"A CLINICAL STUDY ON THE INTRAOCULAR PRESSURE CHANGES FOLLOWING ND:YAG LASER CAPSULOTOMY"

BY

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Dissertation submitted to the

B.L.D.E(DEEMED TO BE UNIVERSITY),VIJAYAPURA,KARNATAKA

In partial fulfillment of the requirements for the degree of

MASTER OF SURGERY

IN

OPHTHALMOLOGY

Under the guidance of

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ABBREVIATIONS

BCVA	**Best Corrected Visual Acuity**
CF	**Counting Fingers**
CME	**Cystoid Macular Edema**
D	**Diopter**
ECCE	**Extra Capsular Cataract Extraction**
HM	**Hand Movements**
IOL	**Intra Ocular Lens**
IOP	**Intra Ocular Pressure**
LEC	**Lens Epithelial Cells**
mJ	**Milli Joules**
Nd:YAG	**Neodymium : Yttrium Aluminum Garnet**
OPD	**Out Patient Department**
PCO	**Posterior Capsular Opacification**
PCIOL	**Posterior Chamber Intra Ocular Lens**
PoIVS	**Posterior Pole Visualization Score**
PL	**Perception Of Light**
PMMA	**Poly Methyl Methacrylate**
RD	**Retinal Detachment**
SCI	**Sealed Capsular Irrigation**
µ	**Micron**

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ABSTRACT

Background: Posterior capsular opacification (PCO) is the most frequent late postoperative complication following cataract surgery. Currently Nd: YAG laser capsulotomy remains the cornerstone of treatment of PCO. However, it can be associated with significant complications like intraocular pressure rise, intraocular lens pitting, cracking, iritis, vitritis, retinal detachment, cystoid macular edema etc. Raised intraocular pressure is a common complication that occurs after Nd: YAG laser capsulotomy.

Aim: To assess the intraocular pressure changes after Nd: YAG laser capsulotomy in patients diagnosed with posterior capsular opacification.

Materials and methods: This was a hospital based, prospective follow up study conducted between October 2018 to April 2020.A sample of 50 patients attending the Ophthalmology Out Patient Department at Shri B. M. Patil Medical College and Research Centre diagnosed with visually significant posterior capsule opacification(PCO) after cataract extraction, willing for Nd: YAG laser capsulotomy were selected. Following an informed written consent, selected patients underwent Nd: YAG laser capsulotomy and the number of shots, energy levels were recorded. These patients were further followed up immediately (0 hour),1 hour,2 hours and 1 week post laser for IOP changes, visual acuity improvement and associated complications.

Results: It was observed that post laser, there was a significant rise of mean IOP with increasing time, energy and number of shots and it reduced to baseline or near baseline levels at the end of 1 week. After laser, the best corrected visual acuity(BCVA) at 1 week, was in the range of 6/24p to 6/6. Out of 50 eyes, other complications such as transient iritis occurred in 4% of eyes, IOL pitting and transient vitritis were encountered in 2% cases each.

Conclusion: In most of our patients, intraocular pressure returned to baseline or near baseline IOP levels at the end of one week. Hence, regular follow up of all patients is necessary. High skill, apt patient selection, proper focusing of laser, lesser number of shots and minimizing energy levels can reduce the incidence of complications**.** Thus Nd: YAG laser capsulotomy is a simple, relatively safe, effective and non-invasive treatment modality for PCO.

INTRODUCTION

Cataract is one among the major causes for blindness worldwide. Posterior capsular opacification (PCO) is the most frequent late postoperative complication associated with decreased vision following cataract surgery. The incidence of development of PCO ranges between 4.7–18.6% at 3 years and 7.1–22.6% at 5 years [1] PCO in paediatric age group is a major problem where the incidence approaches 100%.PCO occurs due to lens epithelial cell proliferation and migration. [2]

Posterior capsular opacification reduces visual acuity when the central area of the visual axis is involved. Clinically, the proportion of visual symptoms may vary widely when compared to the amount of PCO. In the past, central PCO obscuring the visual axis were treated with surgical interventions such as posterior capsule scraping, needling, or surgical capsulotomy. Such procedures are associated with a lot of disadvantages.

Nd:YAG (Neodymium Yttrium Aluminum Garnet) laser posterior capsulotomy presents the advantage of a non invasive, effective, simple, relatively safe technique to manage intact posterior capsule that opacify post operatively. Currently Nd:YAG laser capsulotomy remains the cornerstone of treatment of PCO. It's use as a treatment modality for PCO has replaced surgical capsulotomy nowadays and it does not require patient hospitalisation.

NEED FOR THE STUDY:

Nd:YAG laser posterior capsulotomy can be associated with significant complications. Some of them are intraocular pressure rise, intraocular lens pitting, cracking, iritis, vitritis, retinal detachment, cystoid macular edema etc. [3] Raised intraocular pressure is a common complication and prescribing anti-glaucoma

medications post capsulotomy is a common practice. The purpose of the study is to study the intraocular pressure changes after Nd:YAG laser capsulotomy in patients diagnosed with posterior capsular opacification. This will help to anticipate post procedural intraocular pressure rise in specific patients and treat only selected group of patients with anti-glaucoma medications.

