VISUAL OUTCOME AND INTRAOCULAR PRESSURE CHANGES AFTER Nd: YAG LASER CAPSULOTOMY IN PATIENTS WITH POSTERIOR CAPSULAR OPACIFICATION: A ONE YEAR HOSPITAL BASED PROSPECTIVE STUDY

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This is to certify that the dissertation entitled **"VISUAL OUTCOME AND INTRAOCULAR PRESSURE CHANGES AFTER Nd:YAG LASER CAPSULOTOMY IN PATIENTS WITH POSTERIOR CAPSULAR OPACIFICATION: A ONE YEAR HOSPITAL BASED PROSPECTIVE STUDY"** is a bonafide research work done by **REGISTRATION NO. BK0116003**

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ABSTRACT

INTRODUCTION

Posterior capsular opacification (PCO) is the most frequent post operative complication of cataract surgery. Advances in surgical techniques, intraocular lens (IOL) materials and designs have reduced the incidence of PCO development rate; however, it remains a significant problem resulting in suboptimal visual outcome of cataract surgery. Nd: YAG (Neodymium-Yttrium-Aluminum-Garnet) laser is non-invasive and effective means to deal with PCO. However safe it may have some complications. Rise of intraocular pressure is frequently experienced and incompletely understood complication of YAG laser capsulotomy and documented with contradictory results.

AIMS & OBJECTIVES

Primary objective

To assess the visual outcome after Nd: YAG laser capsulotomy

Secondary objectives

To evaluate IOP changes after Nd: YAG laser capsulotomy and to observe any other complications after Nd: YAG laser capsulotomy.

MATERIALS AND METHOD

This prospective study evaluated 60 eyes of 60 patients undergoing Nd:YAG capsulotomy for posterior capsular opacity. Complete ocular examination including Best Corrected Visual Acuity with Snellen's chart, slit lamp examination, fundus examination and applanation tonometry were performed pre and post laser in all

cases. Posterior capsulotomy was done with APPA YAG laser machine. All cases were examined pre and post laser after 1 hour, 1 week and 1 month. The quantitative variables were expressed as mean ± standard deviation (SD) and compared between the various follow-ups using paired t-test. The qualitative variables were expressed in terms of frequencies and percentages and compared using Chi-square/Fisher's exact test. A p-value < 0.05 was considered statistically significant. Statistical Package for Social Sciences (SPSS) version 16.0 was used for the statistical analysis.

RESULTS

In our study, there were 26 (43.33 %) males and 34 (56.67 %) females. Maximum number of patients were in the age group between 61 to 70 years i.e. 43.33 % followed by patients in the age group 71-80 years i.e. 25%.Average age of the patient was 63.98 years. Pre laser visual acuity ranged from 1/60 to 6/12. Results showed statistically significant improvement in Best Corrected Visual Acuity with 28.33 % patients had BCVA 6/6, 43.33 % had Best Corrected Visual Acuity 6/9 and 23.3 % had BCVA 6/12 at 1 month of post Nd:YAG laser posterior capsulotomy. Baseline mean IOP was mean 15.07 ± 2.81 mm Hg and post laser mean IOP was 17.20 ± 3.46 mm Hg at 1 hour, 16.70 ± 4.45 mm Hg at 1 day which returned to 15.38 ± 3.79 mm Hg on 1 week and returned to baseline value 15.03 ±2.99 mm Hg at 1 month. P values show statistically significant increase in IOP at 1 week. It was observed that 17 % of the patients showed no change in IOP while 63 % patients showed elevated IOP. Among these 78 % patients show rise in IOP that was ≤ 5mm Hg while only 5 % of the patients had a rise of IOP more than 5 mm Hg. Most of these patients achieved their baseline IOP within 1 week and only 5 % patients had

rise in IOP compared to baseline IOP on 1 week. Only 1 patient showed elevated IOP after 1 month that was only of 1 mm Hg.

DISCUSSION

Our study showed that Nd:YAG laser posterior capsulotomy provides excellent outcome in terms of improvement in Best Corrected Visual Acuity (BCVA). Results were statistically significant and most of the patients achieved vision upto or more than 6/9 as per snellen's chart. Most of the patients had a rise of IOP < 5 mm Hg which was transient and routine anti glaucoma medication may not be needed in all patients undergoing Nd: YAG capsulotomy. When correctly done with proper patient selection and thorough fundus examination, it is very economical, convenient, fast and non-invasive OPD procedure with immediate results. It carries a low but limited risk of complications. These complications are rare and rarely vision threatening.

CONCLUSION

Nd:YAG laser capsulotomy is effective, relatively safe, non-invasive, fast, outpatient procedure to improve hindered vision by PCO. To avoid complication it is suggested to screen the patient properly before the procedure and exercise caution and vigilance in high risk patients.

KEYWORDS

Posterior capsular opacification, Nd:YAG laser, posterior capsulotomy, Visual acuity, intra-ocular pressure

LIST OF ABBREVIATIONS

µm	–	micrometre
BCVA	–	Best corrected visual acuity
LEC	-	Lens Epithelial Cell
BD	–	Twice a day
CCC	–	Continuous curvilinear capsulorhexis
CME	–	Cystoid macular edema
D	–	Dioptre
ECCE	–	Extra capsular cataract extraction
ICCE	–	Intra capsular cataract extraction
IOL	–	Intraocular lens
IOP	–	Intraocular pressure
i.e	–	that is
nsec	–	Nano seconds
Nd:YAG	–	Neodymium-Yttrium-Aluminum-Garnet
PCO	–	Posterior capsular opacification
Psec	–	Pico seconds
PMMA	–	Polymethyl methacrylate
QID	–	Four times a day
RD	–	Retinal detachment
UV	–	Ultraviolet
VA	–	Visual acuity

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INTRODUCTION

Posterior capsular opacification also known as secondary cataract or after cataract, is the most common late complication of uncomplicated cataract surgery, historically occurring eventually in up to 50% of patients. It is caused by the proliferation of lens epithelial cells that have remained within the capsular bag following cataract extraction.[1]

The term posterior capsule opacification is actually a misnomer. It is not the capsule which opacifies; rather an opaque membrane develops as retained cells proliferate and migrate onto the posterior capsular surface.[1]

Ridley, who performed the first intraocular lens implantation in 1949, himself noted these complications in his earliest patients [2].Clinical studies have reported an incidence varying between 10% - 50% of posterior capsule opacification following ECCE or phacoemulsification with PCIOL implantation [3-9]. Its incidence has been reported to reach as high as 50% five years after surgery [3,10.] . In younger age groups, almost 100% opacification occurs within 2 years after surgery[11,12,13]. This is thought to be because of the higher proliferative capacity of the lens epithelial cells in the young compared with the old.

Factors for Prevention of Posterior Capsule Opacification

Surgery-related factors to reduce PCO:

- Hydrodissection-enhanced cortical clean up[14]: with the goal of removal of equatorial cells and cortex as opposed to single layer of anterior epithelial cells that does not migrate. Recent experimental animal studies have shown that use of

preservative-free lidocaine 1% during hydrodissection may diminish the amount of live LECs by facilitating cortical cleanup, loosening the desmosomal area of cell-cell adhesion with decreased cellular adherence, or by a direct toxic effect.

- In-The-Bag (Capsular) intraocular lens fixation[15]: The most obvious advantage of in-the-bag fixation are the accomplishment of good optic centration and sequestration of the IOL from adjacent uveal tissues.

- Capsulorhexis Edge on Intraocular lens Surface[16]: A significant addition to precise in-the-bag fixation,is creating a CCC diameter slightly smaller than that of the IOL optic. This places the cut anterior capsule edge on the anterior surface of the optic, providing a tight fit ("shrink wrap") and helping to sequester the optic in the capsular bag from the surrounding aqueous humour.

IOL-Related Factors to reduce PCO:

- IOL biocompatibility: It can be defined by many criteria, e.g. the ability to inhibit stimulation of epithelial cellular proliferation.[17]
- Lens design - A truncated, square-edged optic rim appears to cause a complete blockade of cells at the optic edge, preventing epithelial ingrowth over the posterior capsule.[14]
- Maximal IOL Optic-Posterior Capsule Contact: By posterior angulation of the IOL haptic and posterior convexity of the optic. This is due to the creation of a "shrink wrap", a tight fit of the posterior capsule against the back of the IOL optic.[14]
- Barrier effect of the IOL Optic: If IOL is accurately implanted in the capsular bag, it provides an excellent barrier effect, with almost complete filling of the capsular

bag and contact of the posterior IOL optic to the posterior capsule ("no space, no cells").[14]

Pharmacological agents to prevent PCO:

To prevent PCO, instillation of several drugs on the posterior capsule during cataract surgery have been tried. The main objective is to inhibit their proliferation and migration to kill the remaining lens epithelial cells and to minimize intraocular inflammatory reaction after surgery. Antimetabolites, cytotoxic drugs, immunotoxins, antiprostaglandins and more recently trypan blue ophthalmic dye have all been used effectively in vitro and in vivo in experimental animal studies.[21-27]

The main causative problem is limiting the effect to the lens epithelium and protecting the rest of the eye. Animal experiments have documented toxic effects on corneal endothelium, iris, ciliary pigment epithelium and retinal cells. An effective , practical and safe method of preventing PCO with pharmacological agents is not yet available.[21-27]

When "PCO" evolves following "ECCE", it leads to the same symptoms of cataract, like blurring of vision and glare. At present, the most widely practiced procedure for the management of symptomatic "Posterior capsular opacification" is Nd:YAG LASER capsulotomy. This procedure is not always free of complications and several complications have been reported in the various clinical studies.

The Nd: YAG lasing medium is a man made crystal of Neodymium doped yttrium-Aluminum-Garnet is a photodisrupter not a photo-coagulator like argon or krypton laser.[18] In laser machines, emitted photons are trapped in highly polished mirrors forcing them to travel back & forth in the cavity., the particle will be

stimulated when a photon passes close to an excited particle to emit a photon that is identical in wavelength, phase and spatial coherence to the first. This amplification continues, increasing the number of active photons.[19,20]

While doing Nd: YAG Laser capsulotomy some complications are likely to be encountered like rise in intraocular pressure, inflammations in eyes like vitritis, aqueous flare and retinal problems like retinal detachment, cystoid macular edema, and IOL related changes like IOL pitting are observed.[28]

Some previous studies reported incidence of CME in their study. The cause of these complications may be because these studies were conducted for longer follow up period of 6 months and 2 years. They also noticed influence of total energy on complication was significant.[29]

Among the complications, the rise in intra ocular pressure, although transient, is the most common complication associated with the procedure. Studies show a rise of about 25 to 30 mm Hg in about 1.6% patients undergoing the procedure.[16] Various reasons postulated for the rise in IOP are acute inflammation, trabecular clogging by capsular debris and released lens matter, trabeculitis from radiating pressure wave and vitreous herniation causing pupillary block. Studies show that rise in intraocular pressure is more commonly associated in patients with pre-existing open angle glaucoma and high myopia.[30,31]

Some of the studies did not find good visual acuity results and had reported very higher rates of risks associated with this procedure.[26]

The study was conducted to observe Visual Outcome, IOP changes, Inflammation and other complications following Nd: YAG laser capsulotomy.

OBJECTIVES

PRIMARY OBJECTIVE:

★ To assess visual outcome after Nd: YAG laser capsulotomy.

SECONDARY OBJECTIVES:

★ To assess IOP changes after Nd: YAG laser capsulotomy.

★ To observe any other complications after Nd: YAG laser capsulotomy.

REVIEW OF LITERATURE

HUMAN CRYSTALLINE LENS:

- It is a transparent structure, which is biconvex in shape and placed in between iris and vitreous in the saucer shaped depression, the patellar fossa. The main functions of lens are :
  - Optical function ie. Refracting the light.
  - To provide accommodation and thus aid in near vision.
- The lens has two surfaces. The anterior surface, which is less convex than the posterior surface. These two surfaces meet at the equator which is circular and has almost an undulating appearance. The centre of anterior and posterior surfaces are called anterior and posterior pole respectively.[32]

LENS TRANSPARENCY:

- Normal lens is a transparent structure. Its transparency is mainly accredited to the low number of scattering centres. Normal lens transmit almost 80 % of light without scattering. Lens is made of mainly protein molecules which are about 10 nm in diameter. Lens particle size is sufficiently small to reduce this scatter. Lens fibres are regularly arranged and are uniformly distributed. The factors which contribute to the transparency of lens are[32] :
  - Single layer of thin epithelial cells
  - Lens capsule is semi permeable
  - Sparsity and highly packed nature of lens cells
  - Characteristic arrangement of lens proteins

- Pump mechanism of lens fibres which regulate the water and electrolyte balance, thus maintain the lens in dehydrated state
- Lens is avascular
- High reduced glutathione concentration ensures the integrity of lens membrane pump.[32]

PERMEABLITY AND TRANSPORT MECHANISM OF LENS:

- It is essential for the maintenance of water and cat- ion balance, for transfer of nutrients for lens metabolism, also for disposing of waste products. [32]

- Most of the Na^+, K^+ ATPase activity in lens is found in its epithelium. 90% of energy generated by ATP in lens after glucose metabolism is utilised for active transport mechanisms. Important products which get transported by active process are sodium, aminoacids, potassium, taurine , inositol.[32]

- Passive transport occurs at lens capsule for water, ions and waste products of metabolism like lactic acid and carbondioxide.[32]

- The combination of active transport and this membrane permeability is called as pump leak system of the lens. By this theory, electrolytes like potassium and aminoacids can be actively transported into the anterior lens via lens epithelium from the aqueous humour. Then they can diffuse out to the posterior part of lens depending upon the concentration gradient as there is not any active transport mechanism over here. Sodium and potassium exchange occurs only by this mechanism.[32]

- Glucose enters the lens by a facilitated diffusion,which is not directly linked to active transport. Waste products of lens metabolism leave by simple diffusion.[32]

STRUCTURE OF THE LENS AND ETIOPATHOGENESIS OF PCO:

- The lens capsule is a basement membrane forming a complete sheath around the lens. It is thickest anteriorly, 14-20μm, and much thinner posteriorly, only 3-4μm, because the lens epithelium stops at the equator of the adult lens.[33] The pathogenesis of PCO has been well documented in the literature. Most cases of clinically significant PCO are caused by proliferation and migration of residual lens epithelial cells and their derivatives after cataract surgery.[4,34] In the normal lens, the epithelium consists of cuboidal anterior epithelial cells, which are continuous with the cells of the equatorial lens bow.[34] These two types of lens epithelial cells react in different ways following external stimuli.
- The **anterior epithelial cells** primarily differentiate into spindle-shaped, fibroblast-like myofibroblastic cells which are able to contract.[35] The contraction may cause folds and wrinkles of the posterior capsule similar to those seen in anterior polar cataracts.[36] In more advanced stages, white fibrotic opacities develop, leading to increasing capsular wrinkling and decreasing BCVA.[35] The **equatorial epithelial cells** consist of the germinal cells, those are the primary cells in the origin of PCO. They normally migrate centrally from the lens equator and contribute to the formation of nucleus, epinucleus and cortex throughout life. They tend to migrate backward and form large, balloon-like clusters called pearls, instead of undergoing a fibrotic transformation**.** They were first noticed by Hirschberg in 1901, and then by Elschnig in 1911, and are

nowadays referred to **Elschnig's pearls**.[4]The diameter of these cells is in the range of 5 -120µm.

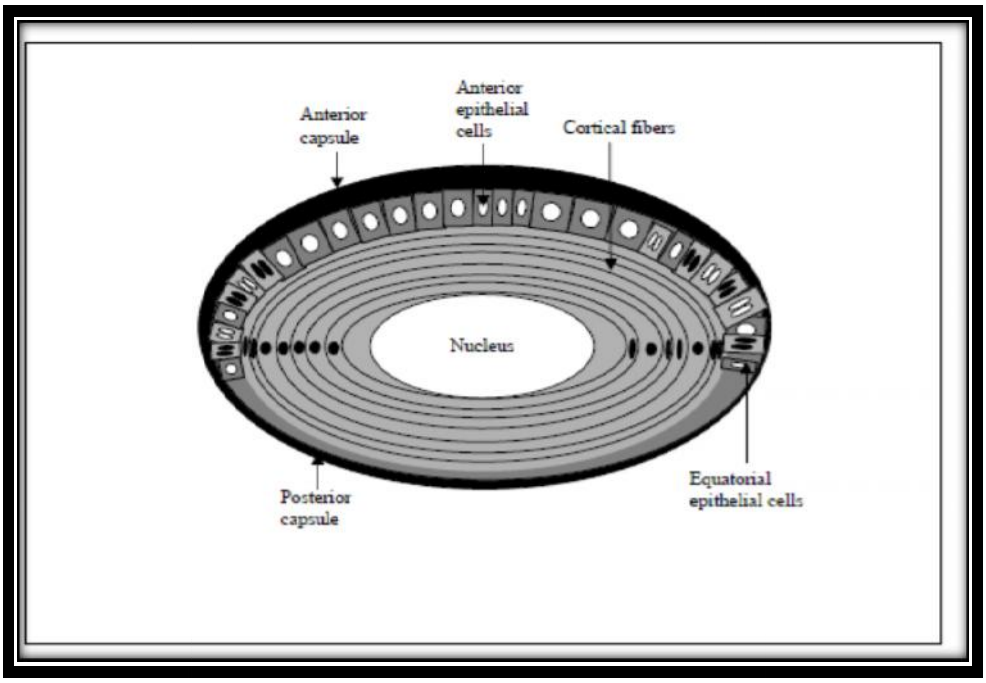


FIGURE 1: A SCHEMATIC DRAWING OF THE LENS AND THE EPITHELIAL CELLS

- Each pearl probably represents the aberrant attempt of one epithelial cell to differentiate into a new lens fiber.[4,35] As epithelial cells proliferate and migrate onto the posterior capsule, two main types of opacities are often clinically differentiated. It is thought that anterior epithelial cells play a major role in the pathogenesis of the **Fibrosis type of PCO** (Figure 2) and equatorial epithelial cells account for the **Pearl type of PCO** (Figure 3).[4,37]

Figure 2: Fibrosis Type of PCO

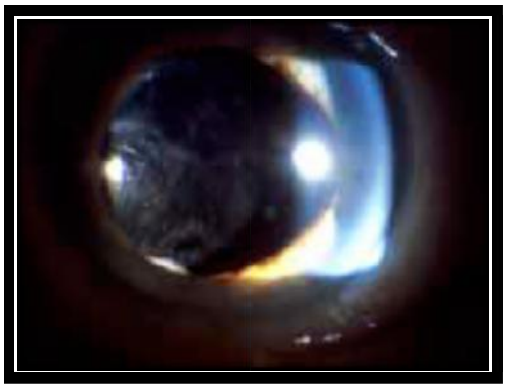
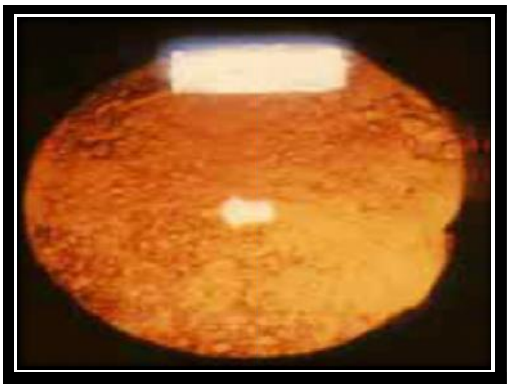


Figure 3: Pearl Type of PCO



- The equatorial cells are also responsible for the formation of **Soemmerring's ring**, which is a doughnut-shaped lesion composed of retained or regenerated lens cortex and cells, and which may form after any type of disruption of the anterior lens capsule.[4,36] Clinically significant PCO decreases visual acuity, impairs contrast sensitivity and increases glare.[38,39]

RISK FACTORS FOR PCO FORMATION:

- Several systemic and ocular conditions are said to associated with increased formation of PCO.[40] They include :
  - Diabetics are associated with severe PCO formation compared to non diabetics.
  - Myopic eyes were postulated to have more incidence of PCO formation.
  - Patients with previous uveitis in the eye is associated with more chance of PCO formation. However, usage of hydrophobic acrylic lenses in place of PMMA minimises the risk of PCO formation.
  - Steroid induced cataracts are associated with high incidence of PCO formation post operatively compared to others.

- Myotonic dystrophy patients have more incidence of posterior capsular opacification and thus more need for multiple Nd: YAG capsulotomies.
- Patient with retinitis pigmentosa has more chance of developing PCO post operatively compared to normal population.
- Traumatic cataracts are prone for PCO formation in almost 92% percent in a three-year follow up study.
- As the age of the patient is less, there is more chance of getting PCO post operatively. Paediatric cataracts are more prone to develop PCO.[40]

INCIDENCE OF PCO:

- **Aron Rosa D** et al in 1980 studied the incidence of PCO in USA. The incidence of clinically significant posterior capsular opacity in the USA had been quoted to be approximately 10% at 1 year, 20% at 3 years, and almost 30% at 5 years after surgery.[41]
- **Prajna NV** et al in 2000 did study to estimate the cumulative incidence of posterior capsular opacification. 1,700 patients with BCVA 20/120 or worse in the better eye had ECCE with posterior chamber IOL implantation, and 1,474 (86.7%) of these completed the 1-year follow-up examination. From this group of 1,474 pseudophakic patients, 400 were randomly selected for re examination 4 years after the original surgery. 327 (81.8%) of the selected population were examined between October 1997 and December 1998. Results showed that the median age of population was 60 years & 57.2% were women. 4 year incidence of visually significant posterior capsular opacity was 13.5% & each year of increased age was associated with decreased risk of opacification.[42]

- **K H Baratz, B E Cook** et al in 2001 studied Probability of Nd:YAG Laser Capsulotomy after Cataract Surgery. Rochester Epidemiology Project databases were used to identify retrospectively all Nd:YAG laser posterior capsulotomies performed on Olmsted County,Minnesota residents, who had previously undergone cataract extraction between 1988 and 1996.The study showed the cumulative probability of Nd:YAG laser posterior capsulotomy after cataract extraction as 6% at 1 year, 15% at 2 years, 23% at 3 years, 33% at 5 years and 38% at 9 years. In this study positive risk factors included younger age, extracapsular cataract extraction and earlier calendar year of surgery.[43]

- In a review of 90 studies related to complications following cataract extraction with IOL implantation, the pooled percentage of eyes experiencing PCO was 20%.[44] In a meta-analysis of 49 studies, published in 1998, the overall pooled estimate of the incidence of PCO was 10% at 1 year, 20% at 3 years and 25% at 5 years after surgery[45].It was seen that visually significant PCO develops during the first 5 years after surgery in more than 25% of patients undergoing standard ECCE and phacoemulsification with posterior chamber IOL implantation.[45]

ANALYSIS AND GRADING OF PCO:

- **SLIT LAMP GRADING OF PCO:**
- **Kruger** et al[46] had used a system for Slit – Lamp grading 0 to 3 to evaluate capsule opacification.

