciprofloxacin) eye drop one day prior to surgery.
- Systemic oral antibiotics (Tab.Ciprofloxacin 500mg) were given on night before surgery and in the morning on the day of surgery.
- Tropicamide 0.5% and Phenylephrine 5% eye drops were instilled every 15 minutes, starting two hours prior to surgery for obtaining mydriasis.

SURGICAL TECHNIQUE

1. All surgeries were performed by a single surgeon.
2. All cases were performed under local peribulbar anesthesia.
3. Under strict aseptic precautions the eye to be operated was painted with 5 % Povidone Iodine and was draped.
4. A wire speculum was placed to retract the eye lids.
5. Superior Rectus Birdle suture was applied and secured.
6. A fornix based conjunctival flap was raised superiorly with the help of corneoscleral scissors.
7. Hemostasis was achieved by cautery of bleeding vessels.

Patients were divided into two groups

The first group (Group A): were implanted with 13.5mm PMMA (polymethylmethacrylate) IOL with 6.0mm optic after performing phacoemulsification through a scleral corneal tunnel incision of size about 6.5mm.

The second group (Group B): were implanted with 13.0mm acrylic IOL with 6.0mm optic after performing phacoemulsification through a 3.5mm temporal clear corneal incision.

1. In Group B patients- a 3.5mm clear corneal temporal incision was made with a 2.75 mm keratome blade.

2. Viscoelastic was used to inflate the anterior chamber
3. Continuous curvilinear capsulorrhexis of about 4–5 mm was performed with bent 26 gauge needle.
4. Hydro dissection and Hydro delineation were done.
5. ‘‘Divide and conquer’’ phacoemulsification technique were performed
6. The cortex was removed with automated irrigation/aspiration.
7. Viscoelastic was placed into the capsular bag, followed by‘ ‘in the bag’’ placement of the Acrylic foldable posterior chamber IOL with the help of the injector system.
8. Then excess viscoelastic was washed.
9. Anterior chamber was formed with air.
10. Sub conjunctival dexamethasone 0.5ml was given in the inferior fornix.
11. Tight pad and bandage was applied.
12. Any surgical complication such as CCC rim tear, zonular dehiscence, failure to place the IOL in the capsular bag, posterior capsular rupture, or vitreous loss led to exclusion from the study.
13. Postoperatively, all patients were administered ciprofloxacin 0.3%, NSAIDs, and Fluorometholon 0.1% four times a day for one month, and NSAIDs only were used for the next month. In order to

prevent posterior synechiae, homatropine 1% was used once daily for the first week.

POST OPERATIVE EVALUATION

Patients under this study were examined during post-operative visits at 1 week, 2 weeks, 2months, 4months and 6months. All patients were told to report back if there was any visual loss post operatively with regard to the following points:

1. At each visit patient was asked about subjective complaints such as decreased vision, pain in the operated eye, redness, photophobia, watery eyes, diplopia glare, halos etc.,.
2. Visual acuity recorded on Snellen's chart and pin hole improvement is noted.
3. Anterior segment evaluation by using slit lamp was done. Presence of flare and cells (Anterior chamber reaction) was noted.
4. Pupils were dilated and examined on slit lamp by using retro illumination for assessing the Posterior Capsular Opacification as Elschnig pearls and fibrosis.

POSTERIOR CAPSULAR OPACIFICATION WAS GRADED AS:

- Grade-0:Nil
- Grade-1:PCO not reaching IOL edge
- Grade-2:PCO just within the IOL edge
- Grade-3:PCO well inside the IOL edge but not involving the visual axis
- Grade-4:PCO obscuring the visual axis

RESULTS

The present study was conducted in 100 patients who underwent Phacoemulsification at Department of Ophthalmology, Madurai medical College, and Madurai during the study period.

The patients were divided into two groups

The first group (Group A) : were implanted with 13.5mm PMMA (poly methyl meth acrylate) IOL with 6.0mm optic after performing phacoemulsification through a scleral corneal tunnel incision of size about 6.5mm.

The second group (Group B): were implanted with 13.0mm acrylic IOL with 6.0mm optic after performing phacoemulsification through a 3.5mm temporal clear corneal incision.

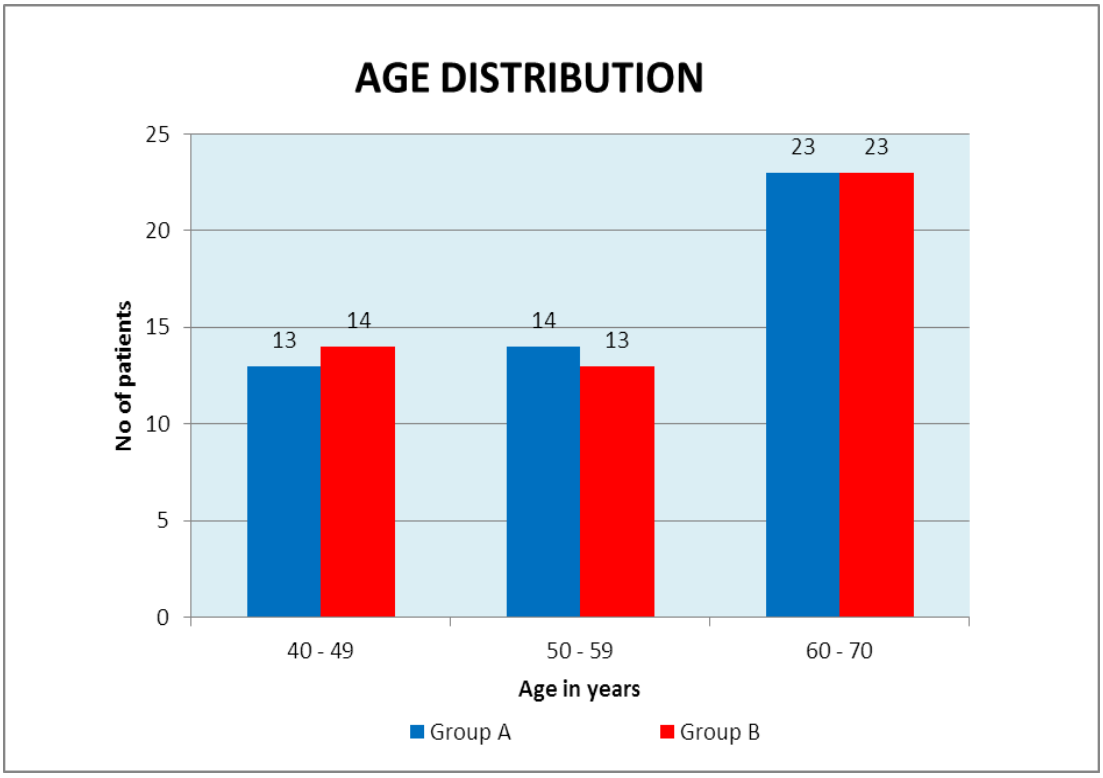
Table No 1: Showing the age distribution:

Age in Years	Group A	Group B	Total
40-49	13	14	27 (27.00%)
50-59	14	13	27 (27.00%)
60-70	23	23	46 (46.00%)

The entire study population was stratified by the age criteria into three groups, viz. and patients of the age group 40 – 49 years, 50 – 59 years and 60 to 70 years in which the distribution was seen as above:

27 people (27%) were in the age group of 40 – 49 years among whom 13 of them underwent surgery with PMMA IOL and 14 underwent surgery with Acrylic IOL. 27 people (27%) were in the age group of 50 - 59 years among whom 14 of them underwent surgery with PMMA IOL and 13 underwent surgery with Acrylic IOL. 46 (46%) people were in the age group of 60 – 70 years among whom 23 of them underwent surgery with PMMA IOL and with Acrylic IOL.

CHART No 1: showing the age distribution



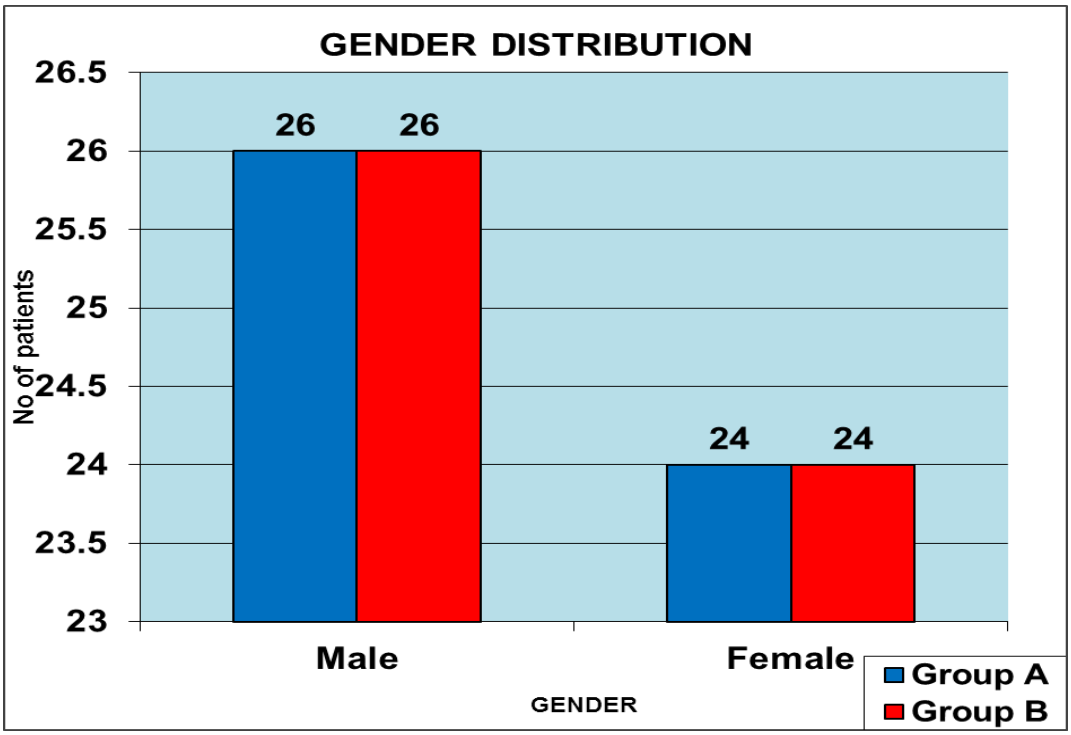
Mean age in Group A was 56.72 ± 9.18 years (mean SD), range 40-70 years.