AIMS AND OBJECTIVES OF STUDY

To assess the intraocular pressure changes after Nd:YAG laser capsulotomy in patients diagnosed with posterior capsular opacification.

REVIEW OF LITERATURE

THE HUMAN LENS:

Human lens is a crystalline, transparent, biconvex, semisolid, elliptical, vascular body located between the iris and the vitreous. The equatorial diameter of the adult lens is about 9 – 10 mm and with a thickness of approximately 4 mm. It is related anteriorly through the pupillary aperture with the anterior chamber of the eye and with the posterior surface of the iris, related laterally to the posterior chamber of the eye and through the zonules to the ciliary processes. Lining it's posterior surface is the hyaloid membrane in the front of the vitreous. It possesses 2 surfaces, anterior and posterior and the equator, which is a border where two surfaces meet. The equator of the lens forms a circle lying 0.5 mm within the ciliary processes. The lens contributes to 15 diopters of the total refractive power of the eye.

There are three parts of lens namely

1) The lens capsule
2) The lens epithelium
3) The lens cell/fibers

1) The lens capsule

It is a hyaline collagenous membrane which is thin, transparent and encloses the lens completely. Although it is highly elastic in nature it lacks elastic tissue. The basal cell area of the lens epithelium anteriorly and of the elongating fibers posteriorly secretes the capsule. As it is being produced continuously throughout life, the lens capsule is the thickest basement membrane in the human body. The zonular fibers inserts

anteriorly onto the capsule and posteriorly onto the lens periphery and the lens equator.

THICKNESS OF THE LENS CAPSULE

Capsule thickness changes according to age and is not uniform throughout its extent. In front it is more thick than behind. The anterior and posterior portions are thicker near the periphery

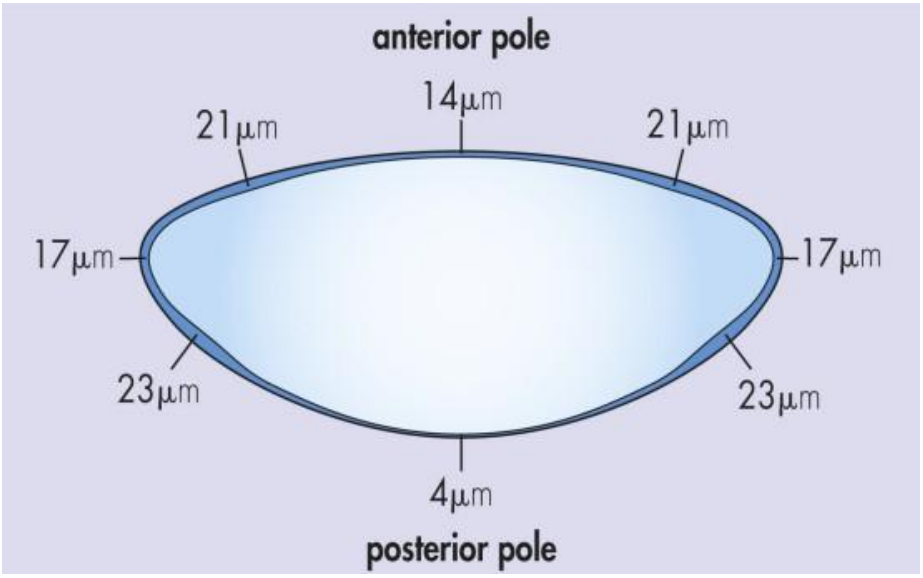


Figure 1: Thickness of the lens capsule

MICROSCOPIC APPEARANCE OF LENS CAPSULE

Electron microscopy reveals the capsule to be a relatively amorphous lamellar structure. On light microscopy, the capsule appears as a homogenous, transparent, lamellar structure with fibers arranged parallel to its surface. It stains with PAS. There are approximately 40 lamellae, with each being approximately 40 nm thick. These lamellae run parallel to the capsular surface. The layers of inserting zonular fibres and it's related capsular layer is termed as the zonular lamella or pericapsular membrane. The presence of fibronectin gives the pericapsular membrane it's zonular adhesive

mechanisms. Alike other basal membranes, the capsule is abundant in type IV collagen and some amounts of type I and type III collagen.

It consists of a single sheet of cuboidal cells distributed over the front of the lens. Inner to the capsule and extending outwards to the equator. On electron microscopy it is observed that these polygonal epithelial cell membranes are tortuous with numerous interdigitations. [4]

2) The lens fibers:

These comprise the main bulk of the lens. The earliest fiber mass situated in the center of the lens is known as embryonic nucleus. This is followed by formation of fetal nucleus and it's Y-shaped sutures. The fibers that develop after birth comprise the earliest part of the fiber mass known as the adult nucleus. The area surrounding the adult nucleus known as the lens cortex contains the recently formed nucleated fibers. The lens fibers are formed by the multiplication and differentiation of the lens epithelial cells at the equatorial region. In the process of development, the lens fibers lose their nuclei and the cytoplasmic organelles become specialized to produce lens proteins known as crystallins. The lens is anchored in position by a series of delicate, radially arranged fibers known as the zonules or the suspensory ligament of the lens. The epithelium of the ciliary process gives rise to the zonular fibers and these run towards the equator of the lens.