Grade 0: Absent

Grade I: Very mild

Grade II: Moderate

Grade III: Dense white.

- The capsule behind the optic was evaluated within a central area measuring 3 mm diameter, and also evaluated in the periphery. Variance was given to grading of Elschnig pearls and fibrosis.

- **Sellman and Lindstrom**[47] graded fibrosis and Elschnig pearl formation on a similar four point scale. The original paper contains diagrams to illustrate the various grades for both fibrosis bands and pearls. Those following grades were given;
  - **1**= no or slight PCO without reduced red reflex, also no pearls at all or pearls not to the IOL edge;
  - **2** = mild PCO reducing the red reflex, Elschnig pearls to the IOL edge;
  - **3** = moderate fibrosis or Elschnig pearls inside IOL edge but with a clear visual axis;
  - **4** = severe fibrosis or Elschnig pearls covering the visual axis and severely reducing the red reflex

FUNDUS VISIBILITY CRITERIA:

- According to **The Madurai Intraocular Lens Study IV: Posterior Capsule Opacification** which was done by **N. Venkatesh Pranjna et al**[42], Posterior capsule opacification was graded according to the following levels of severity, based on slit-lamp and dilated direct ophthalmoscopic evaluation:

- **No posterior capsule opacification**: No evidence of posterior capsule opacification seen before and after pupillary dilation to a minimum of 6 mm. With a direct ophthalmoscope, a clear view of the optic disk, blood vessels, and the nerve fiber layer is obtained.
- **Grade I**: No central posterior capsule opacification is seen. Posterior capsule opacification is seen only with the pupil dilated to a minimum of 6 mm. With a direct ophthalmoscope, a clear view of the optic disk, blood vessels, and the nerve fiber layer is obtained.
- **Grade II:** Posterior capsule opacification is present in the central visual axis, detectable with an undilated pupil.With a direct ophthalmoscope, there is a mild obscuration of fundus detail, in that the optic nerve head is clearly seen but the retinal nerve fiber layer and the blood vessels are not clearly seen.
- **Grade III:** Posterior capsule opacification is present in the central visual axis with an undilated pupil. With direct ophthalmoscopy, there is a marked obscuration of fundus detail, in that even the margins of the optic nerve head are not clearly defined because of the posterior capsule opacification.

LENS OPACITY METER:

- This has been used by **Olson and Crandall** [48] in a clinical study, as well as subjective slit lamp scores.

IMAGING SYSTEMS:

Scheimpflug system:

- **Lasa et al**[49] in 1995 showed that Scheimpflug photography might be a useful tool for future assessment of PCO.

- The Schiempflug photography system was further developed by **Hayashi** in 1998.[50]
  - It is based on the use of the EAS-1000 anterior eye segment analysis system equipped with area densitometry to measure the scattering light intensity.
  - This principle is applied to obtain a cross sectional image of the anterior segment.
  - An alignment system is coupled with a television monitor and the slit image of the best quality is transferred to the online image analysis computer. The computer uses area densitometry to measure the scattering light intensity, which is deemed equal to the opacification density. To measure the central 3 mm portion, three cross sections are taken at meridians of 0, 60, and 120 degrees and averaged out to give an approximate value of PCO.
  - The value obtained was shown to have a good correlation with the visual acuity.[51]

Digital photographic image acquisition systems:

- Digital image acquisition is particularly suited to the study of the biology of PCO.[52]
- Opacification occurs essentially in a single focal plane. The technician sees the final image while the subject is still at the slit lamp, allowing him to determine directly that the image obtained is consistent with the clinical findings. Rapid access to the images is feasible and the images are subsequently in a format accessible to a computerised analysis.
- The main advantage of using computer software to analyse images is that observer bias can be reduced and accuracy increased.[53]

Brightness based analysis:

- This technique relies on the image's pixel grey values (light intensity of the pixel) to classify a pixel as belonging to the PCO area or not, based on a given threshold. The PCO is then evaluated by the percentage of classified pixels.
- **Wang et al**[54] used digital images taken with an EAS anterior segment analysis system. Brightness of different points on the digital image were graded 0 to 255 brightness units. A threshold of transparency was picked at 167 and the computer then calculated the percentage level of transparency in a particular area, with any pixel being above that value considered as being transparent.
- The advantage of this system is that it is objective in the sense that observers are not grading the capsules.

Density map system:

- An uneven illumination is accounted for by an image analysis technique that involves estimating the background illumination across the capsule.
- The original image is then divided by the illumination estimate to provide an illumination compensated image that is relatively free of variation.
- As a result variations in illumination levels caused by flash variation, film processing, and fixation are obviated.[52]
- The grading scheme of PCO assessed both the density (based on grey level of opacification) and percentage coverage. Final coverage was reported as percentage of region of interest covered and average density was converted to scale 0–4 for comparability with the clinical grading.

Computerised analysis of density boundaries:

- **Tetz et al**[55] first described a photographic analysis system in December 1997.Pictures were obtained with standard photographic slit lamp apparatus.
- Retroillumination photographs were obtained at different magnifications using coaxial illumination with standardised flashlight intensity.
- Other photographs with diffuse illumination and with slit at different angles were used to determine other sources of opacification and to determine IOL position.
- On the retroillumination photographs, areas of opacification are encircled and graded 0–4 according to perceived density.
- The overall PCO score is then calculated by multiplying the density of the opacification by the fraction of capsule area involved behind the IOL optic.

Colour coded grid system:

- The POCO-MAN system has been developed by those involved in the original Spalton system with the aim of developing a simple and cheap method for objective measurement of PCO.
- The software places a grid over the digitally captured image and the user identifies areas of PCO.
- The system then automatically calculates the area of PCO in the image as a percentage.[56]

TREATMENT:

- Before the era of Nd:YAG laser posterior capsulotomy, there were two possibilities to treat PCO; primary or secondary surgical capsulotomy and surgical polishing of the posterior capsule.[57-60] Soon it was observed that to minimize postoperative complications such as CME or RD, it is important to keep the posterior capsule intact if possible.[61]
- After the introduction of the Nd:YAG laser, it became the method of choice in treating PCO as it is non-invasive, outpatient based procedure, relatively safer with rapid results. Alternatives to laser capsulotomy are also studied, e.g. polishing with a neodymium:yttrium-lithium-fluoride picosecond laser. A polishing effect was achieved, but with higher energy settings the IOL was damaged.[62]

Nd: YAG LASER POSTERIOR CAPSULOTOMY

PRINCIPLES OF ND:YAG LASER:

- The introduction of Nd:YAG laser (neodymium:yttrium-aluminum-garnet) to eye surgery took place in 1973, when Beckman used it for thermal cyclodestruction.[63] In the same year, Krasnov showed that optical breakdown of transparent non-absorbing tissue by high power pulsed laser was possible.[64] The use of the Nd:YAG laser was permanently established in ophthalmology independently by Fankhauser in Switzerland[65] and Aron-Rosa in France[41] (Figure 4 and 5).

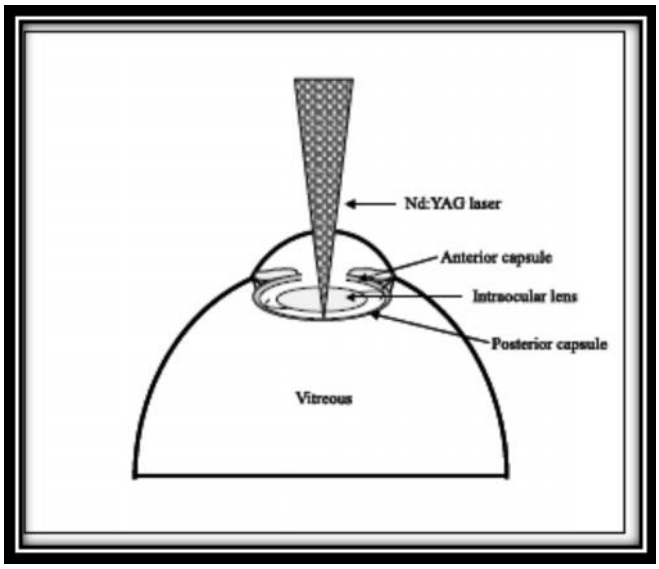


FIGURE 4 : A SCHEMATIC DRAWING OF LASER CAPSULOTOMY

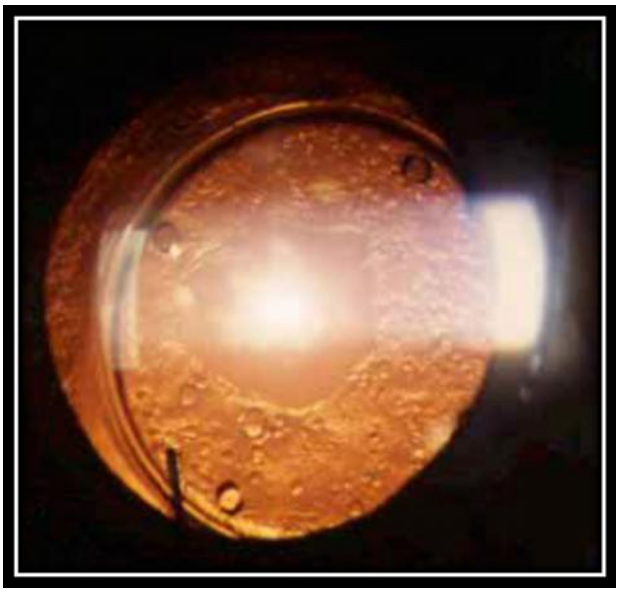


FIGURE 5: POSTERIOR CAPSULE AFTER LASER CAPSULOTOMY

- The active element of a neodymium laser consists of neodymium atoms embedded in a crystal structure. The most successful host for neodymium lasers is the yttrium-aluminum-garnet crystal-Y3Al5O2, known as YAG. The Nd:YAG laser is pumped by a gas discharge lamp. The pump energy is absorbed by the neodymium atoms, which are then excited into a higher energy level and a highly irradiating light pulse at a wavelength of 1064 nm is emitted. The laser beam is invisible but is focused to the target tissue with a

helium-neon guiding laser beam. When focusing the emitted laser energy into a very small region, a sudden temperature rise of approximately 10,000°C is generated. In such a temperature all matter is transformed into a gaseous state. All atoms of this gas become ionized, releasing free electrons. The neutral atoms, emerged ions and free electrons all move at high velocity and collide with each other. This state of matter is referred to as plasma, because it differs in its physical properties from normal gas. The phenomenon itself is designated optical breakdown.[66-68]

- Two main types of Nd:YAG laser devices exist: Q-switched and mode-locked. In a Q-switched laser, the laser pulse is typically 8 to 15 nsec in duration. A mode-locked laser pulse train is composed of seven to eight individual pulses, each of which has a duration of 10 to 15psec; the total pulse train lasts for 30nsec. In both models, the intention is to create very brief pulses of energy.[66] The Nd:YAG laser causes an ionizing, photodisruptive effect. The instantaneous high temperature rise generates an acoustic and hydrodynamic shock wave that results in tissue disintegration. It is thought, that several physical phenomena are responsible for the photodisruptive damage observed clinically; ionization, high temperature, generation of UV light-induced photochemical processes, acoustic transients, electrical field stress and cavitation.[66-68]

BENEFITS OF Nd: YAG LASER CAPSULOTOMY

- In general ophthalmic practice, most attention is given to visual acuity when assessing a patient's visual performance in relation to planned or executed procedures. The improvement in visual acuity after Nd:YAG capsulotomy in patients with significant PCO has been well documented.[69,70]

- **Aron-Rosa et al** reported an immediate improvement in visual acuity in 94% of cases treated by capsulotomy[41]. Decision on whether a patient should proceed to capsulotomy or not is usually made based on a combination of the patient's visual acuity and appearance of patient's posterior capsule, macula, and fundus visibility. Pearl-type opacification has a worse effect on visual acuity and contrast sensitivity than fibrous opacification.[38] These factors are subjective and often deceptive making any accurate prediction of potential visual outcome difficult.[41]

COMPLICATIONS:

Even though laser capsulotomy was first thought to be a very safe, non-invasive method to treat PCO, several complications have been reported.[69] Indeed, because of the abruptness of the plasma formation and the acoustic and hydrodynamic shock wave that it produces, the Nd:YAG laser can cause severe complications, especially if used incorrectly.

- A frequent complication is damage to the intraocular lens (IOL), which occurs in about 20- 40% of cases.[71-77] This may occur when the patient cannot fix his eyes or when he is apprehensive. It is also more likely to occur if the lens is in close proximity to the posterior capsule and if the membrane is thick.[71]

- Another complication is rupture of the anterior hyaloid face. This is more common in aphakia as compared to pseudophakia and occurs in about 15-22% cases.[75] It is thought to be a complication, instead of a usual consequence, because it allows the vitreous to move anteriorly. In aphakic eyes this anterior movement may cause a pupillary block and induce cystoid macular edema (CME), retinal detachment (RD) and late-onset corneal edema.

- The incidence of cystoid macular edema (CME) following laser capsulotomy ranges from 0.4% to 3%. When evaluated with fluorescein angiography, the frequency increases up to 13%.[73] CME is due to vitreous instability secondary to hyaluronic acid and prostaglandin diffusion through the compromised posterior capsule. It is also hypothesized that laser light may generate free radicals, facilitating prostaglandin production and inducing inflammation and ultimately CME.[74] It is less likely to occur if the interval between cataract surgery and Nd:YAG laser capsulotomy is long, at least 3 months.

- Nd:YAG capsulotomy increases the risk of developing retinal detachment. The possible mechanisms are direct retinal burn, vitreous herniation and subsequent traction, shock waves due to laser and chemical changes in vitreous.[78]

- Intraocular infection had been reported to occur after laser posterior capsulotomy in rare cases. It is thought to be due to release of pre-existing bacteria most commonly Propionibacterium acenes encapsulated between the IOL and posterior capsule.[79-80]

- Other less frequently encountered complications include corneal edema, bleeding from rubeosis iris, iris damage, IOL luxation into the vitreous cavity, pupillary block, iritis, vitreous opacification, retinal haemorrhage, prolapse of vitreous, intraocular gas or silicone oil into the anterior chamber.[74, 75,77]

- **INTRAOCULAR PRESSURE ELEVATION AFTER Nd:YAG LASER CAPSULOTOMY**

  - Post treatment pressure elevation is a common although usually transient complication after Nd:YAG laser capsulotomy. In most eyes the pressure

returned to pre-treatment levels within one week. The peak pressure rise was within three hours after the treatment.[81]

- The acute pressure rise is caused by impaired outflow, which may be due to:

  - Acute inflammation & trabecular clogging by capsular debris and released lens matter[82]

  - Release of cytokines and prostaglandin analogues in the media after the procedure are liable to give rise to raised pressure. Obstruction of the trabecular meshwork by debris and inflammatory cells from the capsulotomy is thought to cause a reduced drainage capacity.

  - Trabeculitis from radiating pressure wave[82]

  - Vitreous herniation causing pupillary block and acute glaucoma[82]

  - The pressure rise may result from disruption of the anterior cortical vitreous gel and the release of intra-vitreal substance into the anterior chamber. Also herniation of vitreous may infact push the intraocular lens & iris diaphragm ahead. If there is excess contact between capsule and iris, it may result in papillary block with further rise in intraocular pressure.

- Patient dependent risk factors

  - Patients with pre-existing open angle glaucoma had a higher risk of developing greater pressure elevation. The clinical significance of intraocular pressure elevation is of most concern in these patients with existing glaucomatous damage.[83]

- High myopia

- Intraocular pressure elevations are more common in aphakic than in pseudophakic eyes as intraocular lens could bar the cortical matter from reaching the trabeculum by trapping of the capsular debris posteriorly and may absorb some of the pressure energy.[84]

- **Keates RH et al** in 1984 studied long-term follow-up of Nd:YAG laser posterior capsulotomy in 6,800 subjects, 526 of whom had completed the six-month postoperative course by the time the data base was closed for analysis. Out of the 526 subjects who were treated with the laser, 87.8% had improvement in vision, with 82.9% achieving a visual acuity of 20/40 or better. This result compares favourably with results for the surgically treated population in which only 68.4% experienced improved vision, with 80.2% achieving a visual acuity of 20/40 or better. Complication rates in the patients treated with laser were very low (CME 2.3%, secondary glaucoma 3.6%, retinal detachment 0.4%, overall rate 4.8%). Only 5.7% of subjects had an intraocular pressure (IOP) rise upto 30 mm Hg or greater. The preoperative IOP level was achieved in 89% of subjects in the first 24 hours to one week. Predictors of IOP rise to 30 mm Hg or greater were determined to be preoperative glaucoma and preoperative IOP of greater than 20 mm Hg. [83]

- **Channell MM et al** in 1984 studied intraocular pressure changes after Neodymium:YAG posterior capsulotomy in 33 patients. Seven eyes had larger capsulotomies performed, averaging 250.7 mJ of energy per treatment. Rest had smaller posterior capsulotomies performed, averaging 48.3 mJ per treatment. Average IOP increases within the first day were 16.1 and 12 mm Hg, respectively.

All eyes in which IOP increased more than 5 mm Hg showed the elevation within the first 48 hours. Higher pressures were associated with increased energy and larger capsulotomies. Minimizing debris and shock waves are recommended as well as thorough postoperative pressure monitoring.[84]

- **Gardener KM et al** in 1985 studied Neodymium: YAG laser posterior capsulotomy in 100 cases at Jules Stein Eye Institute. Initial anatomic success was reported in 97 patients. Visual acuity improved in 90 patients, was unchanged in five and decreased in five. In the 5 patients after posterior capsulotomy, the decrease in visual acuity was unrelated to capsulotomy and caused by progression of preexisting retinal disease. The study concluded Nd:YAG laser as a effective modality in management of PCO.[85]
- **Wasserman EL et al** in 1985 studied Neodymium: YAG laser posterior capsulotomy in 367 patients and studied both risks and benefits. Specific attention has been given to intraocular pressure (IOP), corneal endothelial cell integrity, and visual acuity. The average maximum IOP rise was 1.4 mm Hg and this occurred within one hour of the procedure. Visual acuity improved to better than 20/30 in 87.5% of patients.[86]
- **Shani L et al** in 1994 studied Intraocular pressure after neodymium:YAG laser treatments in the anterior segment. They conducted a retrospective study of all Nd:YAG treatments during three years. 340 capsulotomies and 212 iridotomies were performed with the Q-switched Nd:YAG laser. In 15 eyes (4.4%) that had a capsulotomy, an IOP elevation of 10 mm Hg or more within two hours of laser was seen, but in 45 eyes (21.2%) that had an iridotomy. In 13 out of the 15 patients in which the IOP increased after capsulotomy, additional risk factors (glaucoma, high myopia, aphakia) were found. Their results indicate that posterior

capsulotomy with the Nd:YAG laser in otherwise healthy, pseudophakic eyes is usually not accompanied by immediate IOP elevation. Elevation can be predicted by risk factors and therefore anticipated in a small group of vulnerable patients.[87]

- **Magno BV, Datiles MB et al** in 1997 studied Evaluation of visual function following neodymium:YAG laser posterior capsulotomy in 24 patients. Measurements of visual acuity, contrast sensitivity (using the Pelli-Robson chart), and glare disability (using the Brightness Acuity Tester) were obtained from 24 patients before and after Nd:YAG laser posterior capsulotomy. The results showed significant improvement in visual acuity, contrast sensitivity, and glare disability measurements as compared with prelaser values.[88]
- **Holwegar RR and Marefat B** in 1997 studied intraocular pressure (IOP) after neodymium:YAG (Nd:YAG) laser posterior capsulotomy in 101 eyes that had phacoemulsification, anterior continuous curvilinear capsulotomy, in-the-bag intraocular lens (IOL) implantation and no apparent communication between the aqueous and vitreous compartments after the cataract surgery. Intraocular pressure was measured prelaser and at 1 to 3 and 24 hours, 1 week, and 1 month postoperatively. No significant IOP elevations occurred within 24 hours after the Nd:YAG capsulotomy. There was no relation between change in IOP and number of laser pulses, energy per pulse, or total energy.[89]
- **Auffarth GU et al** in 1997 analysed the energy levels for Nd:YAG laser capsulotomy in secondary cataract. They examined 172 patients concerning energy levels required for Nd: YAG laser capsulotomy. They analysed the influence of age, implant duration, IOL fixation and ocular conditions on total energy and repetition rate of Nd:YAG laser capsulotomy. Nd:YAG laser capsulotomies were performed on average 28.2+/ -17.7 months postoperatively.