Mean age in Group B was 56.62 ± 9.38 years (mean SD), range 40-70 years, a P' value=0.957 was obtained and therefore there is no significant difference between the people underwent surgery with two IOLs when age is considered as a factor.

Table No 2: showing the Gender distribution:

Gender	Group A	Group B	Total
Male	26	26	52(52%)
Female	24	24	48(48%)
Total	50	50	100(100%)

Chart No 2: showing the gender distribution

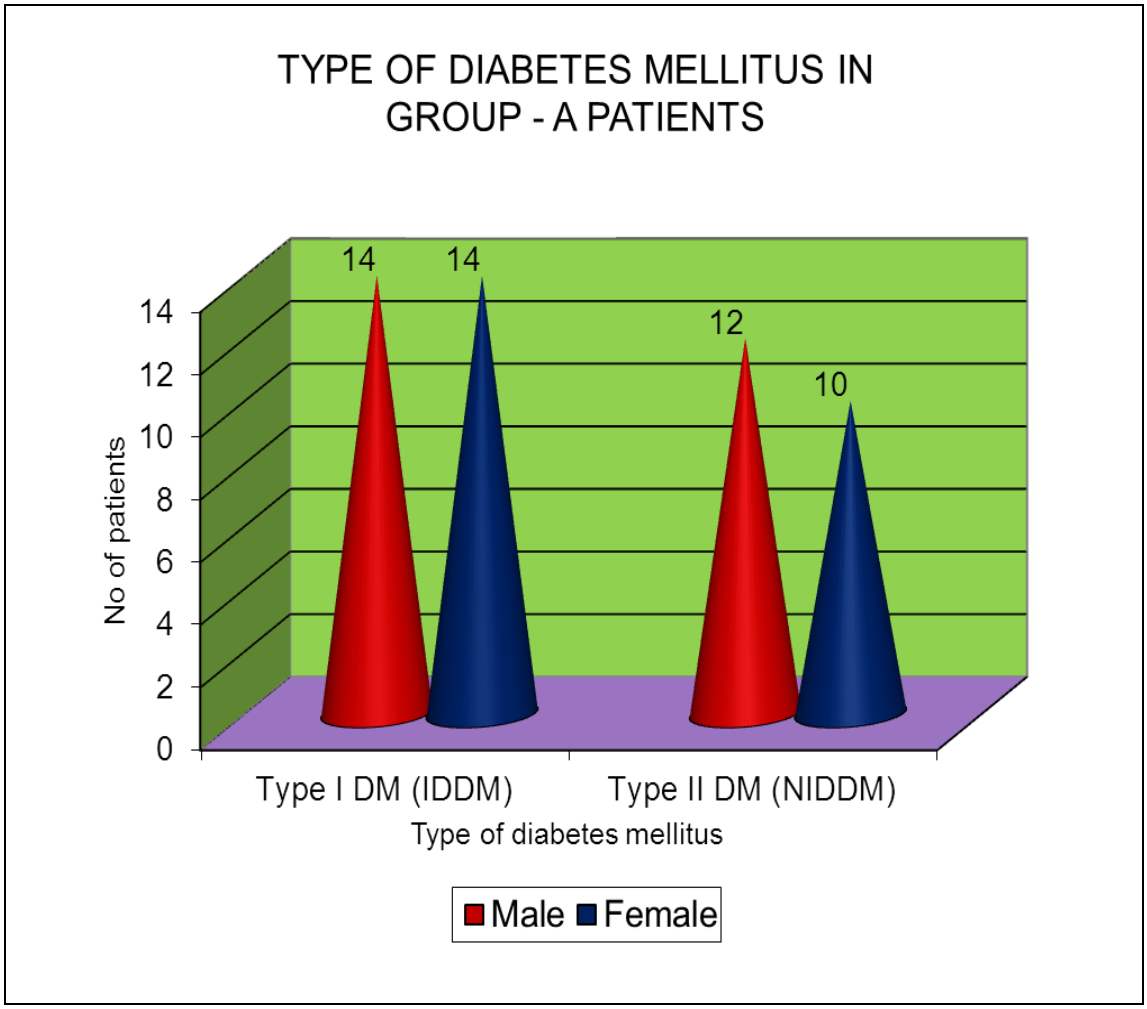


Gender distribution involves stratifying the population on the basis of sex. 52 People (52%) were in the male group among whom 26 of them underwent surgery with PMMA IOL and with Acrylic IOL.

48 people (48%) were in the female group among whom 24 of them underwent surgery with PMMA IOL and 24 with Acrylic IOL.

Table No- 3: showing Type of Diabetes Mellitus in Group A patients

Diabetes Mellitus	Group A Male	Group A Female	Total
Type1DM (IDDM)	14	14	28(56.00%)
Type2DM (NIDDM)	12	10	22(44.00%)
Total	26	24	50(100%)



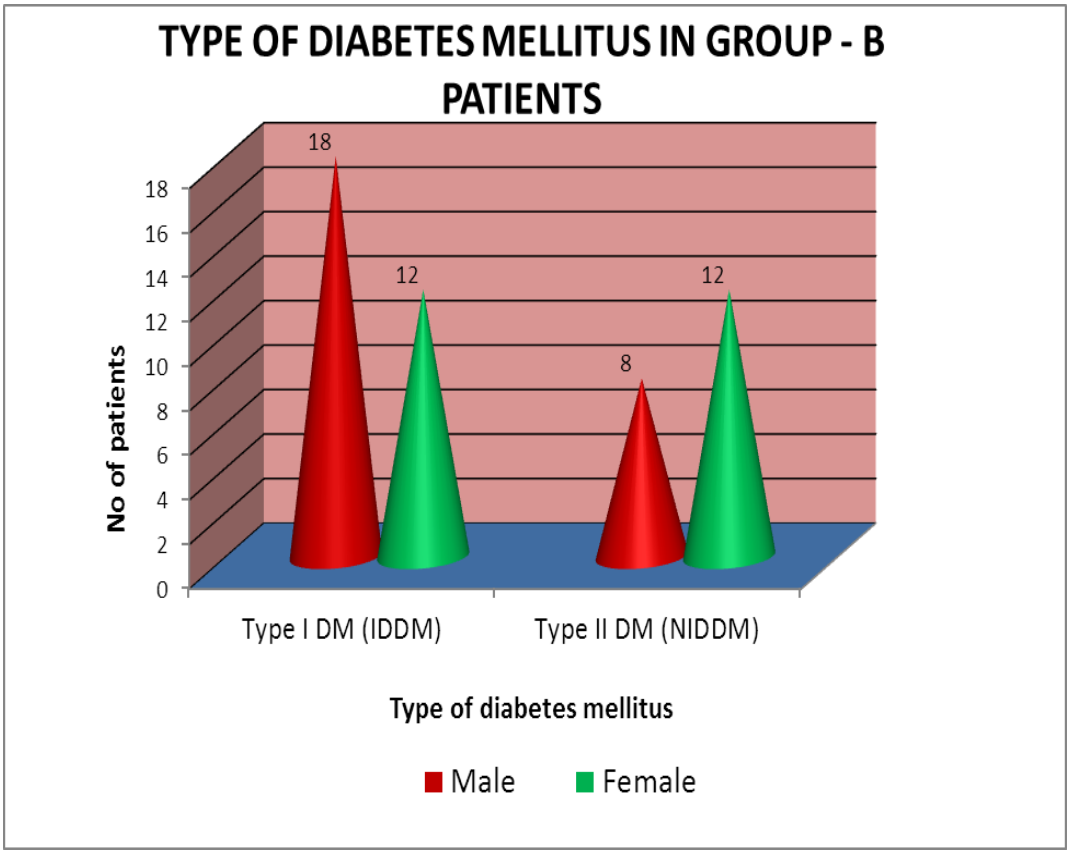
That percentage of study population that underwent surgery with PMMA IOL (50% - 50 in number) was stratified by the type of diabetes mellitus that they presented with viz. Type I DM and Type II DM as above which revealed:28 (56%) of them presented with Type I (Insulin Dependent Type) among whom the distribution was almost 50 – 50% in Male and Females i.e. 14 in each group and 22 (44%) of them presented with Type II (Non-Insulin Dependent Type) among whom the distribution slightly tilted to the side of males with 12 being on their side and 10 on their counterparts.