2) Embryology

The rudimentary lens is first noticed as a thickening of the surface ectoderm. The lens placode, overlies the optic vesicle at 22 days of gestation, giving rise to the lens

vesicle, which comprises of a single layer of cells. The cells of the posterior wall of the lens rapidly lengthen and become enriched with crystallins. These densely packed elongated cells are known as primary lens fibers. Mitotic divisions of the anterior epithelial cells at the equator form additional fibers called as secondary lens fibers. New secondary lens fibers are produced throughout life. The ends of these fibers come into apposition at sites known as sutures on the anterior and posterior surfaces of the lens known as 'Y' sutures.

The hyaloid artery which forms a plexus on the posterior surface of the lens causes rapid growth of lens in the fetus. The mesenchyme gives rise to the vascular lens capsule. The true lens capsule is formed from the thickened basal lamina.[5]

The vesicle's lumen gets obliterated by these fibers to form a solid embryonic lens which is completely developed by the end of fourth week of gestation. The new lens fibers develop concentrically outer to the older central fibers at the equator. This progressive addition of the lens fibers at the equator result in formation of zones that delineate the various stages of lens development. The new fibers develop continuously throughout life. However, it is at much slower rate after 30 years of age.

II) Physiology and Biochemistry of lens

The lens has a unique molecular make up that it is composed of one third protein, two thirds of water, remaining constituents constitute only about 1% of total lens weight.[6]

Lens Composition:

The high protein concentration helps to achieve a high refractive index. The adult human lens comprises of about sixty-five percent of water, out of which the lens capsule constitutes of eighty percent of water.

Lens proteins:

Proteins form about 35% of it's net weight. Based upon water solubility there are two types:

i. Water insoluble proteins comprise of cytoskeletal proteins, membrane proteins, and aggravated crystallins.
ii. Water soluble lens crystallins – constitute for 90% of total lens proteins.

Water insoluble proteins:

1) Membrane proteins represents about 20 – 30% of water insoluble fraction of lens proteins
2) Cytoskeletal proteins

Crystallins:

These are a heterogeneous group of structural proteins. They are of 3 types:

i) **Alpha crystallins:** Comprises of 35% of total lens protein.
ii) **Beta crystallins:** It is most abundant water soluble protein constituting of about 55%.
iii) **Gamma crystallins:** Constitutes 1-2% of total proteins.

Lens lipids:

Mainly composed of cholesterol, phospholipids and glycosphingo lipids. Cholesterol forms about 50 – 60% of lens lipids. Major phospholipids found is sphingomyelin.

Sodium:

Ranges from 14 - 26 msq/kg lens water

Potassium :

Forms about 140 msq/kg lens water.

Normal lens has low sodium and high potassium levels

Calcium:

Constitutes of about 0.3 msq/kg lens water. Raised levels of calcium results in development of cataract.

Carbohydrates:

Glucose in the lens is about 1.0 mM. Glucose metabolism causes energy production in lens.

Amino acids:

The concentration of amino acid in lens is more than that present in the aqueous humor.

Ascorbic acid:

Participates in the modulation of hexose monophosphate shunt (HMP shunt) pathway.

Choline:

The normal lens contains 1 m MP choline. In cataractous lenses due to increased permeability it is present at lower levels. [6]

Inositol:

Myoinositol, being the most abundant isomer of inositol, is actively transported into the lens by sodium dependent carrier mediated mechanism. In diabetic cataract, myoinositol levels are found to be low.

Lens metabolism:

The main site of lens metabolism is in the epithelium. It is directed towards the maintenance of transparency of lens. Composition and metabolism of lens produce significant lens changes.

Carbohydrate metabolism:

The four process through which carbohydrate metabolism occurs in lens are

1) Glycolysis
2) Kreb's cycle
3) Hexose monophosphate shunt/HMP shunt pathway
4) Sorbitol pathway

Protein metabolism

Site of protein synthesis is the lens epithelium and outer cell layers. It involves in transfer of genetic information via mRNA to the ribosomes. The energy is supplied from carbohydrate metabolism in form of ATP molecules.

Glutathione and oxidation – reduction pathways:

Glutathione plays a vital role in protecting the lens from oxidative insult. It's sulfhydryl group in along with ascorbic acid plays a role in oxidative defense mechanism.

POSTERIOR CAPSULAR OPACIFICATION (PCO)

It is also known as "secondary cataract,". It is regarded as the most common postoperative complication following cataract extraction. PCO is due to the secondary opacification of the posterior capsule. It occurs because of the migration, proliferation, and differentiation of lens epithelial cells (LECs).When the central visual axis is involved it can leads significant visual loss.[7]

Epidemiology[8]-[12]

PCO occurs in 20-50% of patients within 2 to 5 years following cataract surgery. Infants and children have an earlier onset and significantly higher incidence and of PCO. This increases along with the potential for associated amblyopia. In children, reported rates of PCO are as high as 100% [10][12].