The average total energy used was 12.7+/ -9.4 mJ. Visual acuity (Pre-YAG- was 0.3+/ -0.2. In the control group there was no correlation between implant duration or age and energy (P>0.43). 26 patients required a second Nd: YAG laser capsulotomy.[90]

- **Hayashi et al** in 1998 evaluated quantitative comparison of Posterior Capsular Opacification after methylmethacrylate, silicone, and soft acrylic Intraocular Lens Implantation in 240 eyes. The density value of PCO in 185 eyes was quantified approximately 2 years after surgery and found that the PCO value in PMMA group was significantly higher than that in silicone and acrylic group.[50]

- **Schaumberg DA et al** in 1998 performed a meta-analysis on incidence of posterior capsular opacification. The overall pooled estimates of the incidence of PCO were 11.8% at 1 year, 20.7% at 3 years, and 28.4% at 5 years after surgery. It concluded that visually significant PCO develops in more than 25% of patients undergoing standard extracapsular cataract extraction or phacoemulsification with posterior chamber intraocular lens implantation over the first 5 years after surgery.[45]
- **Ching-Yu-Cheng et al** in 1999 compared the visual acuity (VA) and contrast sensitivity in 2 types of posterior capsule opacification (PCO) in pseudophakic eyes before and after neodymium:YAG (Nd:YAG) capsulotomy. Study was performed on 29 patients with 14 eyes with fibrosis-type PCO and 15 eyes with Elschnig-pearl-type PCO. It concluded that after cataract surgery, patients with pearl-type PCO had lower VA and contrast sensitivity than those with fibrosis-type PCO. Nd:YAG capsulotomy improved the VA and contrast sensitivity in patients with both types of PCO.[91]

- **Ge J, Wand M et al** in 2000 studied the long-term effect of Nd:YAG capsulotomy on intraocular pressure (IOP). The study included 100 patients and followed up for a median of 1.5 years after capsulotomy. The mean +/- SD age of the study group was 76+/-7 years, and 37 patients had glaucoma. The changes in IOP in the eyes were significantly higher with those treated with capsulotomy than those in noncapsulotomy eyes at each time interval following capsulotomy.After Nd:YAG capsulotomy, long-term IOP is often elevated above precapsulotomy baselines, especially in glaucoma patients or patients who experience a significant IOP increase within hours after the capsulotomy.[92]
- **Wang J et al** in Sep. 2002 measured visual acuity, contrast sensitivity and glare sensitivity in 73 pseudophakic eyes before and after Nd:YAG laser posterior capsulotomy. It concluded that visual acuity, contrast sensitivity curve and glare sensitivity curve improved in all cases post operatively.[93]
- **Ando H et al** in 2003 studied Cumulative probability of neodymium: YAG laser posterior capsulotomy after phacoemulsification in 3997 eyes. The cumulative probability of capsulotomy was 1.95%, 18.50%, and 32.70% at 1, 3, and 5 years after cataract surgery, respectively. The probability of Nd: YAG laser capsulotomy was higher in eyes with a better preoperative BCVA, in women and in patients with retinitis pigmentosa. The foldable acrylic IOL had a significantly lower probability of capsulotomy.[94]
- **Hayashi K, Hayashi H et al** in 2003 in Japan studied 90 pseudophakic eyes of posterior capsular opacity. They measured visual acuity and contrast sensitivity with and without the presence of a circular glare source (using the contrast glare tester) before and after Nd:YAG laser capsulotomy. Scheimpflug videophotography system was used to measure the PCO density value. After

capsulotomy, mean visual acuity, contrast sensitivity, and glare sensitivity at all visual angles improved significantly. There was no significant correlation was found between visual acuity, contrast sensitivity, or glare sensitivity and the PCO value after capsulotomy. Hence, visual acuity reflects most accurately the degree of PCO. After capsulotomy visual function improves markedly and no longer has a significant correlation with PCO.[95]

- **Sheard, R. M. et al**, in 2003 studied the incidence of rational detachment after Neodymium: YAG laser posterior capsulotomy in patients with posterior vitreous detachment (PVD). The prevalence of PVD was significantly higher in eyes after ECCE and IOL implantation than in phakic eyes independent of Nd: YAG laser posterior capsulotomy.Presence or absence of PVD at the time of capsulotomy is not helpful in assessing the risk for RD in first year after laser treatment.[96]
- **Aslam TM and Patton N** in 2004 studied Methods of assessment of patients for Nd:YAG laser capsulotomy that correlate with final visual improvement in 24 eyes. Visual function was measured before and after capsulotomy. Correlations of the various preoperative measures with eventual visual function improvements were calculated. The improvement after Nd:YAG capsulotomy in visual acuity was 95% and contrast sensitivity was also 95%.[97]
- **Meena Zaidi and Saiyid Nasir Askari** in 2004 evaluated the effect of Nd:YAG laser posterior capsulotomy on anterior chamber depth, intraocular pressure, and refractive status on 52 eyes of 49 patients. Study concluded that there was a significant decrease in anterior chamber depth over time, no significant change in the intraocular pressure and changes in the spherical equivalent.[98]
- **Yilmaz, S. et al** in Sept. 2006 conducted a study on 128 pseudophakic eyes to determine the effect of Nd: YAG laser posterior capsulotomy size on refraction

and visual acuity. Patients were divided into 2 groups depending upon capsulotomy size, 80 had small size (< 4 mm) and 48 had large size (> 4 mm). Visual acuity and refractive error were measured post operatively and 1, 14, 30, 90 days post laser. It concluded that size of posterior capsulotomy does not affect refractive error and visual acuity.[99]

- **Zemaitiene R et al** in May 2007 evaluated the impact of sharp edged intraocular lenses (IOLs) with different haptic designs made from same hydrophobic acrylic material on posterior and anterior lens capsule opacification. He concluded that patients with one piece acrylic hydro phobic IOL group more frequently presented with capsular folds behind the IOL optic area than those in the three pieces IOL group.[100]
- **Ari S, Sahin A et al** in 2012 studied the effects of Nd: YAG laser posterior capsulotomy on macular thickness, intraocular pressure, and visual acuity in 30 eyes of patients with posterior capsular opacification following phacoemulsification surgery. Patients were classified according to total energy used during Nd: YAG laser capsulotomy (≤ 80 mJ = group I, > 80 mJ = group II). Mean total energy levels were 58 ± 18 mJ in group I and 117 ± 36 mJ in group II. BCVA at 1 week postoperatively and 1 and 3 months postoperatively was significantly better compared to preoperative BCVA in both groups. In group I, IOP increased 1 week postoperatively and declined to preoperative levels at 1 month. In group II, IOP increased 1 week postoperatively and did not return to preoperative levels during 3 months of follow-up. The results concluded increase in visual acuity. Increased IOP and macular thickness are inevitable after Nd:YAG laser capsulotomy, but the severity and duration are less when a total energy level less than 80 mJ is used.[101]

- **Gore V.S.** in 2012 studied the complications of Nd:YAG laser capsulotomy. Out of 200 patients, after YAG laser capsulotomy, most of the patients (86%) were significantly benifited by improved visual acuity. It concluded that the procedure is absolutely safe if strict selection criteria is followed. Most of complications are transient which can be managed with proper medication. Complications like retinal detachment or cystoid macular edema are multifactorial and cannot always be only due to laser capsulotomy alone.[76]
- **Mohal Lal Gupta** in 2012 studied Visual benefits of Nd:YAG laser capsulotomy in south eastern rajasthan on 100 patients. Nd: YAG capsulotomy was done by single surgeon without anesthesia as OPD patients. At three month follow-up after the Nd: YAG capsulotomy, every case achieved clear pupillary area 97% patients improved visual acuity by more than one line while 2% remained same and 1% patient deteriorated due to retinal pathology. It concluded that Nd:YAG laser capsulotomy results in improvement of visual acuity without serious complications. It is painless outdoor procedure.[102]
- **Khaleeda Nazeen Bari** in 2013 studied Nd:YAG laser posterior capsulotomy and visual outcome in 70 patients who developed PCO within 2 months to more than 2 years after cataract extraction with posterior chamber intra ocular lens implant. The average time interval of Nd: YAG laser capsulotomy and cataract surgery was 23 months. Capsular fibrosis (57.04%) was the predominant type of PCO. The pre laser visual acuity (VA) of more than 61.06% of eyes was 6/36 or below while 41.12% had VA hand movements to finger count. After Nd:YAG laser capsulotomy visual acuity of 6/18 or better was achieved in 63.9% of eyes while 9.94% recovered to 6/9 and 11.36% achieved 6/6. None of these eyes showed further deterioration in visual acuity. It concluded that Nd:YAG laser capsulotomy

for PCO is safe, effective and a rewarding procedure for improvement of vision.[103]

- **Erisa Yotsukura et al** in 2014 evaluated the effect of Neodymium:YAG laser capsulotomy on the visual function in patients with posterior capsule opacification (PCO) and good visual acuity in 16 patients. The Corrected Distance Visual Acuity (CDVA), 10% low contrast visual acuity (LCVA), wavefront aberrations from the 3rd to 6th order, and retinal straylight were measured before and after Nd:YAG laser capsulotomy. The study concluded that Neodymium:YAG laser capsulotomy enabled a significant improvement in visual function even in patients with PCO with good visual acuity. Retinal straylight measurements might be useful to determine the indications for Nd:YAG laser capsulotomy when patients report visual disturbances without decreased visual acuity.[104]
- **Shashi Jain, Shivcharan L et al** in 2014 studied Effect of Nd:YAG laser capsulotomy in pseudophakic eyes with special reference to IOP changes. Study evaluated the changes in IOP and visual acuity after Nd-YAG laser capsulotomy in 280 eyes with significant PCO after uncomplicated small incision cataract surgery with IOL implantation. IOP was recorded before and then after laser at 1hour, 2 hour, 3 hour, 24 hour and on seventh day in order to determine the IOP changes. After laser capsulotomy 91% of cases showed improvement in visual acuity by more than two lines in Snellen's vision chart. Transient rise of post laser IOP <5 mm Hg showed in 57% patients within first 2 hours and 33% patients did not developed rise of IOP. Whereas rise of IOP >10 mm Hg was found in 5% of cases. 92% patients achieved base line pressure within 4 hours. Study showed insignificant rise in IOP, and none of patient show vision threatening complication

after laser capsulotomy. Hence routine antiglaucoma medicine may not be necessary in all patients following Nd: YAD laser capsulotomy.[29]

- **Hawlina et al** in 2014 evaluated Optical coherence tomography for an in-vivo study of posterior-capsule-opacification types and their influence on the total-pulse energy required for Nd:YAG capsulotomy. They included 47 eyes with PCO scheduled for the Nd:YAG procedure were examined and divided into four categories: fibrosis, pearl, mixed type and late-postoperative capsular bag distension syndrome. The IOL/PC distances in two dimensions were measured, using custom-made computer software for OCT image analysis. The IOL/PC distances were compared with those of a control group of 15 eyes without PCO. They found that the total-pulse energy required for a laser capsulotomy differs significantly between PCO types ($p = 0.005$). The highest energy was required for the fibrosis PCO type, followed by mixed, pearl and late-postoperative capsular bag distension syndrome. The IOL/PC distance also significantly influenced the total-pulse energy required for laser capsulotomy ($p = 0.028$, linear regression). Lower total-pulse energy was expected for a larger IOL/PC distance.[105]
- **Biju Gopal** in 2015 studied Visual Outcome Following ND:YAG Laser Posterior Capsulotomy in 75 eyes of 75 different patients. All patients who underwent cataract surgery with posterior chamber intraocular lens implantation by a same surgeon patients in whom there was good post operative vision which gradually diminished over period of few months(atleast 2 months) to years which was purely or maximally attributable to PCO were included in this study. Final visual outcome in 25 eyes(33.33%) with 6/12 visual acuity followed by 15 eyes(20.0%) with 6/9 vision followed by 13 eyes(17.33%) with 6/18 visual acuity and 7 eyes(9.33%) with 6/6 vision.8 eyes did not show any improvement post laser.

There is excellent visual improvement following Nd;Yag posterior capsulotomy for posterior capsular opacification after cataract extraction if there is no other significant ocular pathology.[106]

- **Shankar Ganvit, Meera Shah et al** in 2015 studied Visual outcome and complications following Nd:YAG laser posterior capsulotomy. After thorough pre laser assessment Nd:YAG laser posterior capsulotomy was performed with YAG laser in 100 eyes of 100 patients. Visual acuity and complications like rise in IOP, aqueous flare and pitting of IOL (intra ocular lens) were noted. They found that duration of PCO development was earlier in young patients (3 months in 11 to 20 years of age), average duration is 24 months after cataract surgery and Nd:YAG laser posterior capsulotomy for PCO is universally accepted and rewarding procedure for PCO with good visual outcome.[28]
- **G S Gopinath et al** in 2015 studied Visual Outcome and Complications of YAG Laser Therapy for posterior capsular opacification following cataract surgery in 50 patients that had undergone extracapsular cataract extraction. 94% of patients were having Elschnig pearl and 6 % were with fibrous PCO. Post laser BCVA improved to 6/12 to 6/24 in the maximum number of patients followed by 6/6-6/12. It showed the maximum number of patients had IOP spikes followed by IOL pitting. Maximum IOP spikes were in the range of 21-27 mm Hg.[107]
- **Bhargava Rahul et al** in 2015 studied factors affecting laser energy levels required for neodymium: yttrium aluminium garnet (Nd: YAG) laser capsulotomy and to evaluate whether any correlation exists between applied laser energy levels and complications in 474 eyes and found that total laser energy levels were significantly higher with fibro‑membranous and fibrous subtypes of PCO. It was concluded that Type of PCO significantly influenced laser energy levels required

for capsulotomy, whereas IOL biomaterial and fixation did not. Complications such as IOL pitting, uveitis, IOP, CME was significantly more common when total laser energy was higher. It is recommended that the lowest possible single pulse laser energy be used for capsulotomy to minimize complications.[108]

- **B.Dharmraju et al** in 2016 presented A Clinical Study of Visual Outcome in Nd: YAG Laser Capsulotomy in Posterior Capsular Opacity. It was performed on 100 eyes and patients treated with laser capsulotomy were followed up over a period of 6 months and final visual outcome was evaluated. Visual acuity increased in about 95% patients. The rise of IOP up to 2 mm Hg within 4 hrs was 32%, 8% cases showed IOP rise of 3 mm Hg and 1 case showed rise of 5 mm Hg. Thus Nd-YAG laser therapy presented the advantage of a noninvasive, effective, relatively safe technique to manage intact posterior capsular opacity and it does not require patients hospitalization.[109]

- **Bhatnagar A et al** in 2017 studied The Effects of Different Techniques and Energy Used in Nd: Yag Laser Posterior Capsulotomy on Intraocular Pressure in 154 patients. The patients were divided into three groups. Group I forcruciate technique, group II for circular technique and group III for inverted U technique. Preprocedure intraocular pressure was recorded by using applanation tonometry. Patients undergoing Nd: YAG laser capsulotomy were seen after 2 hours, 1 day, 1week, 1 month and 3 months and IOP was recorded. The outcome was measured in terms of number of shots given in the technique, total energy used and intra ocular pressure changes after the laser. They found that the techniques cruciate and inverted U appears to be better and safer than the circular technique in terms of amount of energy used and the complications associated with it.[110]

MATERIALS AND METHODS

STUDY SITE

The study has been conducted at KLES. Dr. PRABHAKAR KORE HOSPITAL AND MEDICAL RESEARCH CENTRE, BELAGAVI.

STUDY POPULATION

Patients attending the Outpatient Department of Ophthalmology at KLES. DR. PRABHAKAR KORE HOSPITAL AND MEDICAL RESEARCH CENTRE, BELAGAVI.

STUDY DESIGN

The study was hospital based prospective study.

SAMPLE SIZE

The study included 60 patients who underwent posterior capsulotomy with Nd : YAG laser.

Sample size for the study is calculated by following formula:

$n = [(Z\alpha+Z\beta)\ SD/d]^2$

Mean difference = 2

Assumed SD of mean difference = 4

Effect size = Mean difference/ SD

= 2/4

=0.5

Type of error is 0.05

Power = 0.8 or 80

Z alpha = 1.96

Z beta = 0.84

$n = (2.8 \times 4)^2$

$= 31.36$

$= 35$

On accounting of dropout rate of around 20%, we had taken our sample size of 60 patients.

SAMPLING METHOD:

Simple Random Sampling among the patients attending Out Patient Department of Ophthalmology at KLE'S Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi.

TIME FRAME TO ADDRESS THE STUDY

The study was done between 1st JANUARY 2017 to 31st DECEMBER 2017.

MATERIALS REQUIRED

- SNELLEN'S CHART FOR DISTANCE VISION
- JAEGER'S CHART FOR NEAR VISION
- SLIT LAMP BIOMICROSCOPE
- GOLDMANN'S APPLANATION TONOMETER
- DIRECT AND INDIRECT OPHTHALMOSCOPE
- APPA YAG LASER INSTRUMENT

INCLUSION CRITERIA

1. Patients with age group > 10 years.
2. Patient with IOP of ≤ 21 mm Hg.
3. Pseudophakic eye with visual impairment due to significant PCO on examination with slit lamp.
4. Minimum period of 3 months following uneventful cataract surgery.
5. Decrease in vision by at least 2 lines on snellen's chart after 6 months of cataract surgery.
6. IOL implants following traumatic cataracts.

EXCLUSION CRITERIA

Patients of PCO unlikely to be benefited satisfactorily due to presence of co-morbidities like:

- Vitreous Opacities
- Corneal Opacities
- Retinal pathology accounting for loss of vision
- Operative complications like
    - Posterior capsular rent
    - Vitreous Loss
    - Residual Cortex
- Co-existing Pseudo-exfoliation
- Age below 10 years
- Patients unable to fixate adequately for the procedure
- Uveitis associated collagen vascular disorders
- Patient with glaucoma, glaucoma suspect or ocular hypertension
- Any history of previous intra-ocular surgery other than cataract surgery

METHODOLOGY

Patients who met the eligibility criteria were enrolled in the study. Detailed ocular, systemic, family history was noted with special reference to the date of the cataract surgery, type of the surgery, type of the IOL material and details of post-operative recovery period.

Pre-laser visual acuity by Snellen's chart, refractive status by auto-refractometer and subjective testing, intraocular pressure by Goldman's Applanation Tonometry was recorded. Pre-laser slit lamp examination and fundus examination with direct and indirect ophthalmoscopy, anterior and posterior segment photography were carried out. Patient was followed up with the same evaluation procedure immediately post-laser within 1 hour, 1st day post-laser, at 1 week and at 1 month.

BEST CORRECTED VISUAL ACUITY

It was measured by Snellen's chart for distant vision. Patient was instructed to read the letters on the Snellen's chart from a distance of 6 meters and the BCVA for distance vision will be noted. The same values were converted to logMAR scale for comparison and statistical analysis. Similarly BCVA for near vision will be recorded by using Jaeger's chart for near vision.

REFRACTIVE STATUS

Auto-refraction was recorded. Further, subjective testing for refraction was performed.

IOP MEASUREMENT

IOP would be measured by Goldmann Applanation Tonometer after using proparacaine eye drops (0.5%) and staining the eye with Fluorescein strip (fluorescein sodium I.P. 1mg), keeping the base reading of tonometer at 10 mmHg.

SLIT LAMP BIOMICROSCOPY

Slit lamp examination was done for evaluation of red reflex to quantify grading of PCO and anterior segment pathology.

FUNDUS EXAMINATION

Fundus examination was done after dilating the pupil with combination of Tropicamide 0.8% + Phenylephrine 5.0% drops. Fundus was evaluated using direct ophthalmoscopy and indirect ophthalmoscopy.

- **ND:YAG LASER CAPSULOTOMY**

  - Patient was informed about the procedure and written informed consent was taken.
  - Capsulotomy was done using APPA YAG - Q switched Nd:YAG laser instrument.
  - Eye undergoing procedure was dilated with combination eye drop Tropicamide 0.8% + Phenylephrine 5.0% to facilitate visualisation of the capsule and to reduce reflex pupillary constriction due to slit lamp beam.
  - Patient was reminded about painless nature of procedure and small clicks and pops heard during the procedure.

- Stool, table, chinrest and footrest were adjusted to optimal patients comfort and head strap applied to maintain fore head position.
- Room was darkened and illuminated fixation target was provided for the fellow eye.
- Capsule was focused with Helium- Neon (He-Ne) beam. Laser capsulotomy was started with using minimal energy (1 mJ initially and increased as per the need). Shots of laser were placed across the tension lines and openings created starting from 12'o clock position and moving towards 6'o clock.
- Patient was reviewed after 1 hour and post-procedural IOP was noted with Goldmann's applanation tonometry.
- Post-laser topical non-steroidal anti-inflammatory eye drops (Nepafenac 0.1 % w/v) was started four times a day for seven days to counteract post laser infection and inflammation. Anti-glaucoma medication (Timolol maleate 0.5%) was started two times a day in case of IOP > 25 mm Hg.
- Post-laser fundus photography and B scan were done at 1 month to rule out any posterior segment complications.

• STATISTICAL METHODS

The quantitative variables were expressed as mean ± standard deviation (SD) and compared between the various follow-ups using paired t-test.The qualitative variables were expressed in terms of frequencies and percentages and compared using Chi-square/Fisher's exact test. A p-value < 0.05 was considered statistically significant. Statistical Package for Social Sciences (SPSS) version 16.0 was used for the statistical analysis.

OBSERVATIONS AND RESULTS

ANALYSIS PLAN

Total of 60 eyes of 60 patients were included in the study.