Table No- 4: Type of Diabetes Mellitus in Group B patients

That percentage of study population that underwent surgery with Acrylic IOL (50% - 50 in number) was stratified by the type of diabetes mellitus that they presented with viz. Type I DM and Type II DM as above which revealed:

Diabetes Mellitus	Group B Male	Group B Female	Total
Type1DM (IDDM)	18	12	30(60.00%)
Type2DM (NIDDM)	8	12	20(40.00%)
Total	26	24	50(100%)

Chart No-4: Type of Diabetes Mellitus in Group B patients



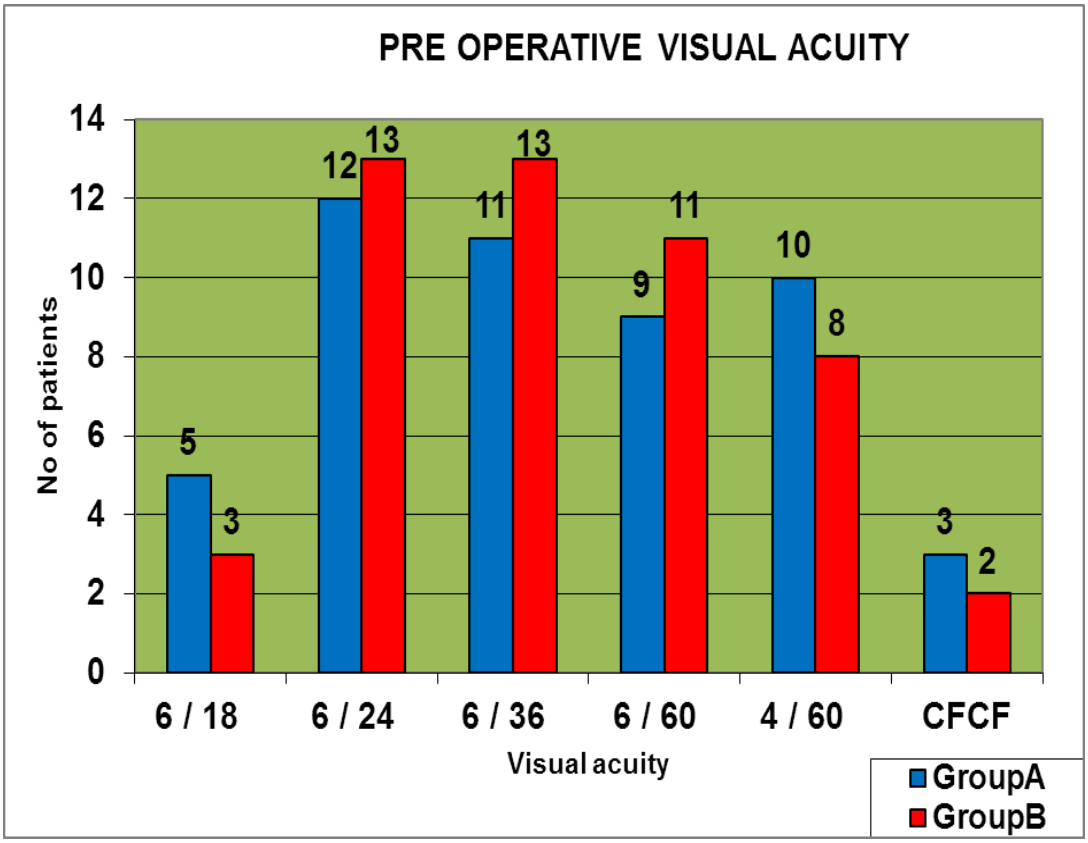
30 (60%) of them presented with Type I (Insulin Dependent Type) among whom the distribution was almost high in Male accounting to 18 and Females relatively low i.e. 12and 20 (40%) of them presented with Type II (Non-Insulin Dependent Type) among whom the distribution slightly tilted to the side of females with 12 being on their side and 8 on their counterparts.

Table No 5: showing the Pre-operative visual acuity

V/A	Group A	Group B	Total
6/18	5(10.00%)	3(6.00%)	8
6/24	12(24.00%)	13(26.00%)	25
6/36	11(22.00%)	13(26.00%)	24
6/60	9(18.00%)	11(22.00%)	20
4/60	10(20.00%)	8(16.00%)	18
CFCF	36.00%)	2(4.00%)	5
Total	50(100%)	50(100%)	100

Of the total people undertaken, they were stratified base on their pre-operative visual acuity and they were subjected to PMMA IOL implantation and Acrylic IOL implantation as below.

Chart No 5: showing the Pre-operative visual acuity



Among those who had a visual acuity of 6/18, 5 (10%) were subjected to PMMA IOL implantation and 3 (6%) were subjected to Acrylic IOL implantation. Among those who had a visual acuity of 6/24, 12 (12%) were subjected to PMMA IOL implantation and 13 (26%) were subjected to Acrylic IOL implantation. Among those who had a visual acuity of 6/36, 11 (22%) were subjected to PMMA IOL implantation and 13 (26%) were subjected to Acrylic IOL implantation.

Among those who had a visual acuity of 6/60, 9 (18%) were subjected to PMMA IOL implantation and 11 (22%) were subjected to

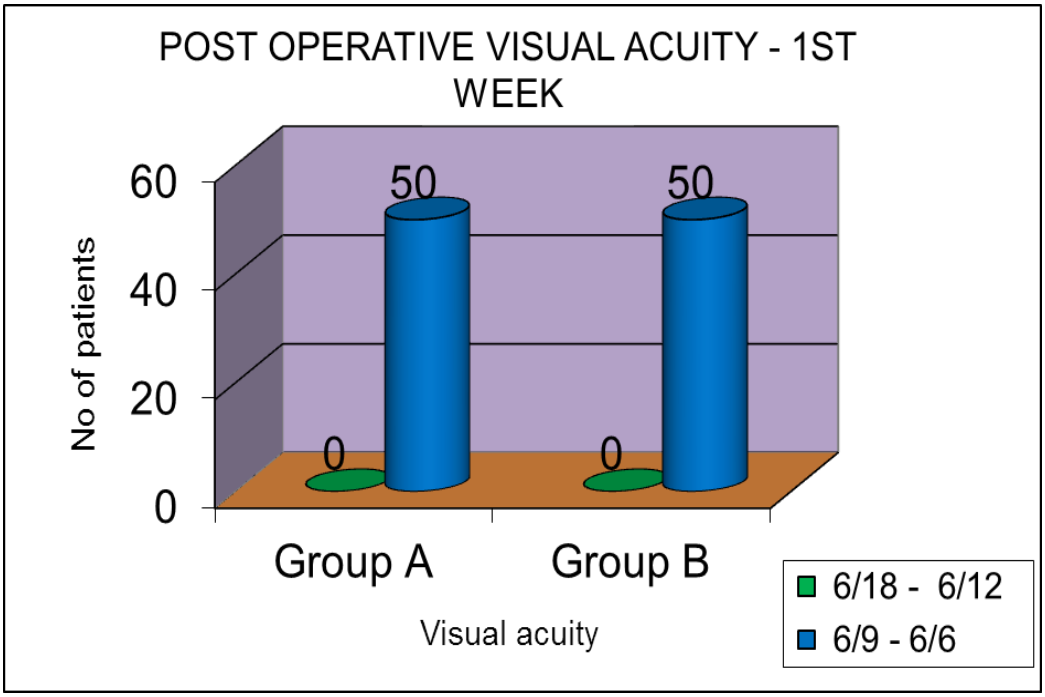
Acrylic IOL implantation. Among those who had a visual acuity of 4/60, 10 (20%) were subjected to PMMA IOL implantation and 8 (16%) were subjected to Acrylic IOL implantation.

Among those who had a visual acuity of CFCF, 3 (6%) were subjected to PMMA IOL implantation and (2%) were subjected to Acrylic IOL implantation.

Table No-6: Shows Best Corrected Visual Acuity (BCVA) of both groups at 1st week after surgery

Visual acuity	Group A	Group B
6/18-6/12	1(2.00%)	0(0.00%)
6/9-6/6	49(98.00%)	50(100%)
Total	50(100%)	50(100%)

Chart No-6: shows the BCVA of both groups at 1st week after surgery



Post-operatively, in the first week, the patients were stratified base on their visual acuity as below.

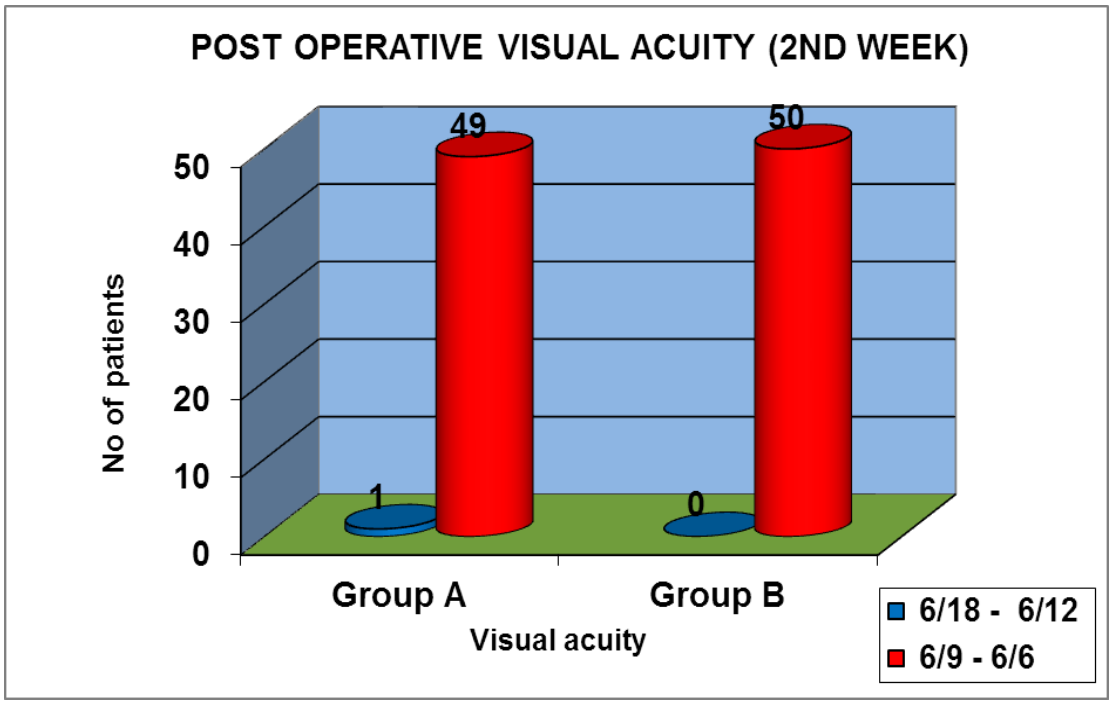
All 50 (100%) patients had their visual acuity in the range of 6/9 – 6/6 in both groups with none in the range of 6/18 – 6/12

Table No-7: BCVA of both groups at 2nd week after surgery

Post-operatively, in the second week, the patients were stratified base on their visual acuity as below.