Risk Factors

1. Younger age (significant risk factor)[13]
2. Traumatic cataract[14]-[17]
3. Diabetes.
4. Uveitis
5. Myotonic dystrophy
6. Retinitis pigmentosa

Aetiopathogenesis and morphological forms

PCO has a multifactorial aetiology. The residual LECs on the residual anterior capsule undergo three phenomena: proliferation, migration toward the posterior capsule and differentiation which can be normal or abnormal[7].Cytokines and growth factors have been postulated in the pathogenesis of PCO, some examples being fibroblast growth factor 2 (FGF-2) , transforming growth factor β (TGF-β),hepatocyte growth factor (HFG),and matrix metalloproteinases (MMPs).Some viscoelastic substances like exogenous hyaluronic acid (HA), may result in increased rates of ex vivo PCO[16].

In a normal crystalline lens, the LECs are resident to the anterior surface at the equatorial region and as well as the equatorial lens bow. This singular row of cuboidal cells can be divided into two different biological zones [Figure 2].

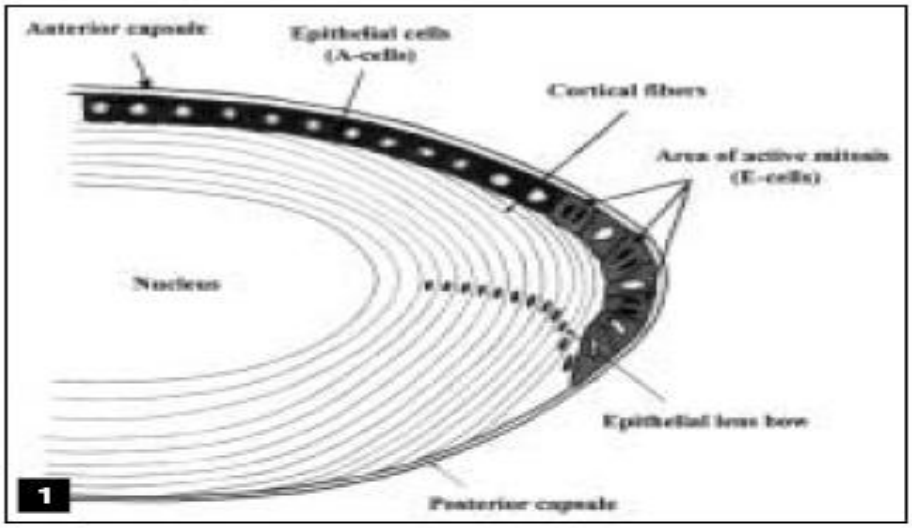


Figure 1. Schematic illustration of the microscopic anatomy of the lens and the capsular bag, showing the "A" cells of the anterior epithelium and the "E" cells, the important germinal epithelial cells of the equatorial lens bow. The primary cells of origin for posterior capsule opacification (PCO) are the mitotic germinal cells of the epithelial lens bow. These cells normally migrate centrally from the lens equator and contribute to formation of the nucleus or epinucleus throughout life. In pathologic states, they tend to migrate posteriorly to form such lesions as a posterior subcapsular cataract, as well as postoperative PCO following ECCE. Beside PCO, postoperative proliferation of lens epithelial cells can also lead to postoperative opacification of capsular bag secondary to development of anterior capsule opacification/fibrosis and interlenticular opacifcation;

Figure 2: Microscopic anatomy of the lens and the capsular bag.

A. The Anterior-Central Zone (which corresponds to the zone of the anterior lens capsule) comprise of a monolayer of flat cuboidal epithelial cells with very minimal mitotic activity. A variety of stimuli cause the anterior epithelial cells ("A" cells) to proliferate and undergo fibrous metaplasia. This has been termed as "pseudo fibrous metaplasia".[18]

B. The second zone is crucial in the pathogenesis of "pearl" formation. This layer is a continuation of anterior lens cells around the equator, forming the equatorial lens bow. These are called "E" cells. Unlike within the A-cell layer, cell mitosis, division

and multiplication are fairly active in this region. New lens fibres are continuously produced in this zone throughout the life of a person.

In addition to PCO, postoperative LEC proliferation is also involved in the pathogenesis of anterior capsule opacification/fibrosis (ACO)[19],[20] and interlenticular opacification (ILO); a recently noted complication related to piggyback IOLs.[21],[22] Therefore, within the capsular bag there are three distinct anatomic locations where clinically significant opacification may occur postoperatively. Most cases of classic PCO are caused by mainly the proliferation of the equatorial cells.

MORPHOLOGIC FORMS

There are two morphologic forms.

One form consists of capsular ***pearls,*** which are made up of clumps of opacified, swollen epithelial "pearls" or aggregations of posteriorly migrated equatorial epithelial (E) cells (Bladder or Wedl cells). Both these LEC types can also be causative in formation of ***fibrous*** form of opacification. Anterior epithelial (A) cells are predominant in the pathogenesis of fibrous PCO, as the primary response of these cells is to undergo fibrous metaplasia. Although the preferred type of growth of the equatorial epithelial (E) cells is in the direction of bloated, swollen, bullous-like bladder or Wedl cells, these also may contribute in formation of the fibrous form of PCO by undergoing fibrous metaplasia. This is commonly noted in fibrous plaques of posterior sub capsular cataract and in cataracts where operation is delayed for numerous years.