The following observations were made:

TABLE 1: AGE – WISE DISTRIBUTION OF THE CASES (n=60)

Age (years)	n (%)
21 – 30	1(1.67%)
31 - 40	1(1.67%)
41 - 50	5(8.33%)
51 - 60	10(16.67%)
61 - 70	26(43.33%)
71 - 80	15(25.00%)
81 - 90	2(3.33%)
TOTAL	**60(100%)**
mean± SD	63.98±11.28

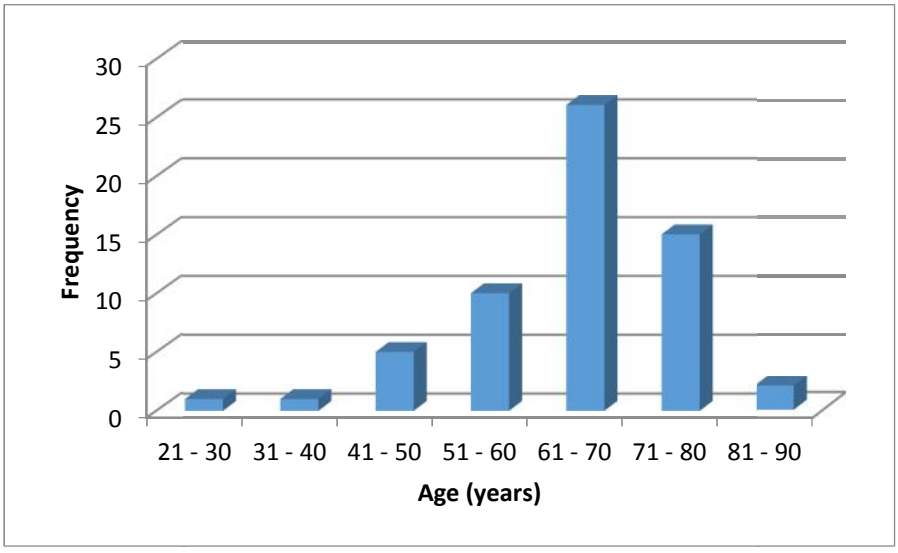


CHART 1: AGE – WISE DISTRIBUTION OF THE CASES

As shown in table 1, in our study maximum number of patients were in the age group between 61 to 70 years i.e. 43.33 % followed by patients in the age group 71-80 years i.e 25%. Average age of the patient was 63.98 years.

TABLE 2: GENDER – WISE DISTRIBUTION OF THE CASES

GENDER	NUMBER (%)
MALE	26(43.33%)
FEMALE	34(56.67%)
TOTAL	**60(100%)**

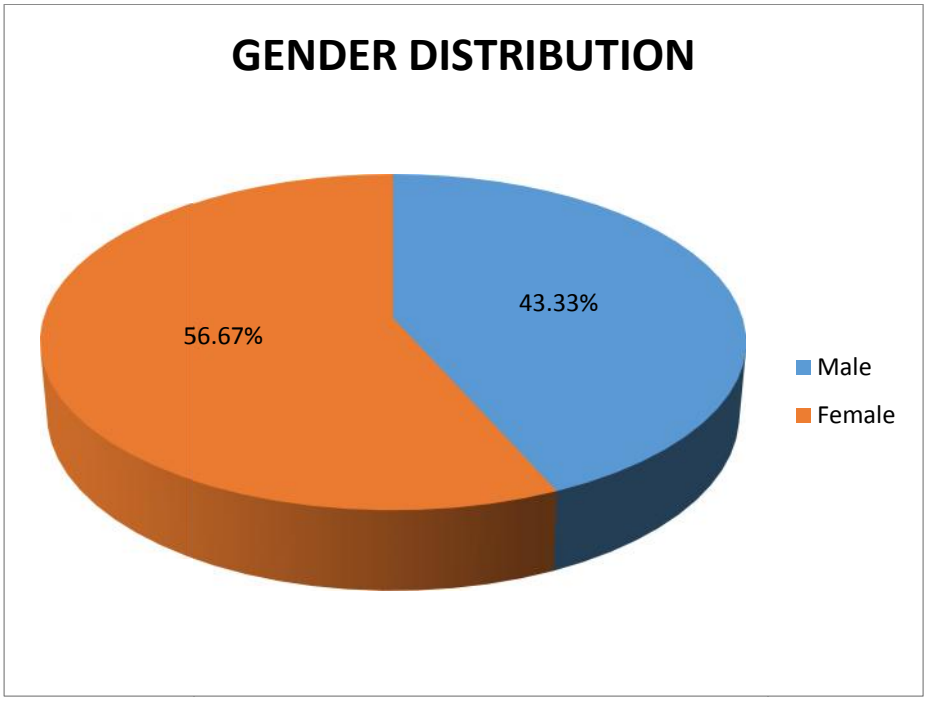


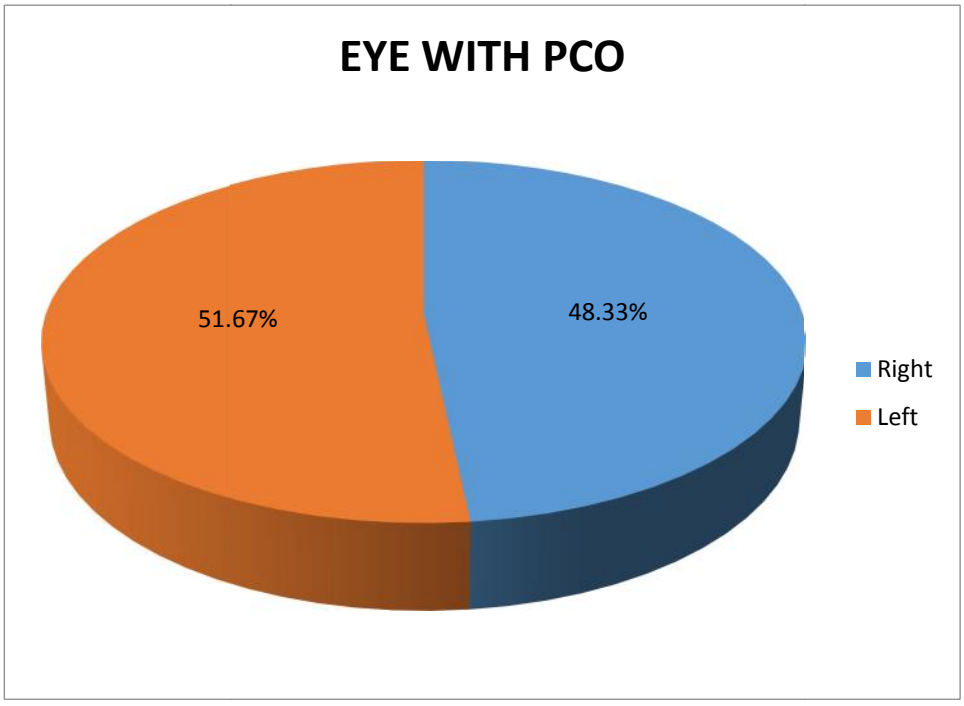
CHART 2: GENDER - WISE DISTRIBUTION OF CASES

As shown in Table 2, in our study there were 26 (43.33 %) males and 34 (56.67 %) females.

TABLE 3: LATERALITY OF INCIDENCE OF POSTERIOR CAPSULAR OPACITY

LATERALITY	INCIDENCE OF POSTERIOR CAPSULAR OPACITY (%)
RIGHT	29(48.33%)
LEFT	31(51.67%)
TOTAL	60(100%)

CHART 3: LATERALITY- WISE DISTRIBUTION OF CASES

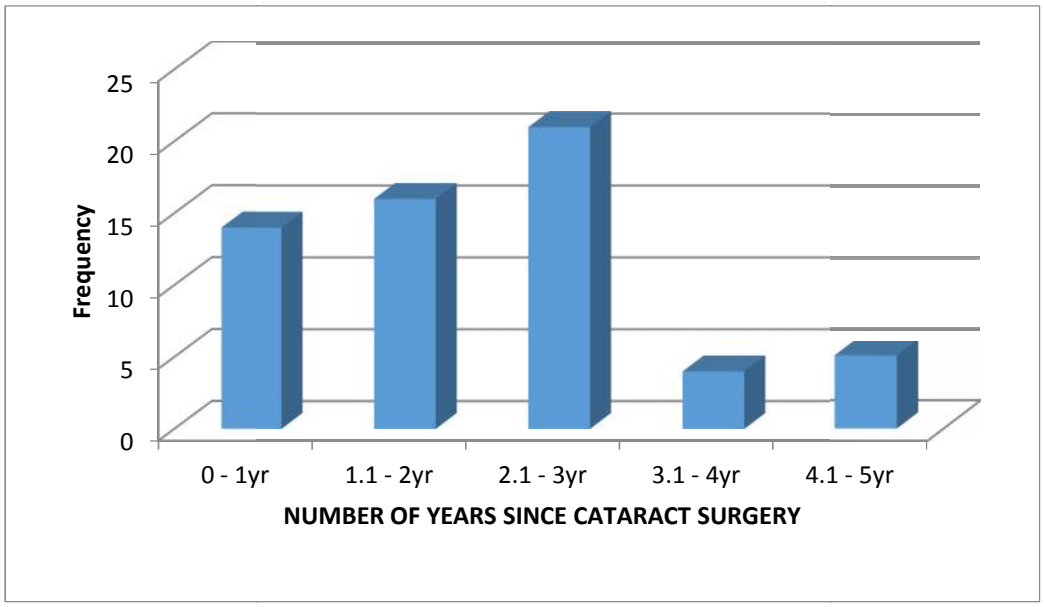


As shown in Table 3, in our study incidence of PCO in Right eye was 48.33 % and in Left eye it was 51.67%.

TABLE 4: DURATION BETWEEN CATARACT EXTRACTION AND DEVELOPMENT OF PCO (n=60)

S.NO	PCO SEEN AFTER CATARACT SURGERY(YEARS)	NUMBER OF EYES *(%)*
1.	0 – 1	14 (23.33%)
2.	1.1 – 2	16 (26.67%)
3.	2.2 – 3	21 (35.00%)
4.	3.1 – 4	04 (6.67%)
5.	4.1 – 5	05 (8.33%)
6.	**TOTAL**	**60 (100%)**
	Mean ± SD	**2.28 ± 1.17**

CHART 4: DURATION BETWEEN CATARACT EXTRACTION AND DEVELOPMENT OF PCO

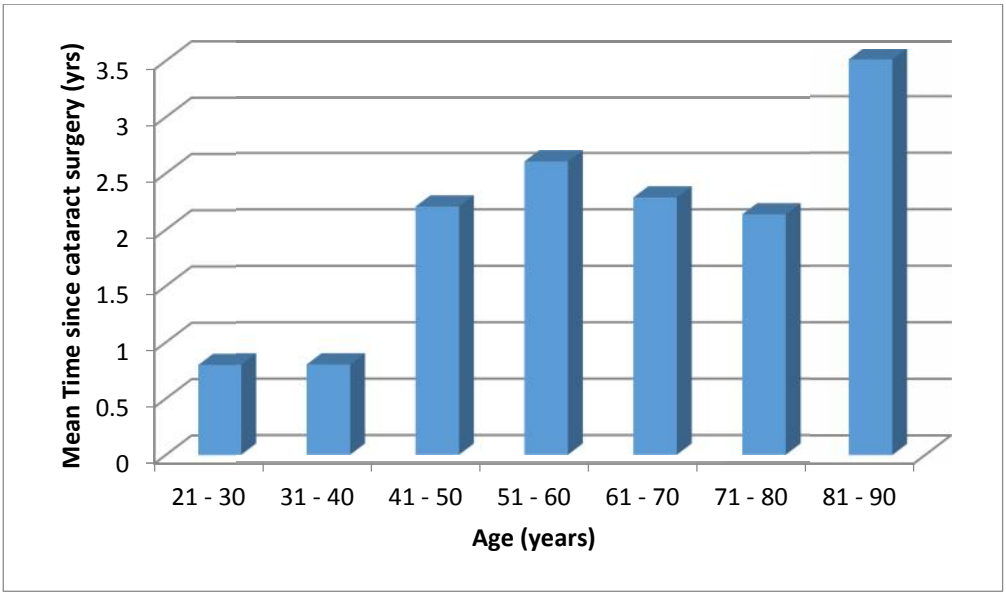


It can be observed that in 23.33 % cases PCO developed within 1 year, in 26. 67% cases within 1.1 to 2 years, in 35% cases within 2.1 to 3 years, in 6.67 % cases within 3.1 to 4 years and in 8.33 % cases within 4.1 to 5 years. Mean duration of time between cataract surgery and development of PCO was 2.28 Years.

TABLE 5: CORRELATION BETWEEN PATIENT'S AGE AND DURATION BETWEEN CATARACT EXTRACTION AND DEVELOPMENT OF PCO (n=60)

Age (years)	n	Time since cataract surgery (yrs)	
		mean	± SD
21 - 30	1	0.8	±0
31 - 40	1	0.8	±0
41 - 50	5	2.2	±1.75
51 - 60	10	2.6	±0.72
61 - 70	26	2.28	±1.42
71 - 80	15	2.13	±1.01
81 - 90	2	3.5	±0.71
TOTAL	**60**	**2.1**	**±1.27**

CHART 5 : CORRELATION BETWEEN PATIENT'S AGE AND DURATION BETWEEN CATARACT EXTRACTION AND DEVELOPMENT OF PCO

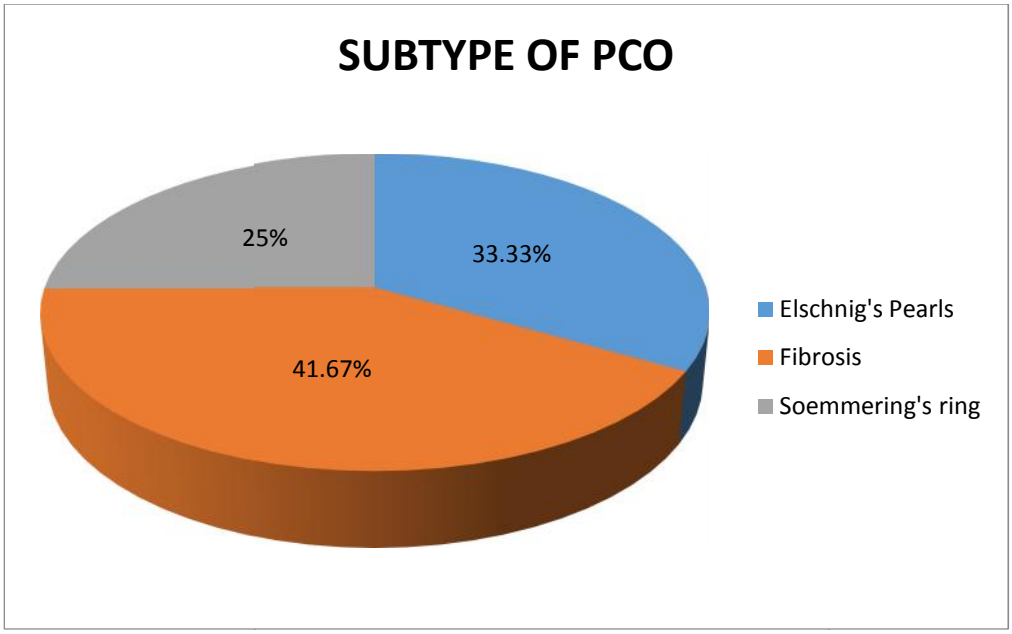


As shown above, under the age of 40 years PCO developed within 1 year of cataract surgery. In the age group of 41 to 80 years, it developed between 2-3 years post cataract surgery and in patients above the age of 80 years, it developed within 3.5 years post cataract surgery.

TABLE 6: DISTRIBUTION OF CASES ACCORDING OF SUBTYPES OF PCO

SUBTYPE OF PCO	INCIDENCE IN NUMBER (%)
ELSCHNIG'S PEARLS	20(33.33%)
FIBROSIS	25(41.67%)
SOEMMERING'S RING	15(25%)
TOTAL	60(100%)

GRAPH 6: DISTRIBUTION OF CASES ACCORDING OF SUBTYPES OF PCO



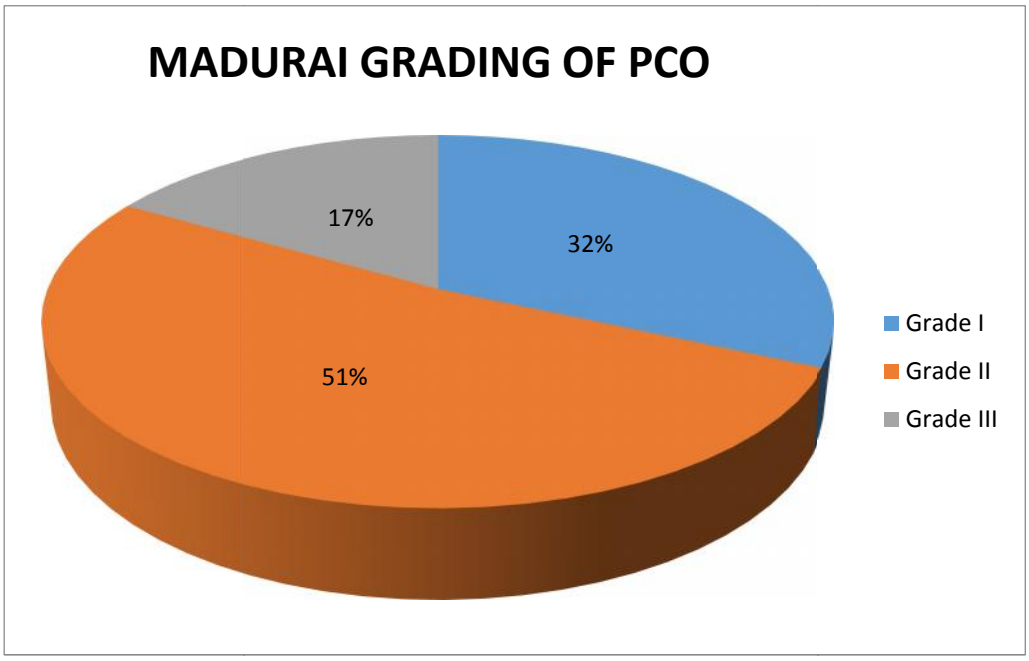
As shown above, fibrosis type of PCO was seen in 25 cases (41.67%), followed by elschnig's pearls in 20 cases (33.33%) and soemmering's ring in 15(25%) cases.

According to **The Madurai Intraocular Lens Study IV: Posterior Capsule Opacification**, Posterior capsule opacification was graded according to the levels of severity, based on slit-lamp and dilated direct ophthalmoscopic evaluation. Results are as following:

TABLE 7: DISTRIBUTION OF CASES ACCORDING TO GRADES OF PCO

MADURAI GRADING OF PCO	TOTAL NUMBER OF CASES (%)
GRADE I	19 (31.67%)
GRADE II	31 (51.67%)
GRADE III	10 (16.67%)
TOTAL	60(100%)

GRAPH 7: DISTRIBUTION OF CASES ACCORDING TO GRADES OF PCO

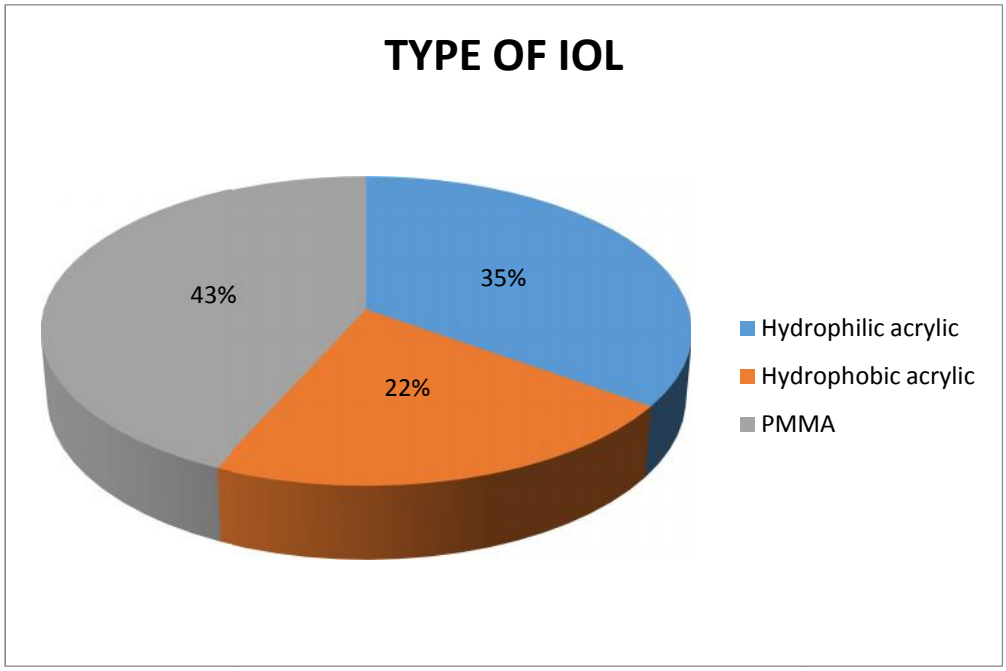


As shown in table 7, According to Madurai Grading System of PCO, it was observed that the Grade II was more prominent with incidence of 51 % followed by Grade I, with 32% and Grade III, with 17% respectively.