Visual acuity	Group A	Group B
6/18-6/12	2(4.00%)	0(0.00%)
6/9-6/6	48(96.00%)	50(100%)
Total	50(100%)	50(100%)

Chart No-8: BCVA of both groups at 2nd week after surgery



All 50 (100%) patients had their visual acuity in the range of 6/9 – 6/6 in Group B whereas 49 (98%) patients had their visual acuity in the range of 6/9 – 6/6 in Group A and 1 (2%) in the range of 6/18 – 6/12.

Table No-8: BCVA of both groups at 2nd month after surgery

Visual acuity	Group A	Group B
6/18-6/12	3(6.00%)	0(0.00%)
6/9-6/6	47(94.00%)	50(100%)
Total	50(100%)	50(100%)

Post-operatively, in the second month, the patients were stratified base on their visual acuity as below. All 50 (100%) patients had their visual acuity in the range of 6/9 – 6/6 in Group B whereas 47 (94%) patients had their visual acuity in the range of 6/9 – 6/6 in Group A and 3 (6%) in the range of 6/18 – 6/12.

Chart No-8: Shows the BCVA of both groups at 2nd month after cataract surgery

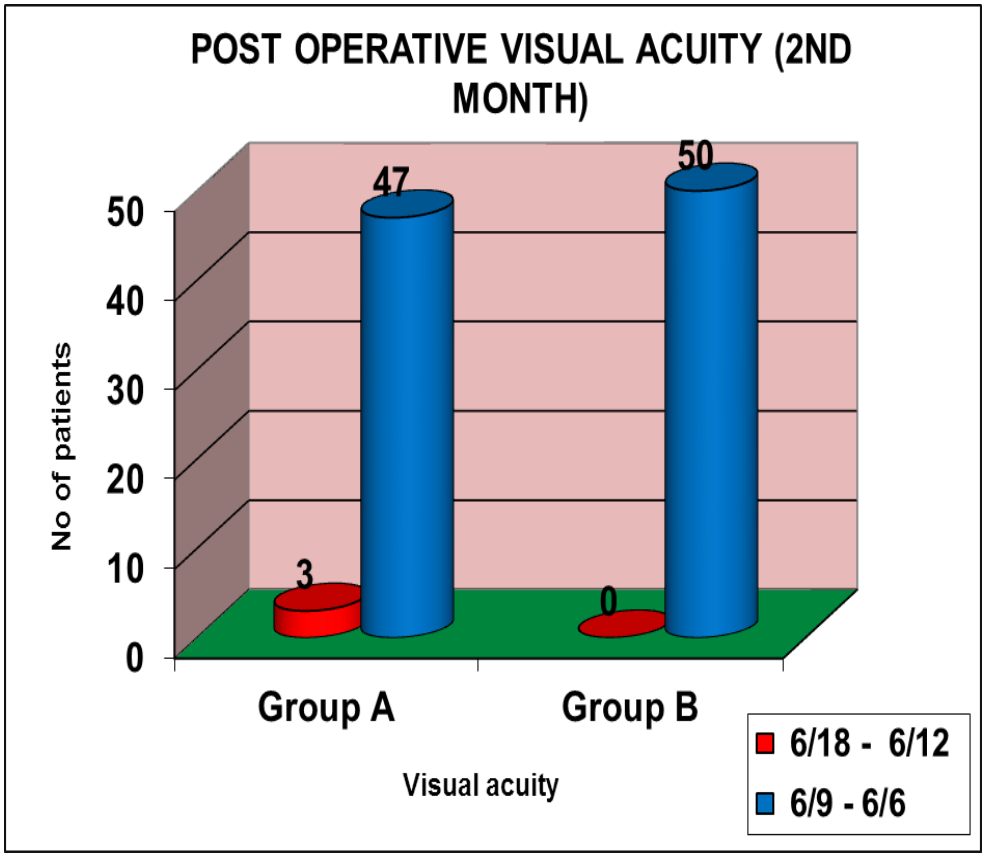


Table No-9: BCVA of both groups at 4th month after surgery

Post-operatively, in the fourth month, the patients were stratified base on their visual acuity as below.

VA	Group A	Group B
6/24-6/18	3(6.00%)	0(0.000%)
6/18-6/9	4(8.00%)	1(2.00%)
6/9-6/6	43(86.00%)	49(98.00%)
Total	50(100%)	50(100%)

49 out of 50 patients (98%) had their visual acuity in the range of 6/9 – 6/6 and the remaining 1(2%) in the range of 6/18 – 6/9 in Group B whereas 43 (86%) patients had their visual acuity in the range of 6/9 – 6/6, 5 (10%) in the range of 6/18 – 6/9 and 2 (4%) in the range of 6/24 – 6/18 in Group A

Chart No-9: BCVA of both groups at 4th month after surgery

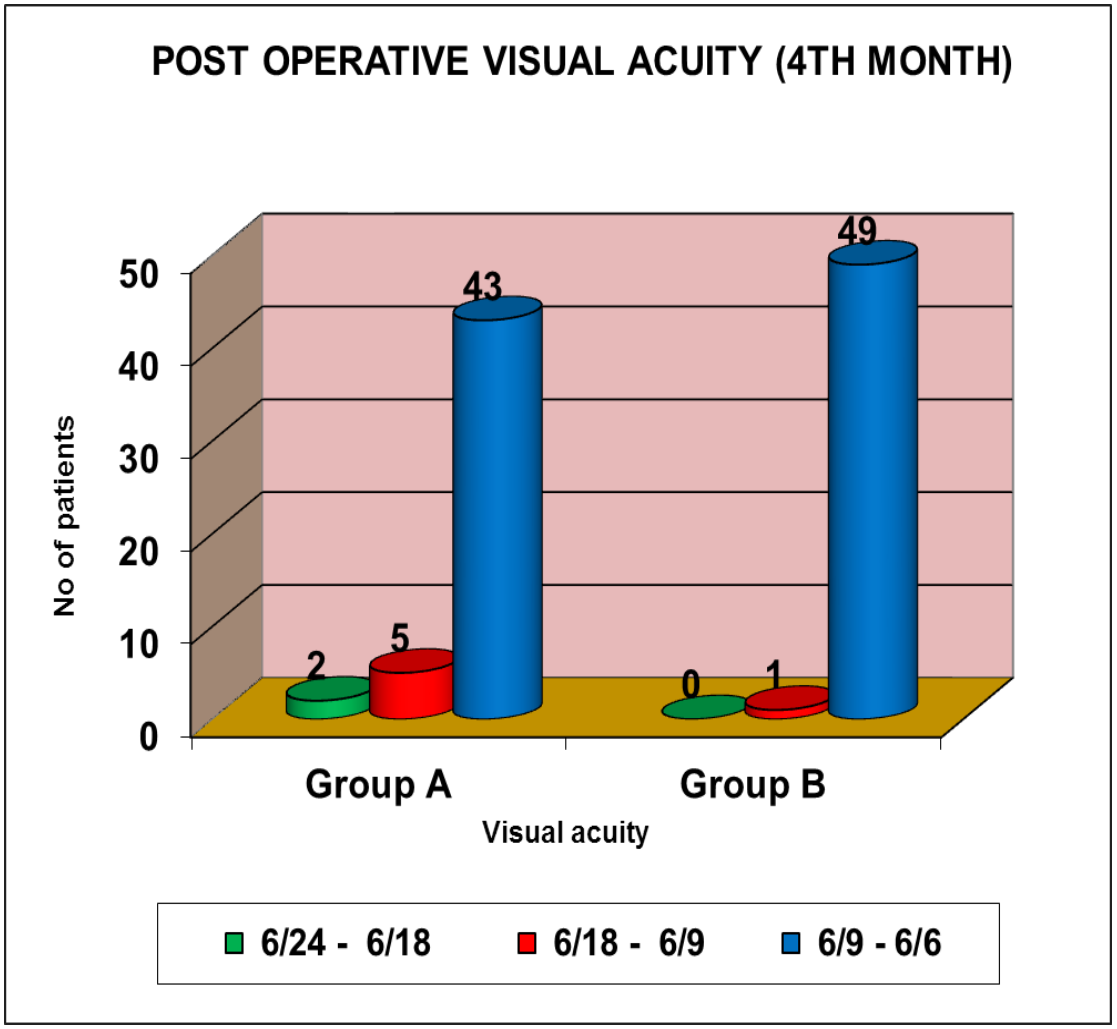
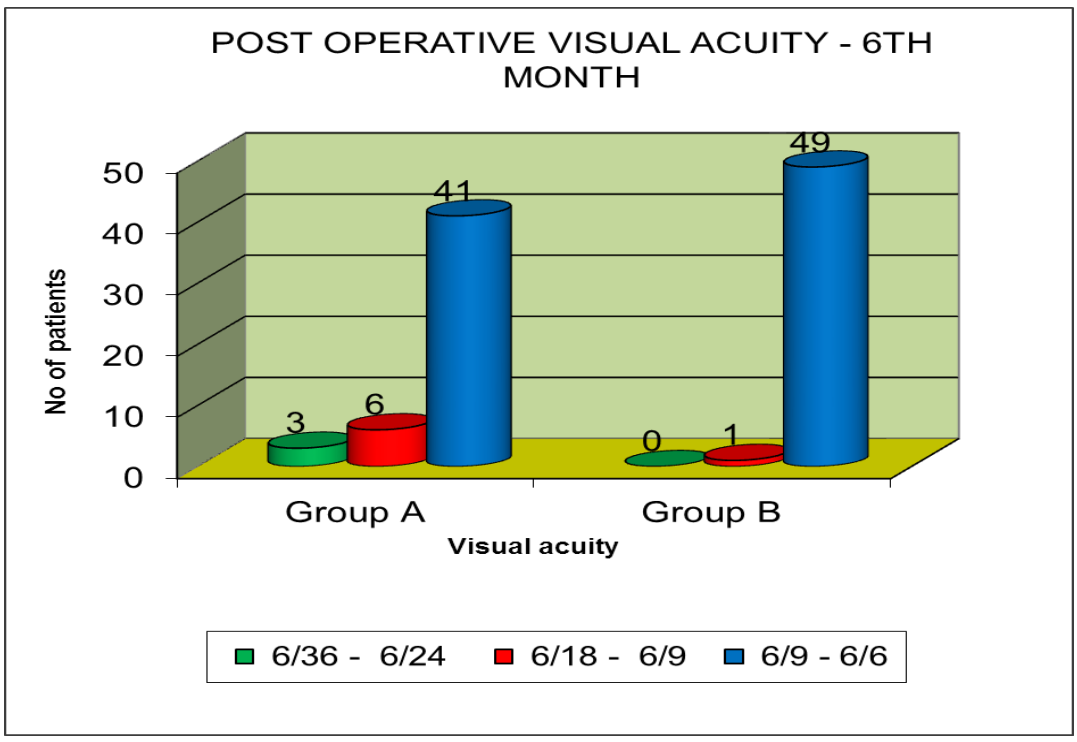