The E cells of the equatorial lens bow tend to form cells that differentiate toward pearls (Bladder cells) and cortex. Equatorial cells (E-cells) are also responsible for formation of a ***Soemmering's ring***. This is a dumb-bell shaped lesion that usually forms after any type of rupture of the anterior capsule like ocular trauma. Rupture of

the anterior lens capsule causes extrusion of nuclear and some part of central lens material. These extruded cortical remnants then transform into Elschnig pearls. Soemmering's ring are regarded as a direct precursor to PCO, surgeons should strive to prevent its formation.

Many other types of cells are found to be associated with PCO. Cataract extraction is often associated with breakdown of the blood-aqueous barrier. This causes release of inflammatory cells, erythrocytes, and many other inflammatory mediators into the aqueous humor. The intraocular lens(IOL) aggravates this severity of inflammation. This foreign body triggers a three-stage immune response that involves many cell types, including polymorphonuclear leukocytes (PMNL), giant cells and fibroblasts. Deposition of collagen onto the intraocular lens and the capsule, results in formation of fine wrinkles and opacities in the posterior capsule. In most of the cases, however, this inflammatory response is clinically insignificant. Iris melanocytes also have been found to adhere and migrate over the anterior surface of the posterior capsule.

PCO CLASSIFICATION [23]

Duke Elder classification of lens remnants:

1. Capsulolenticular remains
2. Capsular remains
3. Pigmentary, inflammatory or haemorrhagic fibrous elements

Clinically PCO is classified as

1. Elschnig pearls
2. Dense membranous
3. Soemmering's ring

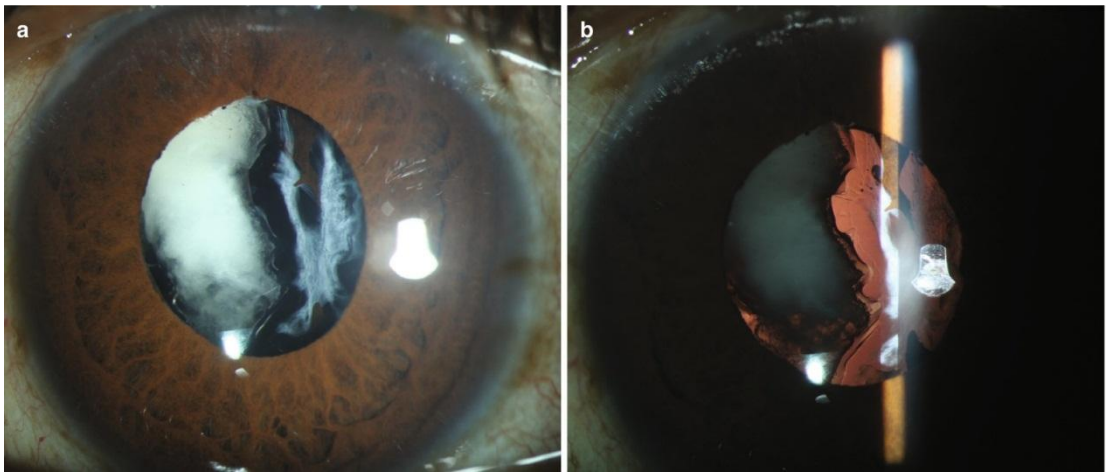


Figure 3: Dense membranous PCO

Figure 4: Soemmering's ring PCO

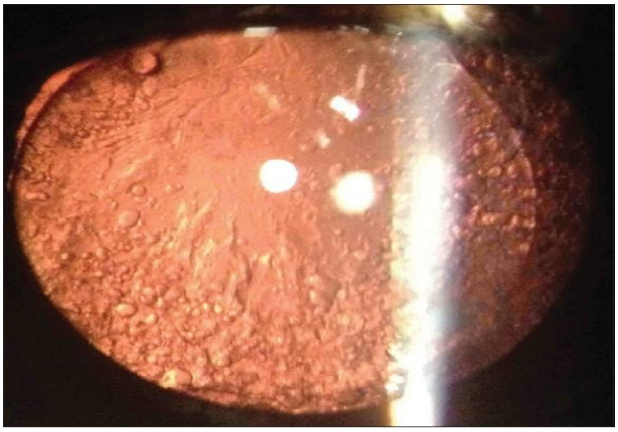


Figure 5: Elschnig's pearls type of PCO

EVALUATION TECHNIQUES FOR POSTERIOR CAPSULE OPACIFICATION

Precise methods of evaluation are vital to quantify the progress of posterior capsular opacification. Most of the evaluations of posterior capsule opacification in patients after cataract surgery are performed after full pupillary dilatation using a slit lamp biomicroscope. PCO is defined as opacification of the posterior capsule in the visual axis that is observed on silt lamp biomicroscopy, which includes Elschnig's pearls and fibrous opacification (behind the IOL optic) and Soemmering's ring (i.e. PCO peripheral to the IOL optic).

The degree of opacification is assessed by the following:

1) Visual acuity after surgery
2) Slit lamp biomicroscopy
3) Fundus visibility

Visual acuity after surgery

Visually significant posterior capsular opacification is defined as a decrease in the best-corrected postoperative vision by two lines in Snellen's distant visual acuity chart.