TABLE 8: DISTRIBUTION OF CASES ACCORDING TO TYPE OF IOL

TYPE OF IOL	n	%
HYDROPHILIC ACRYLIC	21	35.00%
HYDROPHOBIC ACRYLIC	13	21.67%
PMMA	26	43.33%
TOTAL	**60**	**100%**

GRAPH 8: DISTRIBUTION OF CASES ACCORDING TO TYPE OF IOL

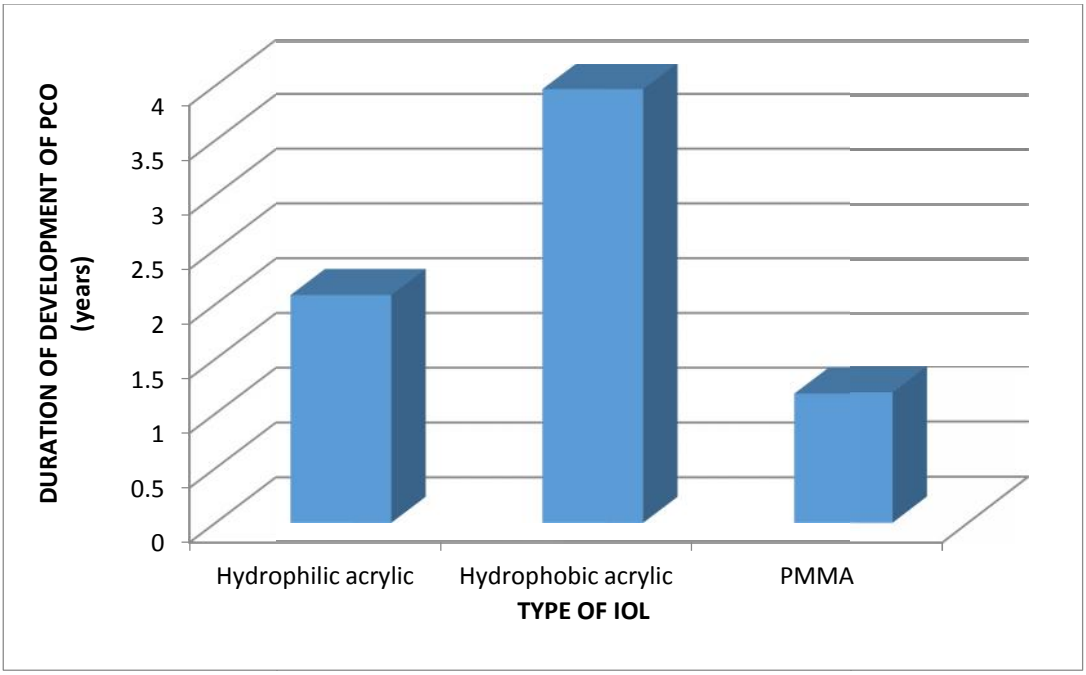


As shown in table 8, PMMA type of IOL were present in 26 patients , follwed by hydrophilic acrylic type of IOL were present in 21 patients , and hydrophobic acrylic type of IOL were present in 13 patients.

TABLE 9 : TYPE OF IOL AND MEAN DURATION OF DEVELOPMENT OF POSTERIOR CAPSULAR OPACITY

TYPE OF IOL	DURATION OF DEVELOPMENT OF PCO (years)	
	MEAN	±SD
HYDROPHILIC ACRYLIC	2.08	±0.62
HYDROPHOBIC ACRYLIC	3.96	±0.8
PMMA	1.18	±0.7

GRAPH 9 : TYPE OF IOL AND MEAN DURATION OF DEVELOPMENT OF POSTERIOR CAPSULAR OPACITY

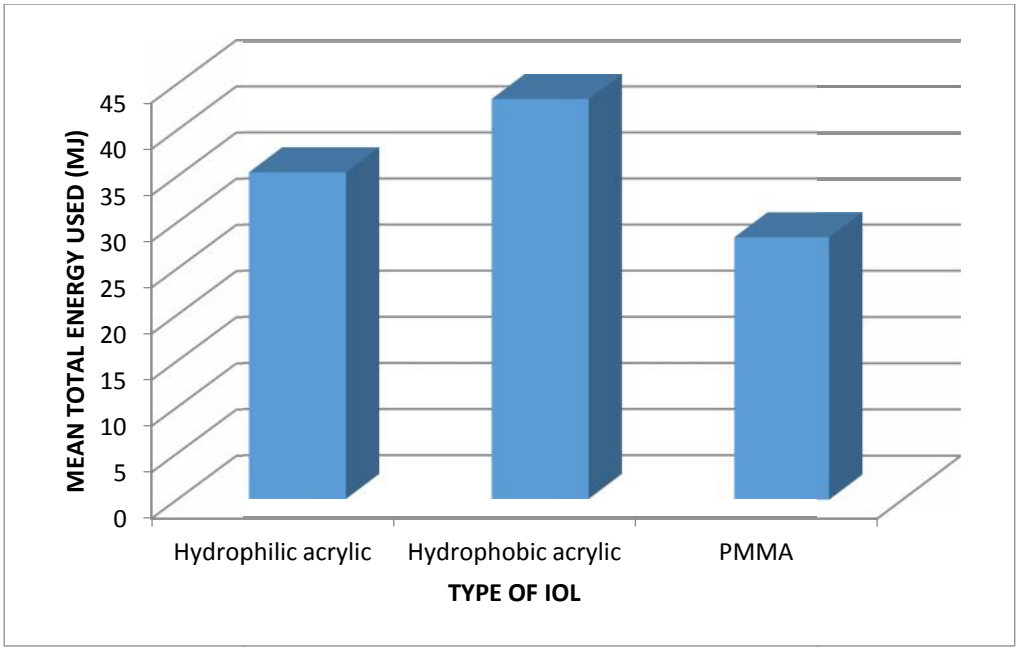


As shown above, Mean duration of development of PCO in hydrophilic acrylic type of IOL was 2.08 ± 0.62 years, in hydrophobic acrylic type of IOL was 3.96 ± 0.8 years and in PMMA type of IOL, it was 1.18 ± 0.7 years.

TABLE 10: MEAN TOTAL ENERGY USED IN DIFFERENT TYPES OF IOL

TYPE OF IOL	TOTAL ENERGY USED (mJ)	
	MEAN	±SD
HYDROPHILIC ACRYLIC	35.43	±15.17
HYDROPHOBIC ACRYLIC	43.38	±16.46
PMMA	28.38	±16.15

GRAPH 10: MEAN TOTAL ENERGY USED IN DIFFERENT TYPE OF IOL

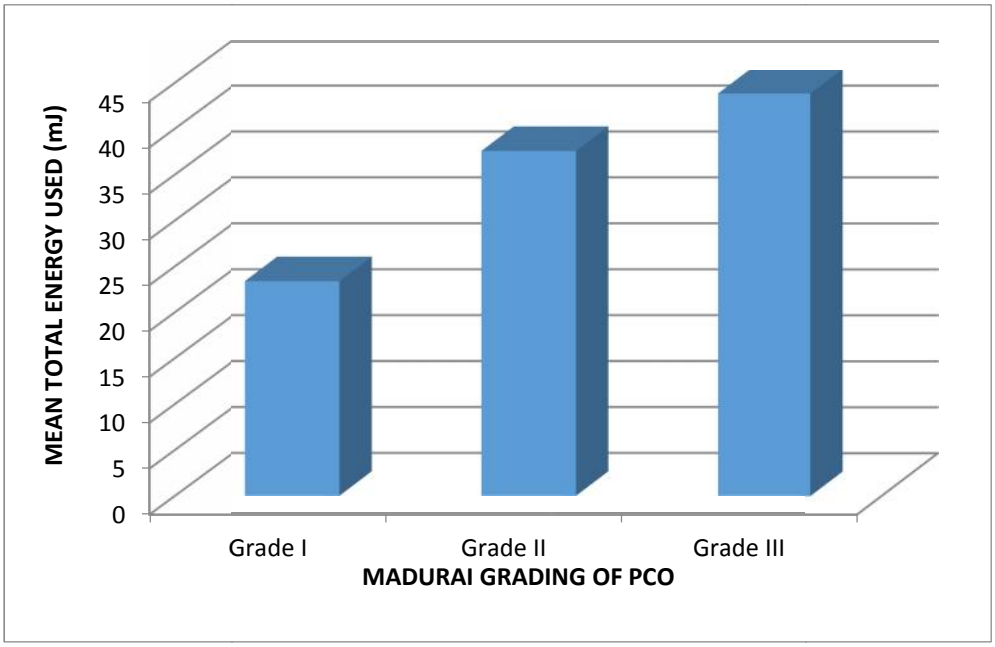


It can be observed that in hydrophilic acrylic type of IOL, mean total energy used was 35.43 ± 15.17 m J , in hydrophobic acrylic type of IOL was 43.38 ± 16.46 m J and in PMMA type of IOL it was 28.38 ±16.15 m J. **(P = 0.024)**

TABLE 11: MEAN TOTAL ENERGY USED IN DIFFERENT GRADES OF PCO

MADURAI GRADING OF PCO	TOTAL ENERGY USED (mJ)	
	MEAN	±SD
GRADE I	23.37	±13.10
GRADE II	37.55	±16.39
GRADE III	43.8	±13.87

GRAPH 11: MEAN TOTAL ENERGY USED IN DIFFERENT GRADES OF PCO

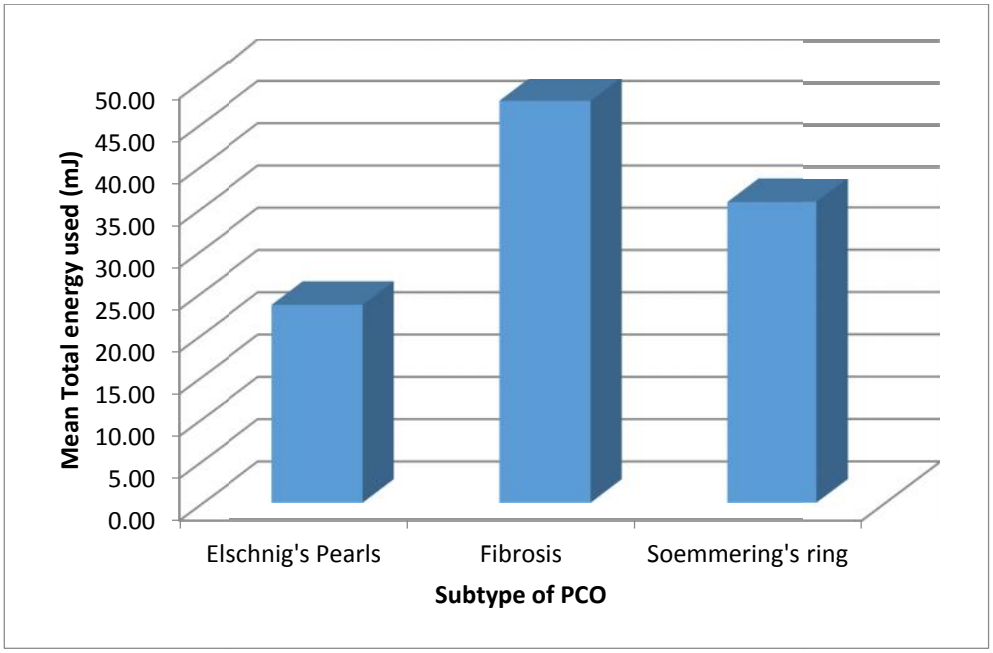


As shown in table 11, Mean total energy used in Grade I was 23.37 ±13.10 m J , in Grade II it was 37.55 ±16.39 m J and in Grade III it was 43.8 ±13.87 m J.

TABLE 12: MEAN TOTAL ENERGY USED IN SUBTYPE OF PCO

SUBTYPE OF PCO	TOTAL ENERGY USED (mJ)	
	MEAN	±SD
ELSCHNIG'S PEARLS	23.40	±11.5
FIBROSIS	47.54	±18.24
SOEMMERING'S RING	35.56	±14.11

GRAPH 12: MEAN TOTAL ENERGY USED IN SUBTYPE OF PCO

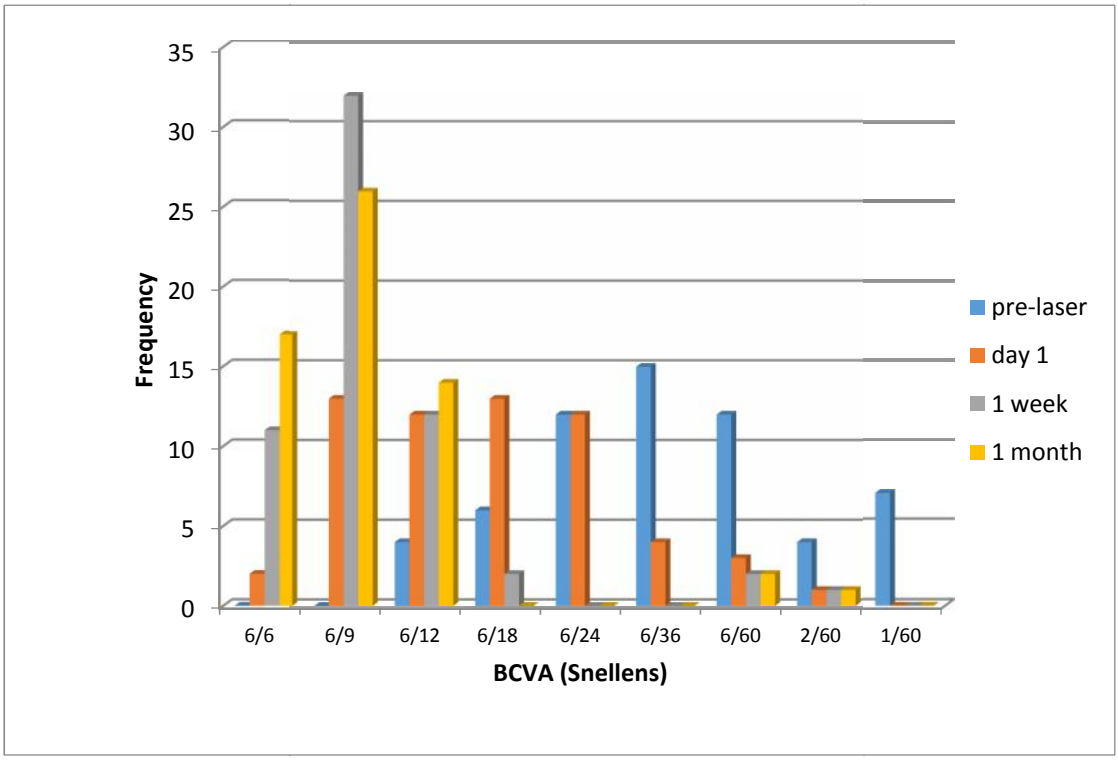


As shown in table 12, The highest Mean total energy used in Fibrosis subtype of PCO was 47.54 ±18.24 m J , followed by 35.56 ±14.11 m J in Soemmering's ring subtype followed by 23.40 ±11.5 m J In Elschnig's pearls subtype of PCO**. (P < 0.001)**

TABLE 13: DISTRIBUTION OF CASES ACCORDING TO PRE-LASER AND POST-LASER VISUAL ACUITY

BCVA (Snellens)	pre-laser	day 1	1 week	1 month
6/6	0	2	11	17
6/9	0	13	32	26
6/12	4	12	12	14
6/18	6	13	2	0
6/24	12	12	0	0
6/36	15	4	0	0
6/60	12	3	2	2
2/60	4	1	1	1
1/60	7	0	0	0
TOTAL	**60**	**60**	**60**	**60**

CHART 13: DISTRIBUTION OF CASES ACCORDING TO PRE-LASER AND POST-LASER VISUAL ACUITY

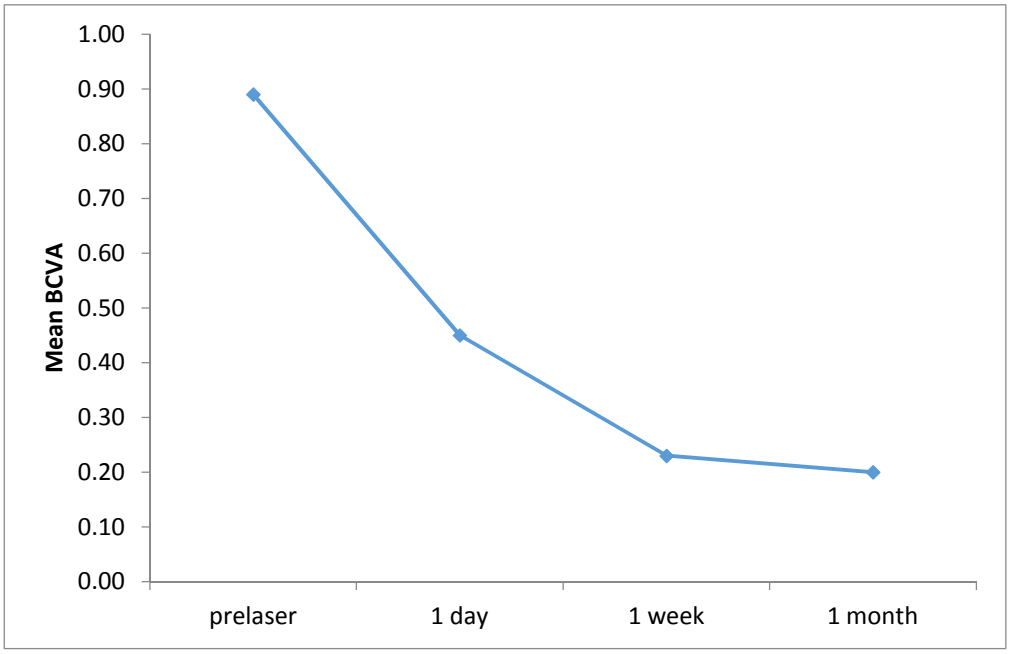


As shown in table 13, Pre laser BCVA ranged from 1/60 to 6/12. 28.33 % patients achieved 6/6 BCVA, 43.33 % achieved to 6/9 BCVA and 23.33% achieved 6/12 BCVA post Nd: YAG laser posterior capsulotomy at 1 month.

TABLE 14: IMPROVEMENT IN VISUAL ACUITY FOLLOWING Nd:YAG LASER POSTERIOR CAPSULOTOMY (logMAR)

BCVA (LOGMAR)	PRE-LASER	DAY 1	1 WEEK	1 MONTH
MEAN	0.89	0.45	0.23	0.20
±SD	±0.42	±0.27	±0.25	±0.25
P-VALUE (VS PRE-LASER)	-	< 0.001	< 0.001	< 0.001

CHART 14 : IMPROVEMENT IN VISUAL ACUITY FOLLOWING Nd:YAG LASER POSTERIOR CAPSULOTOMY (logMAR)

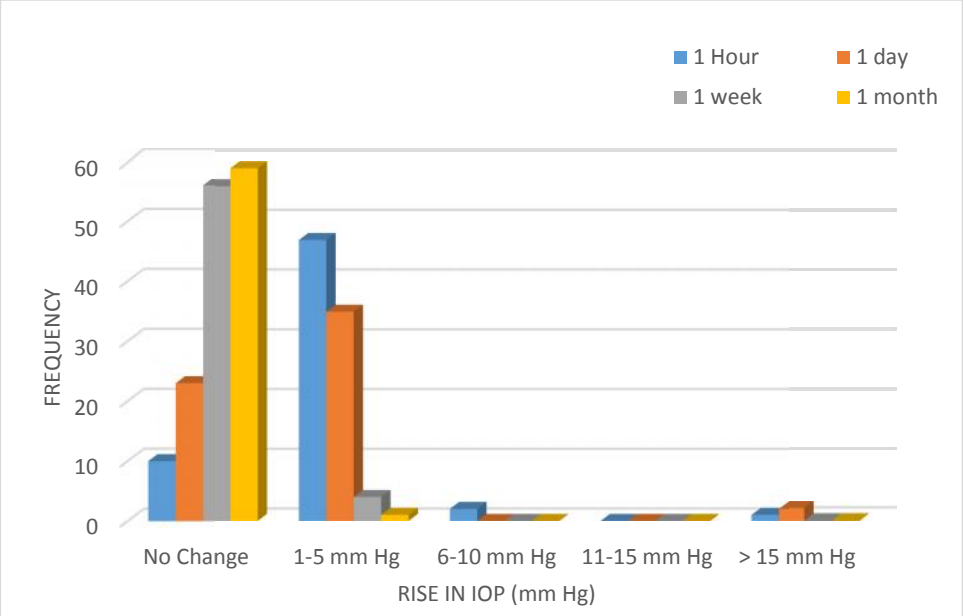


As shown in Table 14 , mean BCVA (logMAR) was 0.89 prelaser which improved to 0.45 1st day post laser, 0.23 on 1 week and 0.20 at 1 month which is statistically significant **(p < 0.001).**

TABLE 15: EFFECT OF Nd: YAG POSTERIOR CAPSULOTOMY ON IOP

Increase in GAT(mm Hg)	1 hour	1 day	1 week	1 month
No change	10	24	56	59
1 - 5	47	35	4	1
6 - 10	2	0	0	0
11 - 15	0	0	0	0
> 15	1	1	0	0
TOTAL	**60**	**60**	**60**	**60**

CHART 15: EFFECT OF Nd: YAG POSTERIOR CAPSULOTOMY ON IOP

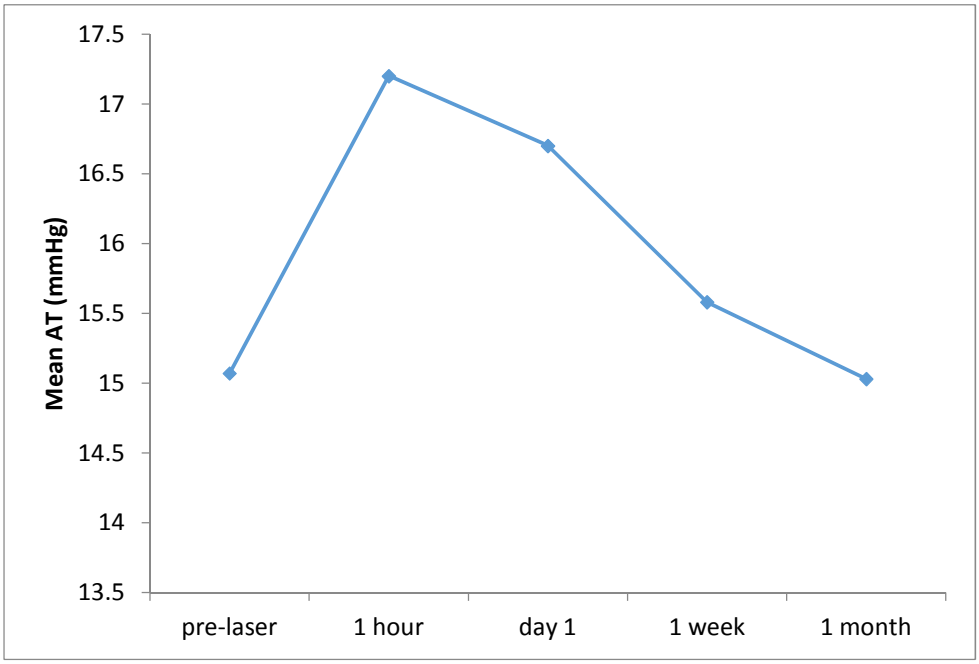


It was observed that 17 % of the patients showed no change in IOP while 63 % patients showed elevated IOP. Among these 78 % patients show rise in IOP that was ≤5mm Hg while only 5 % of the patients had a rise of more than IOP >5 mm Hg. Most of these patients achieved their baseline IOP within 1 week and only 5 % patient had rise in IOP compared to baseline IOP on 1 week .Only 1 patient showed elevated IOP after 1 month.