Table No-10: BCVA of both groups at the end of 6months

Post-operatively, in the sixth month, the patients were stratified base on their visual acuity as below

VA	Group A	Group B
6/36-6/24	4(8.00%)	0(0.00%)
6/24-6/12	5(10.00%)	1(2.00%)
6/9-6/6	41(82.00%)	49(98.00%)
Total	50(100%)	50(100%)

Chart No-10: BCVA of both groups at the end of 6months



. 49 out of 50 patients (98%) had their visual acuity in the range of 6/9 – 6/6 and the remaining 1 (2%) in the range of 6/18 – 6/9 in Group B whereas 41 patients (82%) had their visual acuity in the range of 6/9 – 6/6, 6 in the range of 6/18 – 6/9 and 3 in the range of 6/36 – 6/24 in Group A.

Table No-11: Formation of PCO in both groups at 1st week:

PCO	Group A	Group B
Grade 1 and 2	1(2.00%)	0(0.00%)
Absent	49(98.00%)	50(100%)
Total	50(100%)	50(100%)

Post-operatively, in the first week, the patients were stratified base on the extent of PCO as below. There was no apparent PCO formation (0%) in the first post-operative week in the both the groups

Chart No-11: PCO formation in both groups at 1st week

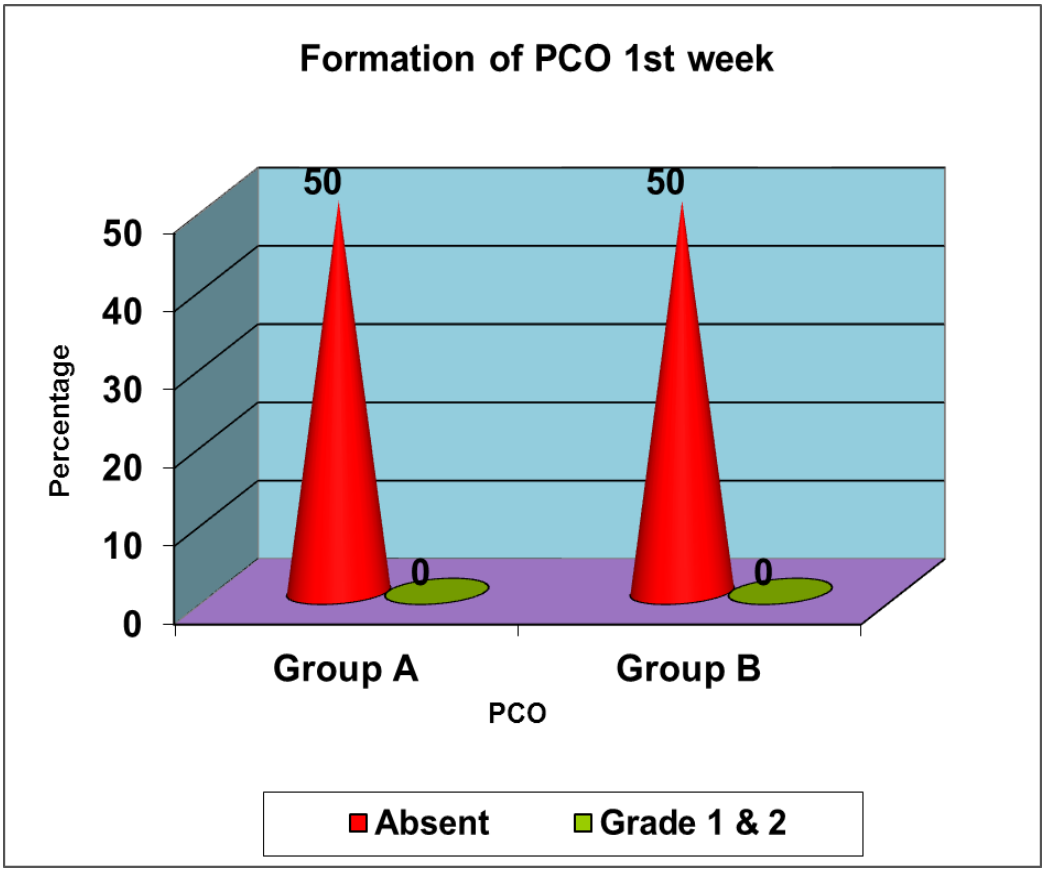


Table No-12: Formation of PCO in both groups at 2nd week:

Post-operatively, in the second week, the patients were stratified base on the extent of PCO as below. All 50 patients had no PCO formation (0%) in Group B whereas 1 patient (2%) had Grade 1 PCO formation in Group A.

PCO	Group A	Group B
Grade 1 and 2	2(4.00%)	0(0.00%)
Absent	48(96.00%)	50(100%)
Total	50(100%)	50(100%)

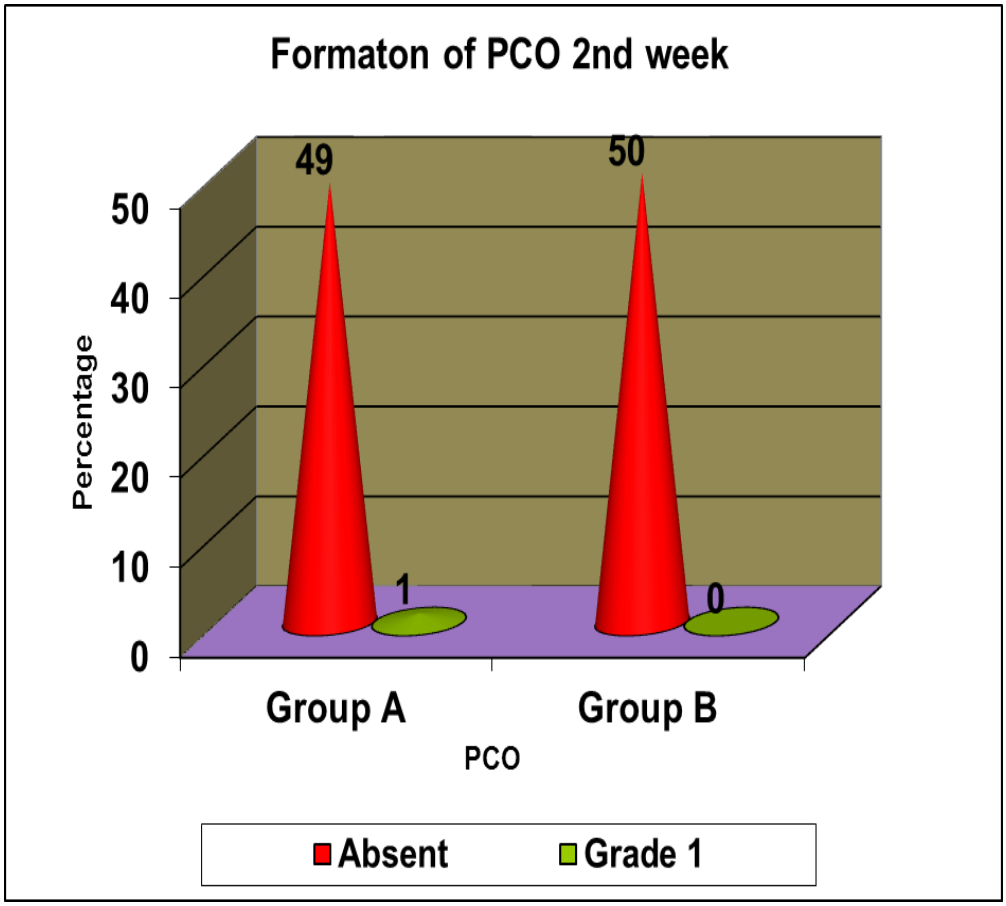


Table No-13: Formation of PCO in both groups at 2nd month:

PCO	Group A	Group B
Grade1 and 2	3(6.00%)	0(0.00%)
Absent	47(94.00%)	50(100%)
Total	50(100%)	50(100%)

Post-operatively, in the second month, the patients were stratified base on the extent of PCO as below. All 50 patients had no PCO formation (0%) in Group B whereas 3 patients (6%) had Grade 1 PCO formation in Group A.