Slit lamp grading

1) **Sellman and Lindstrom grading:**

Sellman and Lindstrom graded fibrosis and Elschnig pearl formation on a four-point scale [24]. The following grades were assigned:

1) 1 = No or slight PCO without reduced red reflex, also no pearls at all or pearls not to the IOL edge.
2) 2 = Mild PCO reducing the red reflex, Elschnig pearls to the IOL edge.
3) 3 = Moderate fibrosis or Elschnig pearls inside IOL edge but with a clear visual axis.
4) 4 = Severe fibrosis or Elschnig pearls covering the visual axis and severely reducing the red reflex.

2) Kruger grading: [25]

Kruger et al used a grading system of 0 to 3 to evaluate capsule opacification. The capsule behind the optic was evaluated within a central area measuring 3 mm diameter, and also in the periphery. Distinction was given to grade Elschnig pearls and fibrosis.

The criteria used were

0 = Absent.

1 = Very mild.

2 = Moderate.

3 = Dense white.

Grading based on fundus visibility

Madurai intraocular lens study IV grading system: [26]

It is based on visualization of the posterior pole assessed by examining the optic disc and macula using a Volk 90D lens.

Visualization of the optic disc was subjectively graded according to the following scale:

1) Clear views of optic disc margin, but disc blood vessels and/or nerve fiber layer are not clearly seen.
2) Optic disc margin, as well as disc blood vessels and nerve fiber layer are not clearly seen

Macular visualization was subjectively graded according to the following scale: -

0 - Clear view of foveal reflex, peri-foveal blood vessels and nerve fiber layer.

1 - Diminished foveal reflex, but clear view of peri-foveal blood vessels and nerve fiber layer.

2 - Blurred foveal reflex, peri-foveal blood vessels and/or nerve fiber layer.

The total scores of the visualization of the optic disc and the macula were combined to produce a total posterior pole visualization score (PoIVS) ranging from 0 to 4 in order of decreasing visualization.

IMAGING SYSTEMS

Scheimpflug system

Lasa et al [27] demonstrated in 1995 that Scheimpflug photography could be a

useful tool for future assessment of PCO. This photography system was further developed by Hayashi in 1998[28]. 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 utilized 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 makes use of area densitometry to measure the scattering light intensity, which is considered equal to the opacification density.

To measure the 3 mm portion in the center, 3 cross sections are taken at meridians of 0, 60, and 120 degrees respectively. These are averaged to give an approximate value of PCO. The value thus obtained was shown to have a good correlation with visual acuity. This measurement method is easy to perform and can be done within a few minutes for each eye.

Digital photographic image acquisition systems

1) Brightness based analysis
2) Texture analysis
3) Density map system
4) Computerized analysis of density boundaries
5) Color coded grid system.

Tetz [29] described a photographic image analysis system that can morphologically score posterior capsule opacification. This method was independent of visual acuity testing. Standardized retro illumination slit lamp photographs were analyzed. Posterior capsule opacification score was calculated by multiplying the

density of opacification and graded from 1-4 by the fraction of capsule area behind the IOL optic that is opacified. This technique showed good inter-and intra-individual reliability.

Apple et al [30] utilized Miyake-Apple posterior photographic technique for analysing commonly used IOL model in eyes that were obtained post-mortem. This helped to evaluate PCO and whether or not an eye had an Nd: YAG laser capsulotomy or not.

Pandey et al [31] developed a system of retro illumination imaging of the posterior capsule using a computerized high resolution digital system that can produce excellent images for objective documentation and also for quantitative measurement of posterior capsule opacification.

PREVENTION OF POSTERIOR CAPSULE OPACIFICATION [32]

One of the methods to minimize the number of retained / regenerated Lens epithelial cells (LECs) and cortex is through meticulous cortical clean up. The second way is to prevent the posterior migration of remaining LECs. The edge of the IOL optic is vital in the formation of such a physical barrier.

SURGERY – RELATED FACTORS TO REDUCE PCO

1. HYRODISSECTION – ENHANCED CORTICAL CLEANUP:

A very vital surgical step is hydrodissection. The necessary tenting up of the anterior capsule during sub capsular (or cortical cleaving) hydro dissection is best achieved by using a cannula bent at the tip. This allows a flow of fluid toward the capsule which will aid in efficient separation of capsule from cortex. By freeing and rotating the lens

nucleus, hydrodissection facilitates removal of lens nucleus and cortex without zonular – capsular rupture. [33]

Use of preservative free lidocaine 1% during hydrodissection may reduce the amount of live LECs thus facilitating cortical clean up. It also loosens the desmosomal area of cell to cell adhesion causing reduced cellular adherence or acts by a direct toxic effect. Corneal endothelial toxicity still continues to be of major concern while using hypoosmolar agents during hydrodissection or any step of cataract surgery, in the absence of a sealed capsular bag.