TABLE 16: MEAN IOP ELEVATION IN RESPECT TO TIME INTERVAL AFTER Nd: YAG LASER CAPSULOTOMY

GAT(MM HG)	PRE LASER	1 HOUR	1 DAY	1 WEEK	1 MONTH
MEAN	15.07	17.20	16.70	15.38	15.03
±SD	±2.81	±3.46	±4.45	±3.79	±2.99
P-VALUE (VS PRE LASER)	-	<0.001	0.008	0.081	0.284

GRAPH 16: MEAN IOP ELEVATION IN RESPECT TO TIME INTERVAL AFTER Nd:YAG-LASER CAPSULOTOMY

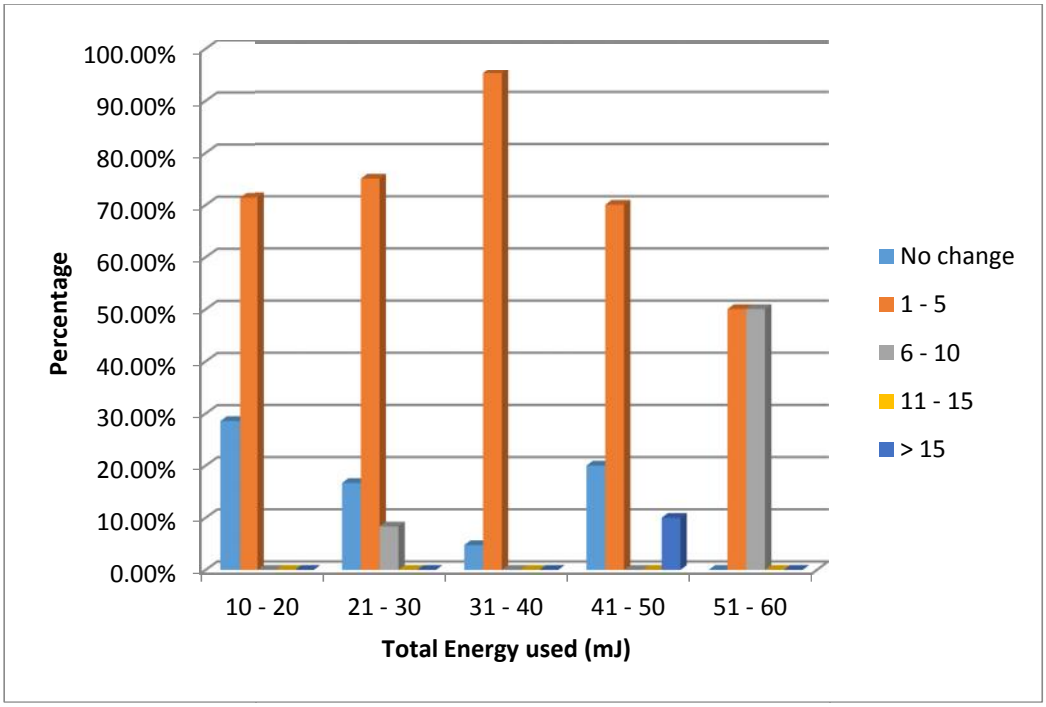


As shown in table 16, base line mean IOP was mean 15.07 ± 2.81 mm Hg and post laser mean IOP was 17.20 ± 3.46 mm Hg at 1 hour, 16.70 ± 4.45 mm Hg at 1 day which returned to 15.38 ± 3.79 mm Hg on 1 week and returned to baseline value 15.03 ±2.99 mm Hg at 1 month. P values shows statistically significant increase in IOP.

TABLE 17: CORRELATION BETWEEN TOTAL ENERGY USED AND RISE IN IOP AFTER Nd:YAG POSTERIOR CAPSULOTOMY (n=60)

Increase in GAT(mm Hg)→	No change		1 - 5		6 - 10		11 - 15		> 15		TOTAL
Total Energy used (mJ)↓	n	%	n	%	n	%	n	%	n	%	
10 - 20	4	28.57%	10	71.43%	0	0.00%	0	0.00%	0	0.00%	14
21 - 30	2	16.67%	9	75.00%	1	8.33%	0	0.00%	0	0.00%	12
31 - 40	1	4.76%	20	95.24%	0	0.00%	0	0.00%	0	0.00%	21
41 - 50	3	3.33%	7	77.78%	0	0.00%	0	0.00%	1	11.11%	11
51 - 60	0	0.00%	1	33.33%	1	33.33%	0	0.00%	0	0.00%	2
TOTAL	**10**	**16.66%**	**47**	**78.33%**	**2**	**3.33%**	**0**	**0.00%**	**1**	**1.66%**	**60**

CHART 17: CORRELATION BETWEEN TOTAL ENERGY USED AND RISE IN IOP AFTER Nd: YAG POSTERIOR CAPSULOTOMY

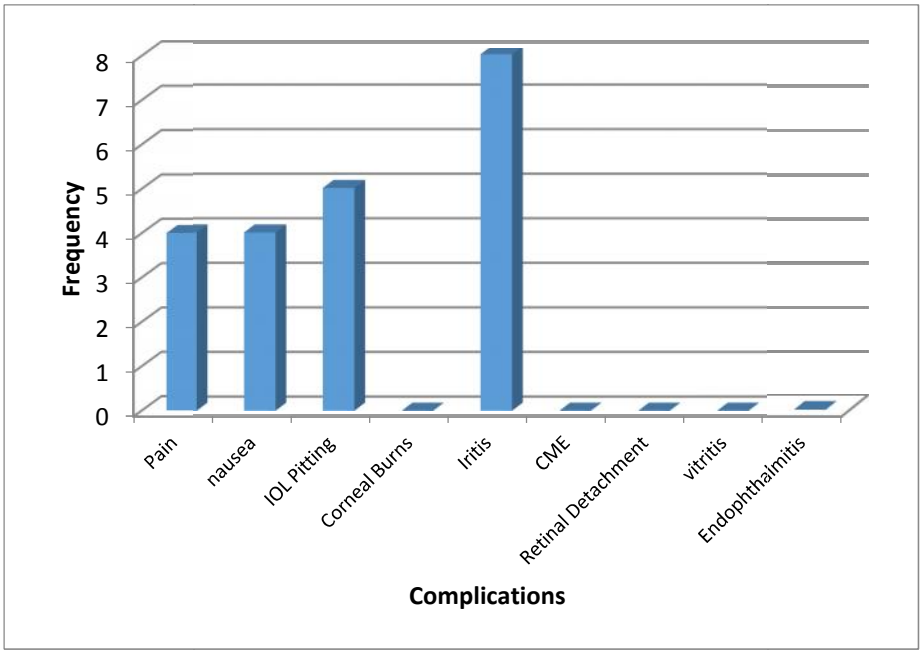


As shown in the table, out of the 60 eyes evaluated, majority of the eyes were treated with 31-40mJ.Correlation between total energy used and rise in IOP was found to be significant **(P = 0.022**)

TABLE 18: OTHER POST Nd: YAG LASER CAPSULOTOMY COMPLICATIONS (n=60)

Complications	n	%
Pain	4	6.67%
Nausea	4	6.67%
IOL Pitting	5	8.33%
Corneal Burns	0	0.00%
Iritis	8	13.33%
CME	0	0.00%
Retinal Detachment	0	0.00%
Vitritis	0	0.00%
Endophthalmitis	0	0.00%

CHART 18: OTHER POST Nd: YAG LASER CAPSULOTOMY COMPLICATIONS



Out of the 60 cases, iritis was observed in 13.3% cases and lens pitting was observed in 8% cases. None of the patients suffered from the other known complications i.e. corneal burns, cystoid macular edema (CME), retinal detachment (RD) or endophthalmitis.

DISCUSSION

Posterior capsule opacification is a major complication of cataract surgery with or without intraocular lens implantation. The use of Nd: YAG laser has definitely simplified the treatment of posterior capsule opacification. Another great advantage is that, it is entirely non-invasive. The study aimed to evaluate the results of Nd: YAG laser capsulotomy in 60 eyes of 60 patients performed at KLES Dr. PRABHAKAR KORE HOSPITAL & MRC, BELAGAVI.

As shown in **Table 1**, in our study maximum number of patients were in the age group between 61 to 70 years i.e. 43.33 % followed by patients in the age group of 71-80 years i.e 25 % . Average age of the patient was 63.98 years with the lowest age of presentation with PCO being 22 years and highest being 87 years. Similar findings have been noted by **Prajna NV et al**[42], **Shashi Jain et al**[29] with median age of 60 years and 58.6 years respectively.

Although the causes of PCO are multifactorial[4], there definitely exists an inverse correlation with age. Younger age is a significant risk factor for development of PCO and its occurrence is a virtual reality in paediatric patients[4]. This is due to greater tissue reactivity in lens epithelial cells in younger age groups[4], but it should be noted that cataract is primarily a disease of the elderly and therefore sample size in younger age group will always be on the lesser side, as is also the case in our study.

In general, the older the patient at the time of cataract surgery, the lower the incidence of development of PCO.[4, 37]An attempt was also made to correlate the age of the patient and duration between cataract extraction and development of PCO. The aim was to look for the age group in which PCO occurs earlier. As shown in **Table 5**, it was observed in our study that PCO occurred earlier in younger age groups. In patients upto 40 years of age, PCO developed in less than a year of surgery and with

increasing age the gap between surgery and development of PCO also widened. Since patients below 18 years of age are not represented in our study, hence no comment can be made on occurrence of PCO in younger age groups based on our study.

There is no sex predilection as far as development of PCO is concerned.[14,36] But most of the studies show more number of female patients undergoing Nd:YAG laser capsulotomy possibly because female sex is at a higher risk for developing cataract[111] and hence cataract surgery complications are inevitably higher. In a study by **C.F.Chung et al**[112] on 56 patients, 62% were females whereas 38% were males; in a study by **Meacock William R. et al** [39] 43% patients were males and 57% females. In a study by **Shaikh et al**[75] out of 314 patients 45% were males and 55% were females. In a study by **Saxena D et al**[113], 43.4% were males and 56.7% were females. Our study is in concurrence with these studies with 43.33% males and 56.67 % females as shown in **Table 2**.

Researchers have tried to predict the approximate time duration between cataract surgery and development of PCO. Development of PCO is a multifactorial entity with influencing factors ranging from type of cataract surgery, IOL design, patient's age etc.[4] In a study done by **Durham Davis G. et al**[114] shows that about 40% cases developed PCO within 2-4 years of cataract surgery. In another study by **Ladas I.D et al**[115] it was observed that the mean time duration between cataract surgery and development of PCO was 1.5 years. **Mohan Lal Gupta**[102] reported that maximum patients presented within 1-5 years with PCO after cataract surgery. As shown in **Table 4**, our study also shows similar result as mean age of development of PCO after cataract surgery was **2.28 years.**

As shown in **table 6**, the relative incidence of different types of PCO showed that the capsular fibrosis was seen in 25 patients, followed by Elschnig's pearls in 20

patients and Soemmering's ring type in 15 patients.**Jafar Dawood et al** studied 560 cases, out of which Elschnig's pearls were 314 and fibrous were 237 and capsular wrinkling was in 9 cases**. Tariq M Aslam et al**[116] studied 24 eyes, out of which Elschnig's pearls were seen in 18 eyes and fibrosis was found in 6 eyes.Capsular fibrosis is the predominant type of PCO in our study as compared to other studies like **Hasan et al**[117] who found that Elschnig's pearls was the predominant type in pseudophakic and secondary fibrosis in aphakic eyes.[117]

As shown in **table 7**, according to **The Madurai Intraocular Lens Study IV: Posterior Capsule Opacification**[42], which graded PCO according to the levels of severity, based on slit-lamp and dilated direct ophthalmoscopic evaluation. It was observed that the Grade II was more prominent with incidence of 51 % followed by Grade I, with 32% and Grade III, with 17% respectively. Our results are consistent with findings of this study.[42]

There is considerable discussion over the impact of IOL on the development of PCO as characteristics and designs of IOL play a crucial role in preventing PCO. As shown in **table 9**, mean duration of development of PCO was shorter in PMMA type of IOL, followed by hydrophilic acrylic type of IOL and hydrophobic acrylic type of IOL**(P < 0.001).** According to **Kugelberg M et al.**[118] **and Richter-Mueksch S et al**.[119] higher PCO rates have been reported for hydrophilic materials. It is also shown that compared to PMMA IOL, hydrophobic IOL are known to have lesser rates of development of PCO in studies done by **Hayashi K et al.**[51] They also found that the density value of PCO in 185 eyes was quantified approximately 2 years after surgery. **Ram J et al.**[120] **and Hollick EJ et al.**[121] found that the PCO value in PMMA group was significantly higher than that in silicone and acrylic group**,** our results show similar findings.

It can be observed from **table 10** that the IOL biomaterial (hydrophobic acrylic, hydrophilic acrylic and PMMA) significantly influence the total laser energy required to create a capsulotomy**. (P = 0.024)**. These finding are not in correlation with other study done by **Rahul Bhargava et al.**[122], which showed that the IOL biomaterial (silicone, hydrophobic acrylic, hydrophilic acrylic and PMMA) did not significantly influence the total laser energy required to create a capsulotomy. Further studies are required to establish the correlation of the IOL biomaterial and total energy used for capsulotomy.

As shown in **table 12**, the total amount of energy used for most of the cases was in the range of 20-50 mJ. The highest mean total energy used in Fibrosis, followed by Soemmering's ring and in Elschnig's pearls.**(P < 0.001**). **Khanzada and co-workers**[122] found that mean initial energy level was 3.2 mJ and the mean summated energy level was 48.8 mJ. Total laser energy levels were significantly higher **(P < 0.001)** with fibro membranous and fibrous subtypes of PCO in study done by **Rahul Bhargava et al.**[108] our results are compatible with these studies.

In eyes with PCO, the Nd: YAG laser was effective in achieving a clear pupillary opening in every case. As shown in **Table 13**, pre-laser BCVA ranged from 1 /60 to 6/12. Post-laser BCVA ranged from 2/60 to 6/6 at 1 month after Nd: YAG capsulotomy.28.33 % patients achieved 6/6 BCVA, 43.33 % achieved to 6/9 BCVA and 23.33 % achieved 6/12, which was statistically significant **(p < 0.001).** Two patients did not improve more than 6/60 who had age related macular degeneration which was not identified pre-laser due to thick posterior capsular opacification and only one patient did not improve more than 2/60 who had optic atrophy which was not identified pre laser.

Similar findings have been noted by **Gardener K M**[85] which reports improvement in visual acuity in 90% patients out of 100 patients studied. **Wasserman et al**[86] noted improvement in visual acuity to 6/9 or better in about 87.5% patients out of 367 patients studied. **Mohan Lal Gupta**[102] reported that 97% improved one or more snellens lines, 61% improved more than 3 snellens lines where as 30% could achieve visual acuity upto 6/6. 2% patients had no improvement on snellens chart due to preexisting retinal pathology. **Stark W.J. et al**[69] noted successful opening in posterior capsule in 98% cases and vision improvement in 84% cases. **Gore V.S.**[76] also found 86% improvement in visual acuity out of 200 patients.

Increase in intraocular pressure has been well-documented complication after virtually all anterior segment laser surgeries. In our study as shown in **Table 14** ,a transient rise in IOP was the most common complication seen in 63% of the patients ranging from 1mm Hg to 17 mm Hg.Among these 78 % patients show rise in IOP that was ≤ 5mm Hg while only 5% of the patients had a rise of more than IOP >5 mm Hg.As shown in **Table 16**,Mean pre-laser IOP was 15.07±2.81 mm Hg which increased to 17.20 ±3.46 mm Hg 1 hour post laser.**(P< 0.001).**It decreased to 16.70 ±4.45 mm Hg on 1st day post laser to achieve baseline value of 15.03 ±2.99 mm Hg by 1 month post-laser. Most of these patients achieved their baseline IOP within 1 week and only 7 % patients show elevated IOP compared to baseline IOP after 1 week. Only 1 patient shows elevated IOP after 1 month and that is also only of 1 mm Hg.The IOP was above 16 mm Hg only in 1 patient, in this patient topical administration of 0.5% timolol maleate eye drops twice a day was started.Rise in IOP was transient in nature, only one paitent had persistent elevation of IOP after 1 month.

Early researchers such as **Stark W.J. et al** [69] reported that 39% patients among the 213 patients had rise of pressure of 5 mm Hg or more in first two to six

hours post laser therapy. **Slomovic et al**[123] reported immediate increase in IOP in 95% patients which reduced to 3% on 1st day post-laser. Study recommended that in patients with no prior history of glaucoma, the use of prophylactic anti glaucoma medications was not indicated, since the IOP elevation within the first 24 hours appeared to be a self-limited process in most cases.**Gore V.S** [76] reported immediate rise in IOP in 39.5% patients and persistent rise of IOP in 3.5% patients for whom antiglaucoma medication was continued for a longer time after which it was reduced and finally omitted. **Shashi Jain et al** [29]studied effect of Nd: YAG laser capsulotomy in pseudophakic eyes with special reference to IOP changes in 280 eyes. Transient rise of post laser IOP <5 mm Hg showed in 57% patients within first 2 hours and 33% patients did not developed rise of IOP. Whereas rise of IOP >10 mm Hg was found in 5% of cases.92 % patients achieved baseline pressure within 4 hours. They concluded that routine antiglaucoma medication may not be necessary in all patients following Nd: YAD laser capsulotomy. **Shankar Ganvit et al** [28] reported immediate rise of IOP in 34% cases which achieved baseline IOP in consecutive follow ups till 1 month. **B.Dharmraju et al**[109] studied 100 eyes and followed them up for 6 months post laser. The rise of IOP up to 2 mm Hg within 4 hrs was 32%, 8% cases showed IOP rise of 3 mm Hg and 1 case showed rise of 5 mm Hg. Our study is also well in accordance with these studies.

ChannelI MM et al [84], **Morique Leys et al.**[124] and **Schubert HD et al**.[125]reported >10 mm Hg of IOP rise in 59%, 29% and 15% cases respectively. The incidence given by these authors and those found in our study are variable which may be due to use of higher energy and larger capsulotomy as explained in their studies. Various other factors documented in different studies explain for rise of IOP after laser capsulotomy were presence or absence of IOL, sulcus or bag fixation of IOL, pre

laser IOP,glaucomatous patients, different time period of IOP recording, type of PCO, size of capsulotomy, initial pulse energy and treatment given.

As shown in **table 16**, In our study total energy used was between 10 – 60 mJ. Majority of the patients were treated with total energy of 31-40 mJ. On applying chi square test, the correlation between the rise of IOP and total used energy was found to be significant **(p =0.022).** Our study shows significant linear correlation between energy levels used and rise in IOP.

Review of literature showing relation between IOP rise and total energy used is not conclusive. As shown in **table 17**, Our study is favoured by studies conducted by **Stark et al** [69], **Mohammad W et al.**[126], **Channell MM et al.**[84] who postulates that higher energy levels tend to cause higher rise in IOP. **Flohr et al** [127] found that maximum patients required less then 200 mJ for capsulotomy & in those who required more than 200 mJ risk of rise in IOP was more. In contrast to our study significant correlation was not found between IOP elevation and energy used by **Slomovic et al**[123], **Kraff et al**[128] **, Dawood Z et al**[129] **, Mahtab AK et al.**[122] who noted that there is no statistifically significant linear correlation between the rise of IOP and total energy used.

Other complications of Nd:YAG laser posterior capsulotomy are corneal damage, iritis, lens pitting, cystoid macular edema (CME), retinal detachment (RD) and endophthalmitis.[69,75,73,78] As shown in **table 18**, In our study there was iritis in 13.33 % patients and lens pitting in 8.33 %.Corneal burns, Hyphaema, Cystoid macular edema, Retinal detachment and Endophthalmitis were not seen in our study. For iritis encountered in the 13.33 % cases, the routine antibiotic and steroid combination prescribed to all patients for 1 week was adequate in treating the iritis.

Similar findings have been noted by **Salaam Ibohal et al** [129] who reported lens pitting in 13.3% cases and iritis in 10% cases. **Shashi Jain et al**[29] reported IOL pitting in 4%, hypheama in 0.6 % and floaters in 4% out of the 280 eyes studied. **Stark et al** [69] reported iritis in 0.6% cases, lens pitting in upto 20% of cases, CME in 1.2% cases and RD in 0.5% cases. **Gore V.S** [76] reported corneal damage in 1%, iritis in 33.5%, hyphaema in 1.5%, lens related complications in 7.5%, CME in 4% and retinal complications in 0.5 % cases. **Durham Davis G. et al**[130] reported lens pitting in 12%, iritis in 10%, hyphaema in 0.15%, CME in 0.68% and RD in 0.17% cases.

There are certain complications produced by the physical effects i.e radiation injury of YAG laser, like sterile inflammatory iritis. Other complications cannot be directly blamed on YAG laser but they occur due to other factors including the experience of operating surgeon, patients compliance of instructions regarding stability of head and no movements of the eyes during the procedure and physical state of trabecular meshwork, which is related to clearance of inflammatory and other debris produced by radiation injury and cutting of posterior capsule.[97]

CONCLUSION

The following conclusions were made from the study.

Nd: YAG laser posterior capsulotomy provides excellent outcome in terms of improvement in Best Corrected Visual Acuity (BCVA). Results were statistically significant and most of the patients achieved vision upto or more than 6/9 as per snellen's chart.