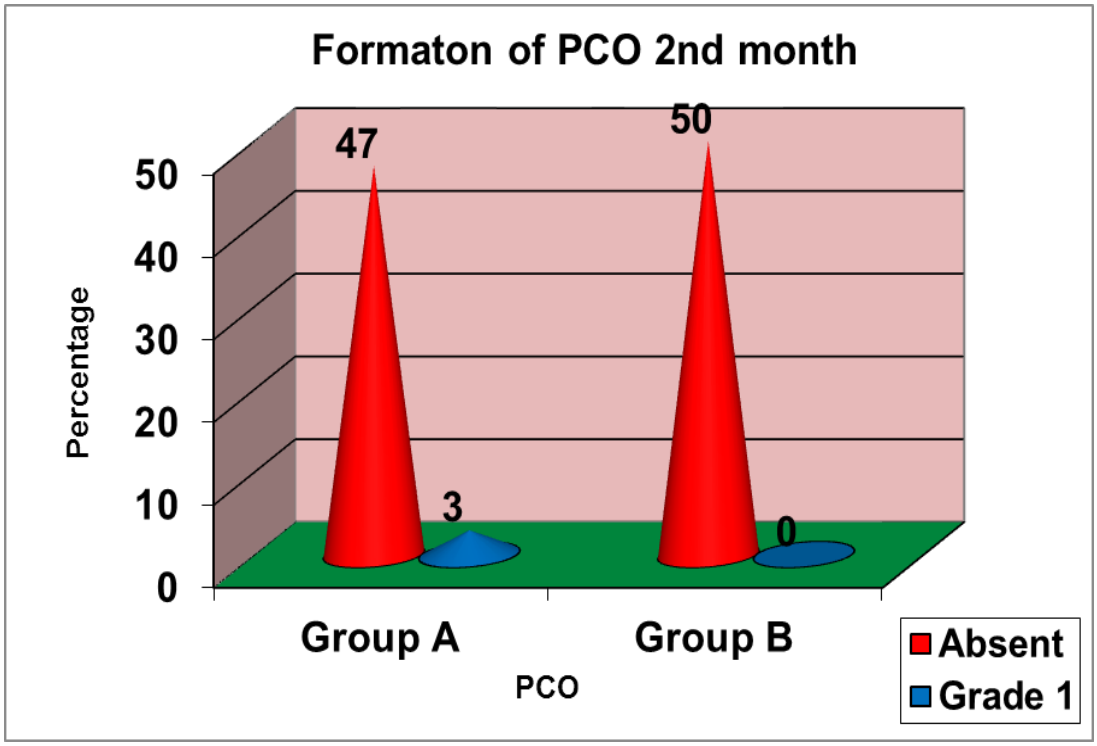
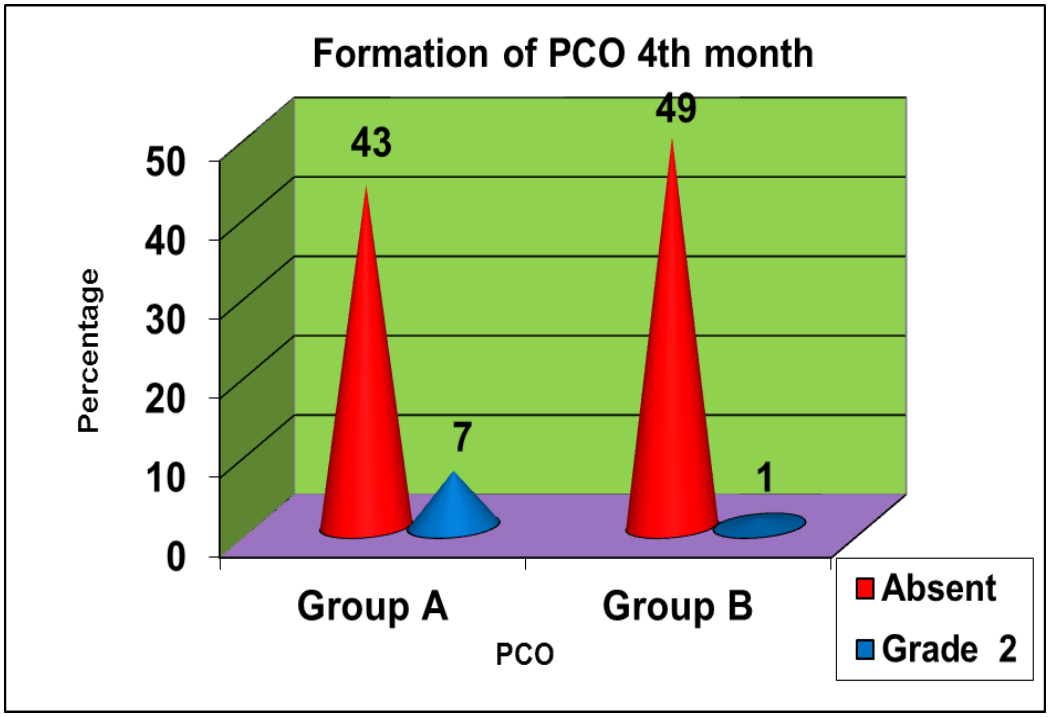


Table No-14: Formation of PCO in both groups at 4th month:

PCO	Group A	Group B
Grade 1and 2	7(14.00%)	1(2.00%)
Absent	43(86.00%)	49(98.00%)
Total	50(100%)	50(100%)

Chart No-14: PCO formation in both groups at 4th month

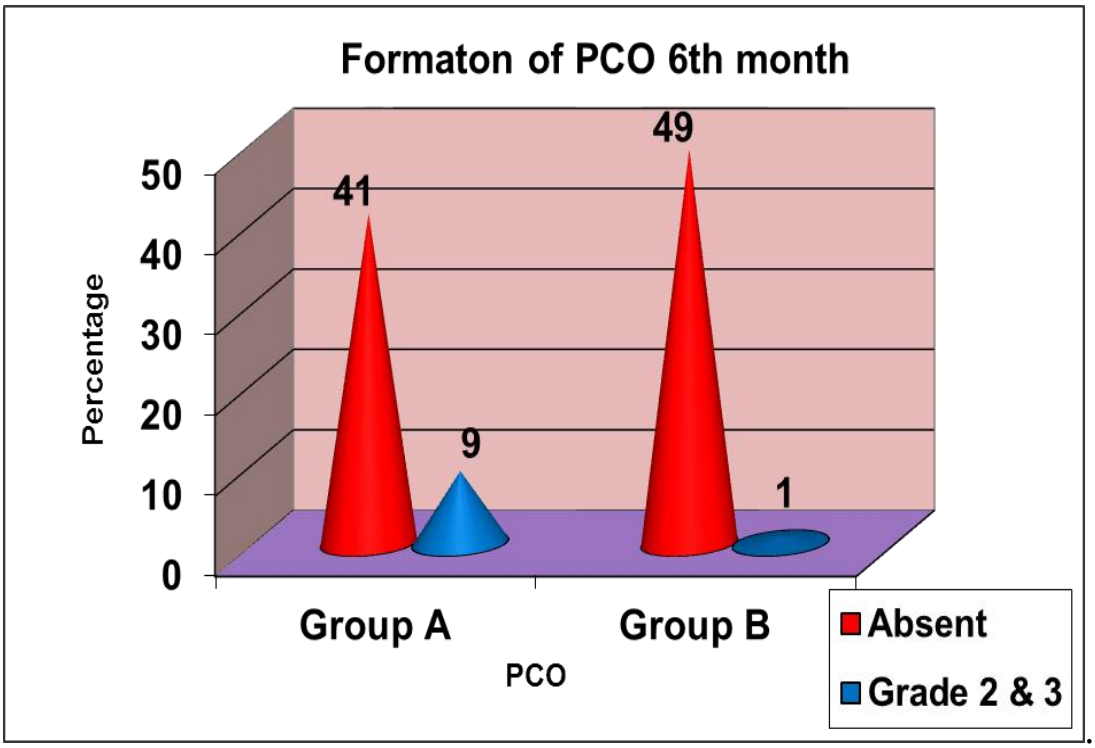


Post-operatively, in the fourth month, the patients were stratified base on the extent of PCO as below. 49 out of 50 patients (98%) had no PCO formation in Group B whereas 1 patient (2%) had Grade 2 PCO formation and in Group A, 43 (86%) had no PCO formation, whereas 7 patients (14%) had grade 2 PCO formation

Table No-15: Formation of PCO in both groups at the end of 6thmonth:

Post-operatively, in the sixth month, the patients were stratified base on the extent of PCO as below.

PCO	Group A	Group B
Grade 3	3(6.00%)	0(0.00%)
Grade 1&2	6(12.00%)	1(2.00%)
Absent	41(82.00%)	49(98.00%)
Total	50(100%)	50(100%)



49 out of 50 patients (98%) had no PCO formation in Group B whereas 1 patient (2%) had grade 2 PCO formation and in Group A, 41(82%) had

no PCO formation, whereas 9 patients (18%) had Grade 2 to 3 PCO formations.

P value=0.037, hence significant.

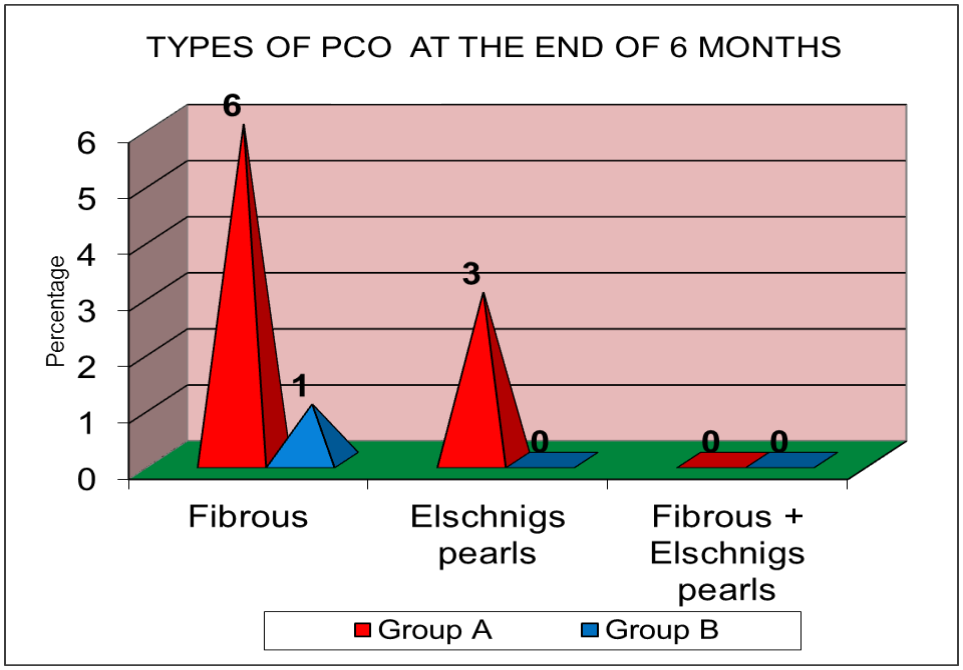
Table No-16: TYPES OF PCO at the end of 6months in both groups:

PCO	Group A	Group B
Fibrous	6(66.66%)	1(100%)
Elschnig's Pearls	3(33.33%)	0
Fibrous+ Elschnig's Pearls	0	0
Total	9(100%)	1(100%)

The various types of PCO were distributed as follows:

Only 1 in the Group B was of the fibrous type whereas in Group A 6 were of the fibrous type, 3 were of the Elschnig pearls type and no mixed type was reported in either of the groups.