2. IN THE BAG /CAPSULAR FIXATION:

The most obvious advantage of in the bag fixation are the achievement of good optic centration and sequestration of the IOL from adjacent uveal tissues. This also reduces the amount of PCO. One desired aim of in the bag fixation is increasing the IOL optic barrier effect. This is maximized when the lens optic stays fully in the bag and is in direct contact with the posterior capsule. In case one or both optics are not placed in the bag, a potential space is created, allowing a group of cells to grow posteriorly towards the visual axis. With the modern foldable IOL implantation, in the bag fixation has increased to over 90%. It is the meticulous surgery including a continuous curvilinear capsulorhexis (CCC) and secure implantation of both IOL loops in the bag rather than the foldable IOL or the small incision that has contributed to this success. [34]

3. CAPSULORHEXIS EDGE ON IOL SURFACE:

Significant addition to precise in the bag fixation, is creating the continuous curvilinear capsulorhexis diameter slightly smaller than that of the IOL optic. The IOL optic is usually 6.0 mm. the capsulorhexis diameter should ideally be slightly

smaller perhaps 5.0 – 5.5 mm. This places the cut anterior capsule edge on the anterior surface of the optic, providing a snug fit and aids to sequester the optic in the capsular bag from the surrounding aqueous humor. This mechanism may support protecting the capsule from atleast some potentially dangerous factors within the aqueous humor, especially some macro molecules and inflammatory mediators.

IOL RELATED FACTORS TO REDUCE PCO:

1. IOL BIOCOMPATIBILITY:

Lens material biocompatibility can be defined by many criteria, e.g. the ability to inhibit stimulation of epithelial cellular proliferation. The lesser the cellular proliferation, the lower the chance for PCO. The amount of cell proliferation is greatly affected by surgical factors, such as meticulous cortical clean up. The time factor such as the duration of the implant in the eye also plays a vital role.

2. MAXIMAL IOL OPTIC POSTERIOR CAPSULE CONTACT:

Other contributing factors in decreasing PCO are posterior convexity of the optic and posterior angulation of the IOL haptic. This is due to the creation of a tight fit of the posterior capsule against the back of the IOL optic. The relative sticky nature of the IOL optic biomaterial helps to produce an adhesion between the capsule and IOL optic. There is evidence that hydrophobic acrylic IOL biomaterial provides bio adhesion or enhanced capsular adhesion. [35]

3. BARRIER EFFECT OF THE IOL OPTIC:

The IOL optic barrier effect plays a vital role as a second line of defence against PCO, especially in cases with retained cortex and cells. If the IOL is correctly implanted in the capsular bag, it provides an excellent barrier effect with almost complete filling of

the capsular bag and increasing contact of the posterior IOL optic to the posterior capsule.

Recently slight difference between optics with a round tapered edge and optics with a square truncated edge was found. A truncated, square edged optic rim causes a complete blockade to cells at the optic edge, thereby preventing epithelial ingrowth over the posterior capsule. This enhanced barrier effect of this particular edge geometry provides another add on factor to the five above mentioned factors, that have significantly reduced the overall incidence of clinical PCO.

Table 1: Six factors to reduce PCO

Surgery – related factors (capsular / surgery)	**IOL – related factors (Ideal IOL)**
Hydrodissection meticulous cortical clean-up	Biocompatible IOL to reduce stimulation of cellular proliferation
Small CCC with edge on IOL surface	IOL optic geometry square, truncated edge.
In the bag fixation	Maximal IOL optic posterior capsule contact, angulated haptic, adhesive, biomaterial to create a snug fit.

MANAGEMENT OF POSTERIOR CAPSULAR OPACITY

There are 2 different methods to manage the Posterior capsular opacification:

1. Surgical capsulotomy
2. Nd: YAG laser capsulotomy.

Surgical Capsulotomy:

Surgical option is chosen when Nd: YAG laser is not available or if there is a thick after cataract which is not amenable to YAG capsulotomy.

It is usually done with a 26-gauge needle, that is introduced through the limbal or pars plana route to make a nick in the posterior capsule. But in certain cases where the posterior capsule is extremely thick, especially in poorly done cataract surgery with retained lens matter, one has to do membranectomy and anterior vitrectomy with the help of vitrectomy cutter via pars plana approach. 20 gauge MVR blade, vitreous scissors or even a capsulotomy punch may have to be used.

Surgical capsulotomy is of 2 types:

Surgical Primary capsulotomy:

This is done while doing the surgery when PCO is noted on the table and also in congenital cataracts where there is almost 100% chance of PCO occurrence within 2 years of surgery. Capsulotomy can be done either even before placing the IOL in the capsular bag or after placing the IOL. Vitrectomy is done taking care that no vitreous strands are present in the anterior chamber. Posterior capsulorhexis can be done in place of primary posterior capsulotomy. If the intraocular lens is not inserted, primary capsulotomy should be done under air as this will prevent vitreous herniation anteriorly.

Ophthalmic dyes for posterior capsulorhexis (PCCC)

Posterior capsulorhexis is recommended as it converts an irregular tear of the posterior capsule to a circumscribed cut extending to the equator. It is also beneficial for removal of posterior capsular plaque in posterior sub capsular cataract or posterior polar cataract. Gimbel and DeBrof recommended performing posterior CCC with IOL optic capture. But this may not prevent opacity in visual axis in pediatric cases because the anterior hyaloid face will also be opacified.