Nd: YAG laser capsulotomy is associated with rise in intraocular pressure (IOP) as compared to baseline values. Most of the patients had a rise of <5mm Hg and the IOP returned to baseline values in most of the patients within 1 week of laser with only one patient having raised IOP values at 1 month post-laser. Thus the rise in IOP is transient in nature and routine antiglaucoma medication may not be needed in all the patient undergoing Nd:YAG capsulotomy, however caution should be exercised in glaucomatous, aphakic, high myopic and other high risk patients.

Thus, Nd:YAG laser capsulotomy is effective, relatively safe, non-invasive, fast, outpatient procedure to improve hindered vision by PCO. To avoid complication it is suggested to screen the patient properly before the procedure and exercise caution and vigilance in high risk patients.

This study has limitations. The sample size was small and represents results at single centre only. Also the results are based on short term follow up period.

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SUMMARY

The study titled "VISUAL OUTCOME AND INTRAOCULAR PRESSURE CHANGES AFTER Nd:YAG LASER CAPSULOTOMY IN PATIENTS WITH POSTERIOR CAPSULAR OPACIFICATION: A ONE YEAR HOSPITAL BASED PROSPECTIVE STUDY'' was done at KLES. Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi.

60 eyes of 60 patients with posterior capsular opacification undergoing Nd:YAG laser posterior capsulotomy were included. Patients attending the Out Patient Department at KLES. Dr. Prabhakar Kore Hospital and Medical Research Centre were enrolled. The study included patients of average age group of 63.98 years with female preponderance.

Thorough preoperative assessment was made to confirm that the visual loss was because of posterior capsular opacification. The average duration between cataract surgery and Nd: YAG laser capsulotomy was 2.28 years. After Nd: YAG laser capsulotomy cases were followed up at 1 hour, 1st day post-laser, 1 week and 1 month to evaluate the visual outcome and changes in intraocular pressure as well as look for any other complications.

Pre-laser visual acuity ranged from 1/60 to 6/12. Results showed statistically significant in improvement in BCVA, with 28.33% patients had BCVA 6/6, 43.33 % had BCVA 6/9 and 23.33 % having BCVA 6/12 post-laser at 1 month.

It is observed that 17 % of the patients showed no change in IOP while 63% patients showed elevated IOP. Among these 78 % patients show rise in IOP that was ≤ 5mm Hg while only 5 % of the patients had a rise of more than IOP >5 mm Hg.

Most of these patients achieved their baseline IOP within 1 week and only 5 % patient had rise in IOP compared to baseline IOP on 1 week. Only one patient showed elevated IOP after 1 month that was also 1 mm Hg. The IOP rise was transient in nature and no patient showed permanent elevation of IOP.

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INFORMED CONSENT FORM

STUDY ID NO: _____

TITLE OF THE STUDY:

"VISUAL OUTCOME AND INTRAOCULAR PRESSURE CHANGES AFTER Nd:YAG LASER CAPSULOTOMY IN PATIENTS WITH POSTERIOR CAPSULAR OPACIFICATION: A ONE YEAR HOSPITAL BASED PROSPECTIVE STUDY"

PRINCIPAL INVESTIGATOR: Dr. _____

GUIDE: Dr. _____

INTRODUCTION AND PURPOSE:

Nd:YAG Laser capsulotomy is a safe and noninvasive procedure for visual acuity improvement in patients with posterior capsular opacification after SICS or Phacoemulsification. It also causes rise in IOP immediately after procedure but within 1 week it comes to normal range, and it is also associated with some complications like vitritis, retinal detachment, cystoid macular edema and IOL pitting, but they occur in very few number of patients.

PROCEDURE:

I request you to kindly participate in the study titled **"VISUAL OUTCOME AND INTRAOCULAR PRESSURE CHANGES AFTER Nd:YAG LASER CAPSULOTOMY IN PATIENTS WITH POSTERIOR CAPSULAR OPACIFICATION: A ONE YEAR HOSPITAL BASED PROSPECTIVE STUDY"** If you agree to participate in the study please furnish the details pertaining to the study. We will check visual acuity and IOP before and after YAG Laser capsulotomy. For detailed eye examination we will take anterior segment and fundus

photographs. After capsulotomy we will do B scan for detecting posterior segment complications.

BENEFITS:

• Results will help to observe changes in visual acuity and IOP after capsulotomy.

• Non invasive

• Cost effective

RISKS: No proven side effects

CONSENT TO PARTICIPATE IN RESEARCH STUDY

I voluntarily agree to take part in this study by signing on the line below. I may withdraw at any time. I am not giving up any of my legal rights by signing this form. My signature below indicated that I have read this entire consent form or it has been read to me, and has been explained to me in my vernacular language and had all my questions answered. I will be given a copy of this consent form.

Signature /Left Thumb print of the Participant or legally authorized representative.

Participant's Name : …….

Signature/ Left Thumb impression: …….

Name of the legally authorized representative: …….

Signature/ Left Thumb impression: …….

Witness's Name: …….

Signature/ Left Thumb impression: …….

Investigators name and Signature: …….

Date and Place: …….

ALTERNATIVES:

If patient is not willing to take part in the study, his / her treatment or any other further investigations the patient wants to undergo, in future, KLE will not be affected by his / her decision.

VOLUNTARY PARTICIPATION/WITHDRAWAL:

Taking part in this study is voluntary. I may choose not to take part in this study, or if I decide to take part. I can later change my mind and withdraw from the study. My decision will not change the present or future health care or other services that I receive. The study doctor or the sponsor may stop my participation in this study. I will tell of any important new findings that may change my willingness to continue to take part. If I choose not to take part in the study I will receive the standard treatment for patients with my condition.

COSTS:

NIL (The study is to be conducted on the participants who are advised by the referring consultant and the participants will bear the charges for it.)

COMPANSATION:

In the event that I become injured as a result of taking part in this study, treatment will be offered to me, No reimbursement, compensation or free medical care is given.

CONFIDENTIALITY:

All information collected about me during the course of the study will be kept confidential to the extent permitted by the law. The code numbers will identify me in this research record. Information from this study may be published but my identity will be confidential in any publication.

QUESTION:

If any enquiries in the future or in case of research related injury illness, you may contact following person.

1) PRINCIPAL INVESTIGATOR: **Dr.** _____ : Post graduate student, Department of Ophthalmology, J N Medical College, Belagavi.

2) GUIDE: **Dr.**_____ Professor, Department of Ophthalmology, J N Medical College, KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH, Belagavi.

PROFORMA

VISUAL OUTCOME AND INTRAOCULAR PRESSURE CHANGES AFTER Nd:YAG LASER CAPSULOTOMY IN PATIENTS WITH POSTERIOR CAPSULAR OPACIFICATION: A ONE YEAR HOSPITAL BASED PROSPECTIVE STUDY

PATIENTS ID NO: ☐☐☐

NAME: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

AGE: ☐☐ Years

SEX: ☐ (1-Male; 2-Female)

ADDRESS: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

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CONTACT NUMBER :- ☐☐☐☐☐☐☐☐☐☐

OP NUMBER: ☐☐☐☐☐☐☐☐

IP NUMBER: ☐☐☐☐☐☐☐☐

DATE OF ADMISSION: ☐☐ ☐☐ ☐☐☐☐

DATE OF DISCHARGE: ☐☐ ☐☐ ☐☐☐☐

IS THE PATIENT ELIGIBLE FOR STUDY? (1-YES; 2-NO) ☐

HAS INFORMED CONSENT BEEN GIVEN? (1-YES; 2-NO) ☐

FINAL RESULT INFORMATION ☐

1- INELIGIBLE
2- ELIGIBLE- REFUSAL
3- ELIGIBLE- PARTICIPATING

SURGEON'S NAME: | | | | | | | | | | | | | | | | | |

SURGEON'S SIGNATURE: _____

DATE: | | | | | | | | |

CHIEF COMPLAINTS:

DIMINUTION OF VISION RE ☐

Duration: _____ days/ months/years

LE ☐

Duration: _____ days/ months/years

HISTORY OF PRESENT ILLNESS:

1 .DIMINUTION OF VISION	1- Gradual; 2- Sudden	☐
	1- Progressive; 2- Static	☐
	1- Painless; 2- Painful	☐
	1- For distance; 2- For near	☐
2. DIPLOPIA/POLYOPIA	1- Present; 2- Absent	☐
3. COLOURED HALOS	1- Present; 2- Absent	☐
4. BLACK SPOTS BEFORE THE EYES	1- Present; 2 - Absent	☐
5. WATERING	1- Present; 2 - Absent	☐
6. REDNESS	1- Present; 2 - Absent	☐
7. DISCHARGE	1- Present; 2 - Absent	☐
8. H/O WEARING GLASSES	(1-Distance; 2-Near; 3-Both)	☐

Duration: ☐☐ months/years

PAST HISTORY:

TRAUMA TO THE EYE: 1- Present; 2- Absent ☐

OCULAR SURGERY: 1- Present; 2- Absent ☐

Type of surgery: _____

Duration: ☐☐ months/years

Type of IOL:

PMMA ☐

HYDROPHIIC ACRYLIC ☐

HYDROPHOBIC ACRYLIC ☐

DIABETES: 1- Present 2- Absent ☐

Duration: ☐☐ months/years

HYPERTENSION: 1- Present 2- Absent ☐

Duration: ☐☐ months/years

ANY OTHER MEDICAL DISORDERS: _____

PERSONAL HISTORY:

SMOKING: 1- Present; 2- Absent ☐

Duration: ☐☐ months/years

ANY OTHER ADDICTIONS: _____ ☐

Duration: ☐☐ months/years

GENERAL PHYSICAL EXAMINATION:

General Appearance:

1- Well built ,2- Moderately built, 3- Poorly built, 4- emaciated ☐

Pallor: 1- Present 2- Absent ☐

If present 1- Mild 2- Moderate 3- Severe ☐

Pulse: ☐☐☐ /minute

BP:- ☐☐☐ ☐☐☐ mm of Hg

Temperature: ☐☐☐ degree Fahrenheit

Respiratory rate: ☐☐ /minute

SYSTEMIC EXAMINATION:

CVS: 1- Normal 2- Abnormal ☐
if 2, specify :_____

RS: 1- Normal 2- Abnormal ☐
if 2, specify: _____

CNS: 1- Normal 2- Abnormal ☐
if 2, specify :_____

Per Abdomen: 1- Normal 2- Abnormal ☐
if 2, specify :_____

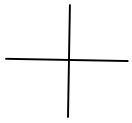
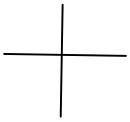
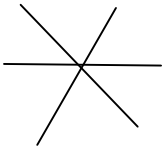
OCULAR EXAMINATION:

Head posture: 1- Erect ,2- Tilted ☐

Visual Axis: 1- Parallel, 2- Deviated ☐

Facial Symmetry: 1- Symmetrical, 2- Asymmetrical ☐

Extraocular movements:

RE-  LE-  Binocular :- 

(N- Normal, R- Restricted) ☐

1) Visual Acuity Before Nd: YAG Laser Capsulotomy :

	RE	LE
DISTANT		
PINHOLE		
NEAR		
AIDED		

2. Adnexa (1- Normal; 2-Abnormal)	☐	☐
3. Sclera (1- Normal; 2- Congested)	☐	☐
4. Conjunctiva (1-normal; 2-conjunctival congestion; 3-ciliary congestion; 4-chemosis)	☐	☐
5. Cornea (1- normal; 2-opacity; 3-vascularisation)	☐	☐

6. Anterior chamber (1- normal depth; 2-shallow; 3-deep)	☐	☐
7. Iris (1-normal colour & pattern; 2-Abnormal)	☐	☐
8. Pupil: Size- ____ in mm Shape- 1- Round & Regular; 2-Abnormal Reaction: Direct (1. Present, 2. Absent) Indirect (1. Present, 2. Absent) Near reflex (1. Present, 2. Absent)	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
9. Lens Clarity- 1. Clear, 2. Opaque Cataract - (1) , PCIOL - (2) Cataract if present- 1.immature 2.mature 3. hyper mature PCIOL if present , PCO - (1) present (2) absent GRADE OF PCO – 1.NO PCO (Madurai PCO Grading scale) 2.GRADE I 3.GRADE II 4.GRADE III SUBTYPE OF PCO: 1.EISCHNIG'S PEARLS 2.FIBROSIS 3. SOEMMERING'S RING 10. TOTAL NUMBER OF SHOTS: 11. TOTAL ENERGY USED(m J):	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

- REFRACTION BEFORE Nd:YAG LASER CAPSULOTOMY

VISION(RE)	SPH	CYL	AXIS	SPH	CYL	AXIS	VISION(LE)

- ANTERIOR SEGMENT FINDINGS BEFORE Nd:YAG LASER CAPSULOTOMY:

- FUNDUS EXAMINATION:

FUNDUS	RE	LE
GLOW		
MEDIA		
DISC		
C:D RATIO		
BLOODVESSELS		
BACKGROUND		
MACULA		

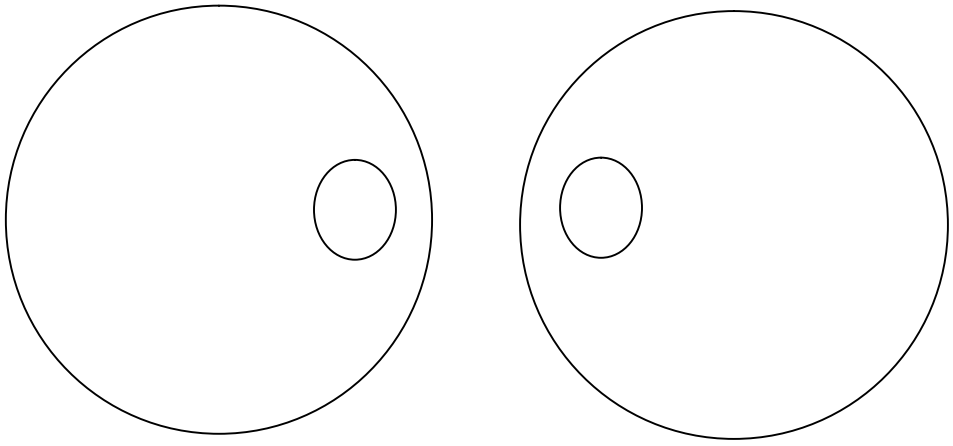
DIAGNOSIS:

IMPRESSION:

INVESTIGATIONS:

FUNDUS PHOTOGRAPH FINDINGS BEFORE Nd: YAG LASER CAPSULOTOMY:

OD OS



Blood sugar: _____mg/dl

Blood Pressure:_____mm of hg

IOP MEASUREMENTS:

TIME	RIGHT EYE	LEFT EYE
	With Goldmann Applanation tonometer	With Goldmann Applanation tonometer
BEFORE YAG CAPSULOTOMY		
1 HOUR AFTER YAG CAPSULOTOMY		
1 DAY AFETR YAG CAPSULOTOMY		
7 DAYS AFTER YAG CAPSULOTOMY		
4 WEEKS AFTER YAG CAPSULOTOMY		

VISUAL ACUITY AFTER 1DAY, 1WEEK, 1 MONTH OF Nd:YAG LASER CAPSULOTOMY:

	RE	LE
DISTANT		
PINHOLE		
NEAR		
AIDED		

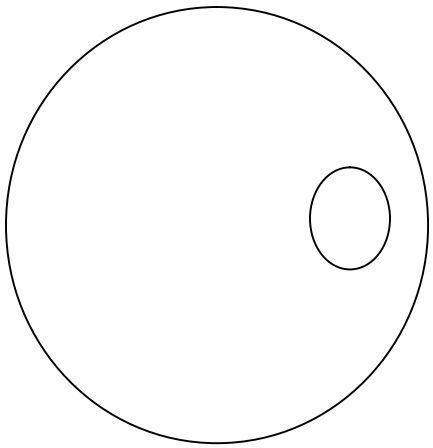
REFRACTION AFTER 1 MONTH OF Nd:YAG LASER CAPSULOTOMY

VISION(RE)	SPH	CYL	AXIS	SPH	CYL	AXIS	VISION(LE)

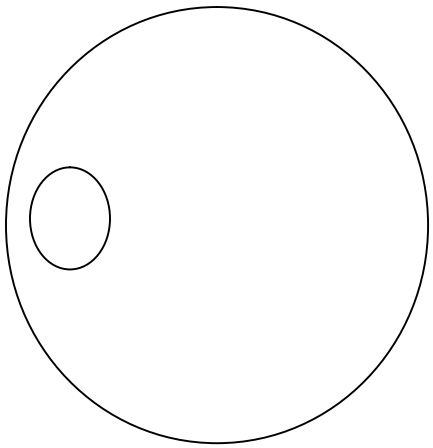
ANTERIOR SEGMENT FINDINGS AFTER 1 MONTH OF Nd:YAG LASER CAPSULOTOMY:

FUNDUS PHOTOGRAPH FINDINGS AFTER 1 MONTH OF Nd:YAG LASER CAPSULOTOMY

OD



OS



B SCAN FINDINGS FOR POSTERIOR SEGMENT COMPLICATIONS AFTER 1 MONTH OF Nd:YAG LASER CAPSULOTOMY

INFERENCE: **PRE LASER** **POST LASER**

VISUAL ACUITY:

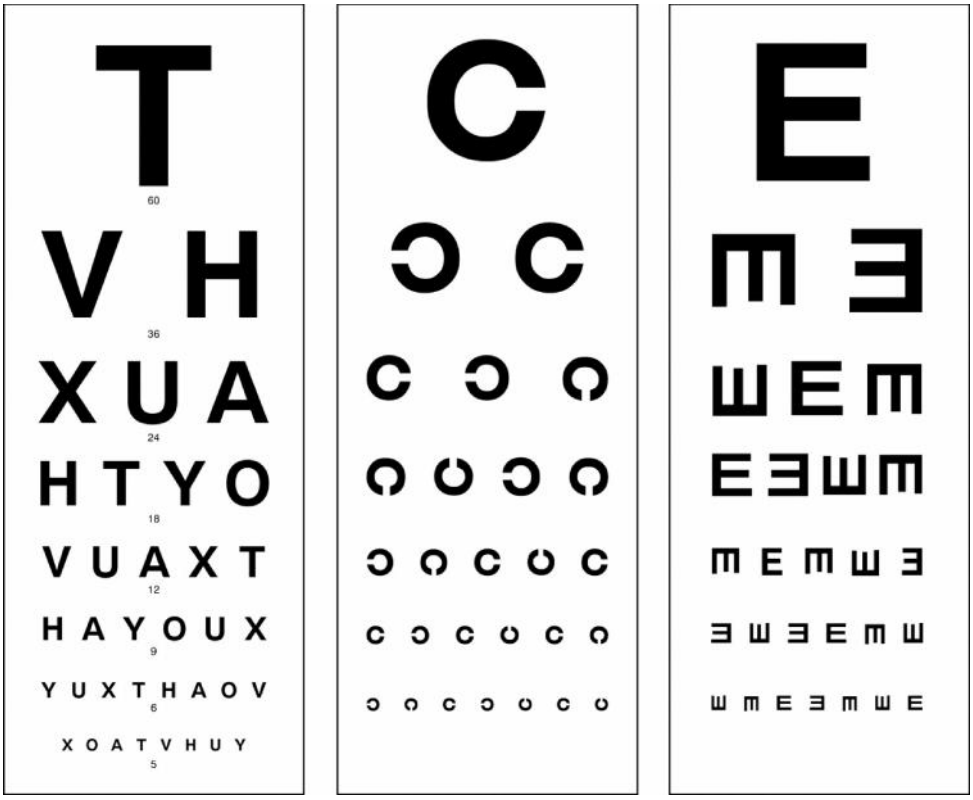
IOP:

ANTERIOR SEGMENT:

POSTERIOR SEGMENT:

RESULTS:

ANNEXURE III- PHOTOGRAPHS



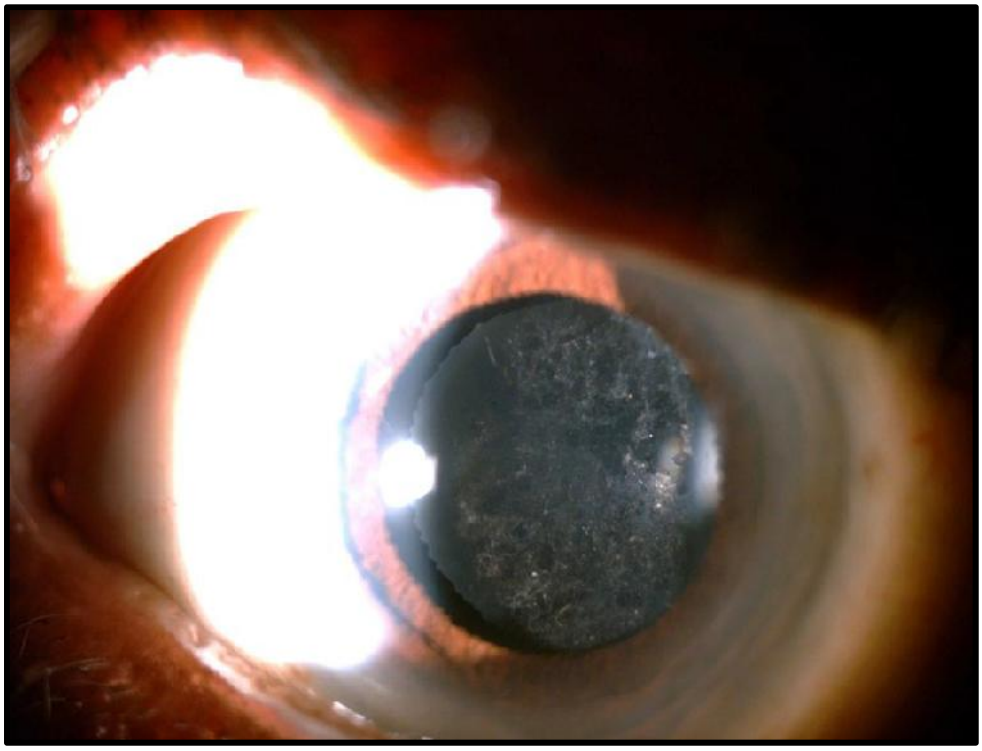
1. Snellen's Chart For Visual Acuity

2. APPA YAG Laser Machine for Nd: YAG Capsulotomy

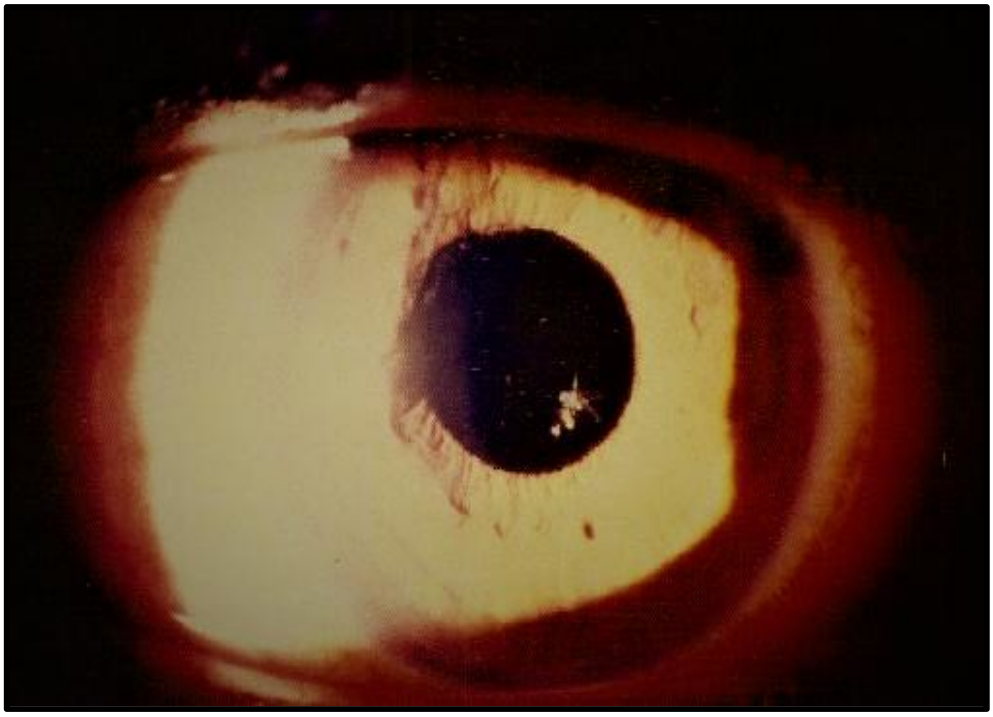
3. Slit Lamp Biomicroscopy

4. Goldmann Applanation Tonometry

5. Nd: YAG Laser Capsulotomy Procedure



6. Slit lamp image of PCO



7. Post Laser eye with Pitting of IOL

ANNEXURE IV – KEY TO MASTER CHART

GAT	–	Goldmann Applanation tonometry
LogMAR	–	Logarithm of Minimum Angle of Resolution
BCVA	–	Best corrected visual acuity
F	–	Female
IOP	–	Intra ocular pressure
LE	–	Left eye
M	–	Male
mm Hg	–	millimeter of mercury
mJ	–	milli joules
O.P.NO.	–	Out Patient Department number
PCO	–	Posterior capsular opacification
IOL	–	Intra Ocular lens
PMMA	–	Polymethyl Methacrylate
RE	–	Right eye
S NO.	–	Serial number
Sx	–	Surgery
CME	–	Cystiod Macular Edema
Yrs	–	Years

S.NO	O.P NO.	AGE	SEX	TIME SINCE CATARACT SURGERY(YRS)	EYE WITH PCO	TYPE OF IOL	SUBTYPE OF PCO	MADURAI GRADING OF PCO	NUMBER OF SHOTS REQUIRED	TOTAL ENERGY USED (mJ)	BCVA(snellens)				BCVA(LogMAR)				IOP GAT(mm Hg)					Increase in IOP GAT(mm Hg)				COMPLICATIONS								
											Prelaser	1 day	1 week	1 month	Prelaser	1 day	1 week	1 month	Prelaser	1 hour	1 day	1 week	1 month	1 hour	1 day	1 week	1 month	Pain	Nausea	IOL Pitting	Corneal burns	Iritis	CME	Retinal Detachment	vitritis	Endophthalmitis
1	3643995	65	M	1	RE	HYDROPHILIC ACRYLIC	ELSCHNIG'S PEARLS	GRADE I	6	18	6/18	6/12	6/12	6/12	0.477121255	0.301029996	0.301029996	0.301029996	18	20	20	18	18	2	2	0	0									
2	4046942	56	M	2.5	LE	HYDROPHILIC ACRYLIC	FIBROSIS	GRADE II	9	36	6/60	6/24	6/18	6/12	1	0.602059991	0.477121255	0.301029996	15	19	17	15	15	4	2	0	0									
3	2498957	72	M	0.8	LE	PMMA	SOEMMERING'S RING	GRADE II	6	60	6/36	6/18	6/9	6/9	0.77815125	0.477121255	0.176091259	0.176091259	11	16	16	11	11	5	5	0	0									
4	2582362	76	M	2.7	RE	HYDROPHILIC ACRYLIC	ELSCHNIG'S PEARLS	GRADE I	6	18	6/18	6/9	6/9	6/9	0.477121255	0.176091259	0.176091259	0.176091259	14	14	16	14	14	0	0	0	0	1				1				
0	4067385	62	F	1	LE	PMMA	ELSCHNIG'S PEARLS	GRADE II	6	18	6/36	6/12	6/9	6/9	0.77815125	0.301029996	0.176091259	0.176091259	10	13	10	10	10	3	0	0	0									
6	4072666	78	M	2	RE	HYDROPHILIC ACRYLIC	FIBROSIS	GRADE II	10	48	6/36	6/18	6/12	6/12	0.77815125	0.477121255	0.301029996		17	23	20	17	17	6	3	0	0		1	1						
7	4088660	63	M	1.5	LE	HYDROPHILIC ACRYLIC	FIBROSIS	GRADE II	6	24	6/60	6/24	6/12	6/12	1	0.602059991	0.301029996	0.301029996	18	19	19	18	18	1	1	0	0									
8	6924883	45	F	5	RE	HYDROPHOBIC ACRYLIC	SOEMMERING'S RING	GRADE II	10	60	6/36	6/24	6/9	6/9	0.77815125	0.602059991	0.176091259	0.176091259	15	18	17	15	15	3	2	0	0									
9	4107759	54	F	2.5	RE	HYDROPHILIC ACRYLIC	ELSCHNIG'S PEARLS	GRADE I	3	18	6/24	6/9	6/6	6/6	0.602059991	0.176091259	0	0	16	16	16	16	16	0	0	0	0									
10	4104337	66	M	0.6	LE	PMMA	FIBROSIS	GRADE II	8	24	6/36	6/12	6/12	6/12	0.77815125	0.301029996	0.301029996	0.301029996	15	15	16	15	15	0	1	0	0									
11	2956417	74	F	2.8	LE	HYDROPHILIC ACRYLIC	ELSCHNIG'S PEARLS	GRADE II	6	36	6/60	6/18	6/9	6/9	1	0.477121255	0.176091259	0.176091259	14	30	30	14	14	16	16	0	0									
12	4035883	67	M	3	LE	HYDROPHOBIC ACRYLIC	FIBROSIS	GRADE II	12	60	6/36	6/24	6/9	6/9	0.77815125	0.602059991	0.176091259	0.176091259	18	18	18	18	18	0	0	0	0	1				1				
13	3841476	48	M	0.5	RE	PMMA	ELSCHNIG'S PEARLS	GRADE I	6	18	6/18	6/9	6/9	6/6	0.477121255	0.176091259	0.176091259	0	17	19	19	17	17	2	2	0	0									
14	3686443	39	F	0.8	RE	HYDROPHILIC ACRYLIC	FIBROSIS	GRADE II	9	18	6/36	6/18	6/9	6/6	0.77815125	0.477121255	0.176091259	0	11	13	12	11	11	2	1	0	0									
15	4158106	55	M	0.5	LE	PMMA	FIBROSIS	GRADE II	8	24	6/36	6/12	6/6	6/6	0.77815125	0.301029996	0	0	17	17	17	17	17	0	0	0	0									
16	4160907	62	F	3	RE	PMMA	ELSCHNIG'S PEARLS	GRADE I	6	18	6/18	6/9	6/6	6/6	0.477121255	0.176091259	0	0	15	17	15	15	15	2	0	0	0									
17	4166930	59	F	1	RE	HYDROPHILIC ACRYLIC	FIBROSIS	GRADE II	6	36	6/60	6/24	6/9	6/6	1	0.602059991	0.176091259	0	17	20	18	17	17	3	1	0	0									
18	4168382	76	M	2	RE	PMMA	SOEMMERING'S RING	GRADE II	6	48	1/60	6/36	6/9	6/9	1.77815125	0.77815125	0.176091259	0.176091259	14	18	17	14	14	4	3	0	0			1						
19	3534597	77	F	4	LE	HYDROPHOBIC ACRYLIC	ELSCHNIG'S PEARLS	GRADE I	6	18	6/24	6/12	6/9	6/9	0.602059991	0.301029996	0.176091259	0.176091259	16	17	16	16	16	1	0	0	0									
20	4174660	61	M	0.7	RE	PMMA	FIBROSIS	GRADE II	8	48	6/60	6/12	6/12	6/12	1	0.301029996	0.301029996	0.301029996	15	18	17	15	15	3	2	0	0									
21	4174498	47	M	2.5	LE	HYDROPHILIC ACRYLIC	ELSCHNIG'S PEARLS	GRADE II	8	24	6/24	6/9	6/12	6/12	0.602059991	0.176091259	0.301029996	0.301029996	19	20	20	19	19	1	1	0	0									
22	4187698	82	M	3	LE	HYDROPHOBIC ACRYLIC	SOEMMERING'S RING	GRADE II	6	36	6/36	6/24	6/9	6/9	0.77815125	0.602059991	0.176091259	0.176091259	10	14	13	10	10	4	3	0	0		1							
23	4058333	56	F	1	RE	PMMA	ELSCHNIG'S PEARLS	GRADE I	6	18	6/12	6/9	6/6	6/6	0.301029996	0.176091259	0	0	11	11	11	11	11	0	0	0	0									
24	4284729	22	M	0.8	RE	HYDROPHILIC ACRYLIC	FIBROSIS	GRADE II	12	24	6/24	6/12	6/6	6/6	0.602059991	0.301029996	0	0	17	18	16	16	18	1	2	2	1					1				
25	4241382	73	F	1	LE	PMMA	ELSCHNIG'S PEARLS	GRADE III	6	18	1/60	6/60	6/60	6/60	1.77815125	1	1	1	19	21	20	19	19	2	1	0	0									
26	4241122	65	F	5	LE	HYDROPHOBIC ACRYLIC	FIBROSIS	GRADE I	8	24	6/24	6/12	6/9	6/9	0.602059991	0.301029996	0.176091259	0.176091259	18	21	21	21	18	3	3	3	0	1		1						
27	4200467	54	F	1.5	RE	HYDROPHILIC ACRYLIC	FIBROSIS	GRADE II	9	36	6/24	6/9	6/6	6/6	0.602059991	0.176091259	0	0	15	17	15	16	15	2	0	1	0									
28	4126884	62	M	0.5	RE	PMMA	SOEMMERING'S RING	GRADE I	6	18	6/18	6/9	6/12	6/12	0.477121255	0.176091259	0.301029996	0.301029996	14	14	16	14	14	0	2	0	0									
29	4250638	67	F	2.5	LE	HYDROPHILIC ACRYLIC	FIBROSIS	GRADE III	9	36	1/60	6/36	6/9	6/9	1.77815125	0.77815125	0.176091259	0.176091259	19	22	21	19	19	3	2	0	0					1				
30	4258871	76	M	1.2	LE	PMMA	FIBROSIS	GRADE II	12	24	6/60	6/24	6/9	6/9	1	0.602059991	0.176091259	0.176091259	16	18	18	16	16	2	2	0	0									
31	4261162	69	F	1	LE	PMMA	ELSCHNIG'S PEARLS	GRADE II	6	18	6/36	6/18	6/9	6/9	0.77815125	0.477121255	0.176091259	0.176091259	18	18	18	18	18	0	0	0	0		1							
32	3341542	71	F	2	LE	HYDROPHILIC ACRYLIC	ELSCHNIG'S PEARLS	GRADE I	8	24	6/12	6/9	6/6	6/6	0.301029996	0.176091259	0	0	17	19	18	17	17	2	1	0	0									
33	1326661	62	F	4.5	RE	HYDROPHOBIC ACRYLIC	SOEMMERING'S RING	GRADE II	4	36	6/60	6/18	6/9	6/9	1	0.477121255	0.176091259	0.176091259	13	18	13	13	13	5	0	0	0									
34	4271644	57	F	1	RE	PMMA	FIBROSIS	GRADE II	9	18	6/36	6/12	6/9	6/9	0.77815125	0.301029996	0.176091259	0.176091259	11	12	12	11	11	1	1	0	0	1								
35	3002643	68	M	2	RE	HYDROPHILIC ACRYLIC	FIBROSIS	GRADE III	8	48	1/60	6/9	6/9	6/9	1.77815125	0.176091259	0.176091259	0.176091259	16	18	16	16	16	2	0	0	0									
36	4278187	73	F	3.5	LE	HYDROPHOBIC ACRYLIC	SOEMMERING'S RING	GRADE I	6	18	6/18	6/12	6/9	6/9	0.477121255	0.301029996	0.176091259	0.176091259	14	15	14	14	14	1	0	0	0					1				
37	4294275	64	F	2	LE	HYDROPHILIC ACRYLIC	FIBROSIS	GRADE II	8	24	6/60	6/24	6/9	6/9	1	0.602059991	0.176091259	0.176091259	13	13	13	13	13	0	0	0	0									
38	4301483	53	F	1	RE	PMMA	FIBROSIS	GRADE II	9	36	6/60	6/18	6/9	6/6	1	0.477121255	0.176091259	0	15	17	16	16	15	2	1	0	0									
39	4303410	66	M	3	LE	HYDROPHOBIC ACRYLIC	SOEMMERING'S RING	GRADE II	6	48	6/60	6/18	6/9	6/9	1	0.477121255	0.176091259	0.176091259	17	17	17	17	17	0	0	0	0									
40	3162923	68	M	0.5	LE	PMMA	ELSCHNIG'S PEARLS	GRADE I	9	36	6/24	6/12	6/12	6/12	0.602059991	0.301029996	0.301029996	0.301029996	11	12	11	11	11	1	0	0	0			1						
41	4305922	61	F	2.5	RE	HYDROPHILIC ACRYLIC	FIBROSIS	GRADE III	9	36	1/60	6/24	6/9	6/9	1.77815125	0.602059991	0.176091259	0.176091259	11	14	13	12	11	3	2	0	0									
42	4306489	67	F	4.5	RE	HYDROPHOBIC ACRYLIC	SOEMMERING'S RING	GRADE III	4	36	2/60	6/24	6/12	6/12	1.477121255	0.602059991	0.301029996	0.301029996	17	18	17	17	17	1	0	0	0		1							
43	2902822	47	M	1	LE	PMMA	FIBROSIS	GRADE II	9	18	6/60	6/18	6/9	6/6	1	0.477121255	0.176091259	0	10	11	11	10	10	1	1	0	0									
44	4140922	66	F	2	LE	PMMA	ELSCHNIG'S PEARLS	GRADE II	8	48	6/36	6/18	6/12	6/12	0.77815125	0.477121255	0.301029996	0.301029996	15	17	16	15	15	2	1	0	0									
45	4315684	76	M	2	RE	HYDROPHILIC ACRYLIC	SOEMMERING'S RING	GRADE I	6	36	6/24	6/9	6/9	6/9	0.602059991	0.176091259	0.176091259	0.176091259	16	20	18	16	16	4	2	0	0									
46	4324232	58	F	0.5	LE	PMMA	FIBROSIS	GRADE II	9	36	6/36	6/24	6/12	6/12	0.77815125	0.602059991	0.301029996	0.301029996	14	16	14	14	14	2	0	0	0					1				
47	4266548	65	F	2.6	RE	HYDROPHILIC ACRYLIC	FIBROSIS	GRADE III	8	48	2/60	2/60	2/60	2/60	1.477121255	1.477121255	1.477121255	1.477121255	12	12	13	12	12	4	1	0	0									
48	3427623	69	M	1.5	RE	PMMA	SOEMMERING'S RING	GRADE I	6	36	6/12	6/9	6/9	6/9	0.301029996	0.176091259	0.176091259	0.176091259	20	23	19	19	20	3	1	0	0									
49	4342641	72	F	1	LE	PMMA	ELSCHNIG'S PEARLS	GRADE II	12	48	6/36	6/18	6/12	6/12	0.77815125	0.477121255	0.301029996	0.301029996	11	13	12	11	11	2	1	0	0			1						
50	4353685	63	F	1.5	LE	PMMA	ELSCHNIG'S PEARLS	GRADE I	6	36	6/24	6/6	6/6	6/6	0.602059991	0	0	0	17	18	17	17	18	1	0	0	0									
51	4372323	65	M	5	LE	HYDROPHOBIC ACRYLIC	FIBROSIS	GRADE II	8	48	6/36	6/18	6/9	6/6	0.77815125	0.477121255	0.176091259	0	15	17	17	15	15	2	2	0	0									
52	1121653	78	F	3	RE	HYDROPHOBIC ACRYLIC	FIBROSIS	GRADE III	6	36	1/60	6/36	6/9	6/9	1.77815125	0.77815125	0.176091259	0.176091259	18	19	18	18	18	1	0	0	0									
53	4390512	46	F	2	RE	PMMA	ELSCHNIG'S PEARLS	GRADE I	6	36	6/24	6/12	6/6	6/6	0.602059991	0.301029996	0	0	16	17	17	16	16	1	0	0	0									
54	4402755	59	F	1	LE	PMMA	SOEMMERING'S RING	GRADE III	4	24	1/60	6/60	6/9	6/9	1.77815125	1	0.176091259	0.176091259	10	15	14	10	10	5	4	0	0					1				
55	4405531	87	M	4	RE	HYDROPHOBIC ACRYLIC	FIBROSIS	GRADE II	9	36	6/60	6/18	6/9	6/9	1	0.477121255	0.176091259	0.176091259	15	18	18	15	15	3	3	0	0									
56	4407128	67	F	1	RE	PMMA	ELSCHNIG'S PEARLS	GRADE I	6	36	6/12	6/6	6/6	6/6	0.301029996	0	0	0	14	15	14	14	14	1	0	0	0									
57	4344633	78	F	3	LE	PMMA	ELSCHNIG'S PEARLS	GRADE I	6	24	6/24	6/24	6/9	6/9	0.602059991	0.602059991	0.176091259	0.176091259	19	19	19	19	19	2	0	0	0									
58	4413910	68	F	4	RE	HYDROPHOBIC ACRYLIC	FIBROSIS	GRADE III	6	36	2/60	6/60	6/60	6/60	1.477121255	1	1	1	17	16	17	17	17	2	0	0	0									
59	4424767	75	M	1	LE	HYDROPHILIC ACRYLIC	SOEMMERING'S RING	GRADE I	6	48	6/24	6/9	6/6	6/6	0.602059991	0.176091259	0	0	20	25	40	35	20	5	4	0	0									
60	4430736	62	F	3	LE	HYDROPHILIC ACRYLIC	FIBROSIS	GRADE III	9	36	2/60	6/36	6/18	6/12	1.477121255	0.77815125	0.477121255	0.301029996	11	14	13	11	10	3	2	0	0					1				

Row Labels
2/60
6/12
6/6
6/60
6/9
Grand Total

65
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66
76
58
65

69
72
63
65
78
46
59
87
67
78
68
75
62

5	1	18	2	1	2
4	2.5	36	4	3	2
6	0.8	60	7	5	3
6	2.7	18	2	1	2
5	1	18	3	1	2
6	2	60	6	5	3
5	1.5	24	1	2	2
3	5	60	3	5	2
4	2.5	18	0	1	1
5	0.6	24	3	2	2
6	2.8	36	2	3	2
5	3	60	6	5	3
3	0.5	18	2	1	2
2	2.6	18	2	1	2
4	0.5	24	1	2	2
5	3	18	2	1	2
4	1	36	3	3	2
6	2	60	4	5	2
6	4	18	1	1	2
5	0.7	48	3	4	2
3	2.5	24	1	2	2
7	3	36	4	3	2
4	1	18	0	1	1
1	1.5	24	1	2	2
6	1	18	2	1	2
5	5	24	0	2	1
4	1.5	36	2	3	2
5	0.5	18	0	1	1
5	2.5	60	3	5	2
6	1.2	24	2	2	2
5	1	18	0	1	1
6	2	24	2	2	2
5	4.5	60	5	5	2
4	1	18	1	1	2
5	2	48	2	4	2
6	3.5	18	1	1	2
5	2	24	0	2	1
4	1	36	2	3	2
5	3	48	1	4	2
5	0.5	18	1	1	2
5	2.5	36	3	3	2
5	4.5	60	1	5	2
3	1	18	1	1	2
5	2	48	2	4	2
6	2	60	4	5	2
4	0.5	18	0	1	1
5	2.6	48	1	4	2

5	1.5	18	0	1	1
6	1	60	2	5	2
5	1.5	18	1	1	2
5	5	48	2	4	2
6	3	36	1	3	2
3	2	18	1	1	2
4	1	60	5	5	2
7	4	60	3	5	2
5	1	18	1	1	2
6	3	24	0	2	1
5	4	36	-1	3	1
6	1	60	5	5	2
5	3	36	3	3	2