Chart No-16: shows the types of PCO at the end of 6 months



Calculation of p- value:

Calculated mid p value: 0.037 which is less than 0.05 and hence there is a significant difference between the outcome in patients who underwent surgery with PMMA and Acrylic IOLs with Acrylic being superior to PMMA IOL.

DISCUSSION

100 patients were included in our study. They were randomly assigned to either Group A or Group B. Those in Group A underwent phaco emulsification with implantation of rigid PMMA IOL. Those in Group B underwent the same procedure with implantation of foldable Acrylic IOL. Both groups had 50 patients each.

1. AGE

In our study mean age of patients in Group A was 56.72 ± 9.18 years. In Group B it was 56.62 ± 9.38 years. More patients belonged to the age group of 60-70 years accounting to 46% of the study population.

2. SEX

Out of 100 patients 52 patients (52%) were males and 48 (48%) were females. Male to female ratio was 1.08:1. As senile cataract doesn't exhibit sexual predilection, there was no P' value = 0.838 which is not significant difference between number of male and female patients in this study.

3. POST OPERATIVE VISION AND PCO FORMATION

49 out of 50 patients (98%) had their visual acuity in the range of 6/9 – 6/6 and the remaining 1 (2%) in the range of 6/18 – 6/9 in Group B whereas 41 patients (82%) had their visual acuity in the range of 6/9 – 6/6, 6 in the range of 6/18 – 6/9 and 3 in the range of 6/36 – 6/24 in Group A after 6 months.

The decrease in the post-operative VA in Group A was analyzed and was found to be associated with the increased incidence of PCO formation when compared to Group B at the end of 6 months as 49 out of 50 patients (98%) had no PCO formation in Group B whereas 1 patient (2%) had grade 2 PCO formation and in Group A, 41(82%) had no PCO formation, whereas 9 patients (18%) had Grade 2 to 3 PCO formation. This was retrospectively analyzed and was inferred as a gradual, increasing intensity PCO formation, than being of abrupt onset.

Hence this can be attributed to the material of IOL used. As this was predominantly a phenomenon in Group A patients, the likely reason for increased incidence is the material used – PMMA.

Decreased incidence (2%) of PCO in Acrylic IOL, when compared to PMMA (18%) IOL is mainly due to following factors:

- Acrylic IOLs have a tacky surface. This will create the bio adhesion between the capsule and the IOL which will prevent the migration of LECs towards the posterior capsule.
- The barrier effect of the Acrylic IOL is superior to the PMMA IOL. Sharp bend and complex folds created in the posterior capsule by Acrylic IOL will induce contact inhibition of migration of LECs towards the posterior capsule. This effect is superior and earlier in Acrylic IOL when compared to others.
- Capsulorrhexis edge is more stable on Acrylic IOLs than others.
- Schauersberger et al found that IOL material was important determinant in PCO rather than the edge design.
- The refractive index of Acrylic IOL was higher than the PMMA IOL. This allows it to have a thinner optic, which can be inserted through the smaller incision. So less BAB damage post operatively, which could not be possible with PMMA IOL. Because it requires larger size incision for its insertion, can induce post-operative astigmatism.

4. TYPES OF PCO:

Fibrous PCO was the commonest type found in our study (66.66%), Elschnig's pearls (33.33%) in Group A patients.

Fibrous PCO can appear 2 months to 6 months after surgery with Elschnig's pearls somewhat later. Higher fibrous PCO in our study might be because of less study duration. In a study by Cheng et al showed that fibrous PCO developed earlier than pearl type which supports our finding.

CONCLUSION

The modern cataract intra ocular lens surgery has given good visual results but this effect could be short term with the development of PCO, which being the most frequent complication following conventional cataract surgery.

In our study the rate of moderate to severe grades of PCO was found to be less with Acrylic IOL when compared to PMMA IOL, the difference was both clinically and statistically significant.

Visual outcome was excellent with Acrylic IOL when compared to PMMA, this also being statistically significant and clinically evident.

However this study must be confirmed by prospective, randomized, long term study in larger populations.

PART

THREE

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PROFORMA

NAME: AGE/SEX :
IP No:
ADDRESS:
TYPE OF DM AND TREATMENT HISTORY:
PPBS:
ALLERGY TO:
CONTACT NOS: OCCUPATION: RELIGION: DATE OF ADMISSION: DATE OF DISCHARGE: PROVISIONAL DIAGNOSIS: HAS INFORMED CONSENT BEEN TAKEN?YES/NO: CHIEF COMPLAINTS:
HISTORY OF PRESENTING ILLNESS:
DIMINUTION OF VISION-Gradual/sudden, Progressive/Static, Painless/painful DIMINUTION OF VISION FOR-Distance/Near/Both: HISTORY OF REDNESS/WATERING/DISCHARGE-Yes/No PAST HISTORY: H/O Bronchial asthma/Hypertension/Tuberculosis/other medical disorders.

OCULAR EXAMINATION:

RIGHT EYE LEFT EYE

ANTERIOR SEGMENT

PUPIL

LENS

PRE OPERTIVE EXAMINATION:

	RIGHT EYE	**LEFT EYE**
UCVA-BCVA		
TN BY SCHIOTZ TONOMETER		
DILATED FUNDUS		
DILATED SLIT LAMP EXAMINATION		
B SCAN		

DATE OF SURGERY:

INTRA OPERATIVE DETAILS:

IOL MATERIAL USED
IOL DESIGN
OPTIC DIAMETER OF IOL/OPTIC SHAPE
IOL-OPTIC EDGE PROFILE
SIZE OF CAPSULARHEXIS
LENS PLACEMENT IN THE CAPSULAR BAG

POST OPERATIVE FOLLOW UP:

TYPE OF IOL ACRYLIC/PMMA	1ST WEEK	2ND WEEK	2ND MONTH	6TH MONTH
UCVA-BCVA				
PCO&GRADING				
PPBS				

IMPRESSION:

MASTER

CHART

KEY TO MASTER CHART

S. No- serial number

IP No- in patient number

F- Female; M- male

IDDM- insulin dependent diabetes mellitus

NIDDM- non insulin dependent diabetes mellitus

Y- Yes

PPBS- post prandial blood sugar

VA- visual acuity

IOL- intraocular lens

PMMA- poly methyl methacrylate

PCO- posterior capsule opacification

A- Absent

SL. No	NAME	IP NO	AGE	SEX	IDDM	NIDM	PPBS	Pre op. VA	Type of IOL	Post operative VA					PCO					Type of PCO
										Week 1	Week 2	Month 2	Month 4	Month 6	Week 1	Week 2	Month 2	Month 4	Month 6	
1	KAVERI	87357	58	F		Y	103	6/18	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
2	POOVALINGAM	87385	46	M	Y		90	6/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
3	VIJAYALAKSHMI	87812	56	F	Y		110	6/24	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
4	KARUPPAYEE	87402	52	M		Y	88	6/24	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
5	BHAKKIAM	87952	53	F	Y		132	4/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
6	UNNAMALAI	87972	49	M		Y	122	6/36	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
7	PETCHIAMMAL	87958	45	M	Y		138	6/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
8	KOYHAI	87976	40	M		Y	112	6/36	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
9	OCHAYEE	87997	41	M	Y		104	6/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
10	CHINNAPANDIAN	87991	43	F	Y		99	6/36	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
11	RAMALINGAM	87964	45	M	Y		87	4/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
12	SARITHA	87949	64	M	Y		69	6/36	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
13	THIRUMALAISAMY	87961	54	M	Y		129	6/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
14	BALAKRISHNAN	87903	70	F		Y	105	4/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
15	PANDIAMMAL	87931	65	M	Y		132	6/36	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
16	KURUNJI	87999	61	F	Y		127	6/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
17	ARASAMMAL	87986	67	M	Y		133	6/36	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
18	PANDYANNAN	87967	64	F		Y	138	6/24	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
19	PONNAMMAL	88129	68	M	Y		121	4/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
20	MAYEE	88134	62	F		Y	112	6/24	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
21	MAYANDITHEVAR	88141	69	M	Y		130	6/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
22	MURUGESAN	88171	51	M		Y	89	6/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
23	SRINIVASAN	88173	69	F	Y		88	6/36	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
24	VIJAYA	87212	45	M	Y		99	6/24	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
25	POOVALIGAM	87385	40	F	Y		124	6/24	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/18-6/9	6/18-6/9	A	A	GRADE 1	GRADE 2	GRADE 2	FIBROUS
26	KARUPPAIA	87400	42	F		Y	122	6/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/18-6/9	A	A	GRADE 1	GRADE 2	GRADE 2	FIBROUS
27	CHELLAMMAL	87415	46	F	Y		105	6/24	PMMA	6/9-6/6	6/18-6/12	6/18-6/12	6/24-6/18	6/36-6/24	A	GRADE 1	GRADE 2	GRADE 2	GRADE 3	FIBROUS
28	SHANKARAPANDIAN	87396	43	M		Y	106	CFCF	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
29	ANDUSAMY	87432	58	F		Y	100	6/36	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
30	KARUPPAIA	87493	49	M	Y		120	4/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/18-6/9	A	A	GRADE 1	GRADE 2	GRADE 2	ELSCHNIGS PEARLS
31	RAMYA	87404	45	M		Y	103	6/24	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
32	KRISHNAMMAL	87436	53	F		Y	85	4/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/18-6/9	6/18-6/9	A	A	GRADE 1	GRADE 2	GRADE 2	ELSCHNIGS PEARLS
33	PITCHAMMAL	87438	51	F		Y	84	6/36	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/18-6/9	6/18-6/9	A	A	GRADE 1	GRADE 2	GRADE 3	ELSCHNIGS PEARLS
34	SELVARAJ	87490	56	M	Y		97	6/24	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
35	CHITRAYEE	87488	59	F		Y	73	6/36	PMMA	6/9-6/6	6/9-6/6	6/18-6/12	6/24-6/18	6/36-6/24	A	A	GRADE 1	GRADE 2	GRADE 3	FIBROUS
36	PUTHUPILLAI	87500	68	M	Y		93	6/18	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/18-6/9	6/36-6/24	A	A	GRADE 1	GRADE 2	GRADE 3	FIBROUS
37	ARUMUGAM	87595	62	F		Y	133	6/24	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/18-6/9	6/18-6/9	A	A	GRADE 1	GRADE 2	GRADE 3	FIBROUS
38	PERIYASAMY	87581	54	M	Y		130	6/36	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
39	CHINNAPONNU	87604	58	F	Y		122	6/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
40	LAKSHMANAN	87510	53	F	Y		112	6/24	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
41	AZHAGAPPAN	87608	55	M		Y	133	4/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
42	KANNAN	87686	64	M		Y	137	4/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
43	AZHAGAN	87579	68	M		Y	117	4/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
44	RABIYA BEEVI	86980	61	F	Y		128	6/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
45	SUNDARI AMMAL	87204	62	F		Y	124	4/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
46	GURUVAMMAL	87069	63	M	Y		135	6/36	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
47	RAMARANIANI	87220	63	F		Y	122	6/24	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
48	RADHAKRISHNAN	86594	61	M	Y		78	6/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
49	GURUVAMMAL	87253	69	M		Y	99	4/60	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
50	VIJAYA	87212	62	F	Y		109	6/18	PMMA	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
1	VEERAMMAL	87342	50	F		Y	112	6/36	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
2	KARUPPAIA	87400	53	M		Y	133	6/24	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
3	BHOOMA	87299	58	M	Y		108	4/60	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
4	CHINNAAZHAGU	87756	54	F		Y	119	4/60	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
5	KAMATCHAMMAL	87792	54	M		Y	106	6/24	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
6	DHAMODHARAN	87749	48	F	Y		99	6/36	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/24-6/12	6/24-6/12	A	A	A	GRADE 1	GRADE 2	FIBROUS
7	POOVALINGAM SAMY	87785	50	M	Y		84	6/60	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
8	SAROJA	87946	57	M	Y		79	6/36	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
9	PANCHAVARNAM	87966	47	M	Y		110	6/24	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
10	PAGYAMMAL	87968	42	F	Y		102	6/18	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
11	SANGILIMURUGAN	87910	41	M	Y		109	6/36	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
12	VADIVELAN	87916	42	F	Y		132	6/60	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
13	SUKUMARAN	87904	45	F		Y	78	6/24	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
14	RATHINAM	87903	63	M		Y	90	6/24	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
15	VASANTHA	87963	69	F	Y		99	4/60	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
16	PALANISAMY	87896	63	M		Y	91	CFCF	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
17	THIRUVENGADAM	87851	52	F		Y	136	6/18	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
18	KARUPPANNAN	87941	62	M	Y		106	6/24	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
19	KALIAKKAL	87939	63	F	Y		108	6/60	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
20	SETHU	87905	68	F		Y	129	6/24	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
21	RONIKKA	88102	68	F	Y		109	4/60	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
22	AROKKIAMMAL	88113	65	F		Y	136	6/36	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
23	MANIVANNAN	88146	63	F	Y		132	6/36	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
24	MADHAVAN	88152	69	M	Y		130	CFCF	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
25	NATESAN	88160	62	F		Y	138	6/24	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
26	NARAYANASAMY	88175	63	M	Y		109	6/60	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
27	GANESAN	88181	68	F		Y	97	6/24	ACRYLIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
28	CHINNA AZHZGU	87226	45	F		Y	89	6/60	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
29	DHAMODHARAN	87349	42	M		Y	87	6/36	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
30	POKKISHAM	87356	48	M	Y		78	6/36	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
31	SEETHA	87457	41	M	Y		93	6/18	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
32	BABU	87441	41	M	Y		95	CFCF	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
33	VIRUMANDI	87469	46	F	Y		96	6/24	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
34	BABU MANI	87442	50	M		Y	112	6/60	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
35	SANGEETHA	87559	54	F	Y		136	4/60	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
36	BALSAMY	87600	57	F	Y		128	6/36	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
37	KANDHAN	87572	65	M		Y	127	6/60	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
38	SEBASTIN	87572	52	M		Y	136	6/36	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
39	VANDISAMY	87508	69	F	Y		125	6/24	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
40	IRULAYEE	87591	56	M	Y		115	6/60	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
41	KAMALAYEE	87599	70	F	Y		105	6/18	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
42	PETCHIAMMAL	86689	68	M	Y		101	6/24	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
43	MAYIL	87240	63	F	Y		109	CFCF	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
44	KRISHNAN	86991	64	F		Y	94	6/18	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
45	GOVINDHAN	87068	68	M	Y		91	4/60	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
46	MANIVANNAN	86666	62	M		Y	90	4/60	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
47	RAMUTHAI	87224	67	F	Y		108	6/36	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
48	PHILOMINAL	87242	69	M		Y	110	6/36	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
49	SADAYANDI	87252	65	F	Y		111	6/24	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	
50	KOMATHI	87192	64	M	Y		134	6/60	ACRILIC	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	6/9-6/6	A	A	A	A	A	

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"COMPARISON OF SHORT TERM CLINICAL RESULTS FOLLOWING IMPLANTATION OF ACRYLIC FOLDABLE INTRAOCULAR LENS AND POLYMETHYL METH ACRYLATE RIGID INTRAOCULAR LENS IN PATIENTS WITH DIABETES MELLITUS"

Submitted in partial fulfillment of requirement of

M. S. DEGREE
BRANCH – III (OPHTHALMOLOGY)

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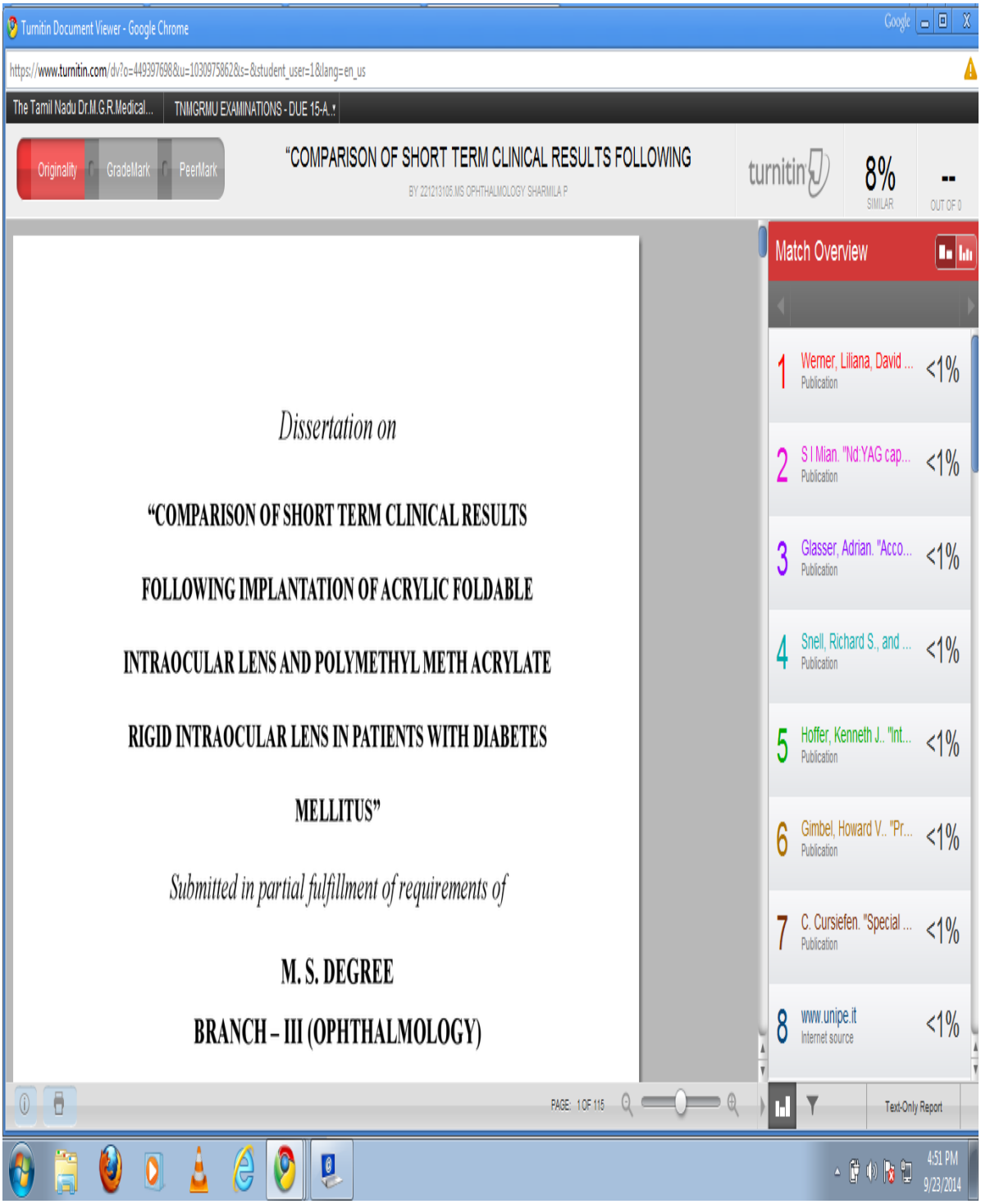
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