Posterior capsulorhexis (PCCC) with optic capture of an intraocular lens with anterior vitrectomy in pediatric cataracts can be used to delay secondary membrane formation or posterior capsular opacification. The dyes commonly used are Indocyanine Green 0. 5 % or 0.1 % Trypan blue.

Surgical Secondary Capsulotomy:

This is indicated when there is non availability of YAG laser in case of Posterior capsular opacification following cataract surgery. It is also performed in cases of thick PCO which is not amenable to YAG capsulotomy. It is done through a slit lamp or operating microscope and with topical or retrobulbar anaesthesia. In this method one can go through the pupil or through iridectomy. The second method is to go through the pars plana with a curved needle which cuts the posterior capsule. This needle thus traverses the vitreous and prevents IOL damage.

Complications of Surgical Capsulotomy include:

1) Vitreous loss
2) Complications of anesthesia
3) Cystoid macular edema
4) Retinal detachment

5) Endophthalmitis

Therefore, in general the approaches adopted for the creation of an adequate pupillary opening may be divided into six categories:

a) Scissors section or two knife section for thicker membranes.
b) Simple decision for a relatively thin membrane
c) Pars plana membranectomy
d) Removal of a portion of the membrane through a larger limbal incision for the thickest membrane
e) Aspiration of Elschnig's pearls
f) Nd:YAG posterior capsulotomy.

Nd: YAG Laser Capsulotomy:

Weighing all the complications of the surgical posterior capsulotomies, it is always better to use the Nd: YAG laser if available, to perform a posterior capsulotomy.

HISTORICAL ASPECTS [36]

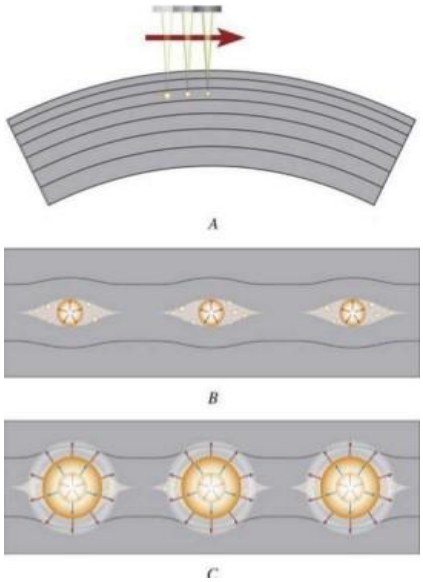
In 1917 it was Albert Einstein who introduced the concept of Light Amplification by the Stimulated Emission of Radiation (LASER). Maiman in 1960, obtained the optical laser (LASER) utilizing a ruby crystal to produce a 200-μs pulse of intense red light energy. This light had a wavelength of 649.3 nm and it was monochromatic in nature. This was a major breakthrough as it gave the ophthalmic world an intense, pure light beam which had the ability to produce extremely tiny burns of varying intensities. In the subsequent year, Zaret and colleagues began experimentation with ruby laser photocoagulation. The following year Zweng, Campbell and others treated human patients.

It was in 1964 at Bell laboratories, the first Nd:YAG laser was developed. It was decades later its widespread application in Ophthalmology came into being. Fankhauser, Aron-Rosa and others discovered the pulsed Nd:YAG laser. This revealed superior outcomes for the breakdown of transparent ocular tissues, membranes especially opacified posterior capsules and vitreous strands.

The ultrashort pulsed Nd:YAG laser was thus a very useful technology in non-invasively treating many significant eye diseases. The usage of Nd:YAG laser in the mode-locked and Q-switched configurations brought forth a new horizon in lasers in ophthalmology where by, the utilization of short bursts of laser energy the posterior lens capsule can be lysed.

PRINCIPLE OF ND: YAG LASER [36]

Nd:YAG Laser works by the principle of **photo disruption**. The Nd:YAG Laser produces an infrared beam of light of 1064 nm. This concentrates a chosen amount of energy at a focal point which is of roughly 11 microns of sufficient energy density. This in turn creates a small **'plasma effect'** thereby causing an acoustic wave which breaks the surrounding tissues. This is called as photo disruptive effect.



A. Laser energy absorbed by the tissues

B. Plasma formation

C. Photo disruption

Figure 6: Principle of Nd:YAG laser

Elements of laser:

All ophthalmic lasers currently used require 3 basic parts:

1) A means of energy input called as pumping.

2) An active medium that can emit coherent radiation.

3) The opportunity for oscillation and amplification via optical feedback.

The atomic environment that supports stimulated emission is termed active medium. This medium permits a huge number of atoms to attain energy above the ground state, such that stimulated emission occurs. Lasers are commonly named after their active medium. Such mediums may be gas (Carbon-dioxide, Helium with Neon, Argon or Krypton,), a liquid (dye) or even a solid (an active element supported by a crystal). Examples of solid active medium include Neodymium supported by Yttrium - Aluminium Garnet (Nd:YAG), Erbium supported by Yittrium Lanthanum Fluoride (Er:YLF) or a semiconductor.

YAG laser is actually a Neodymium laser. Neodymium YAG laser is formed from the Neodymium ion that is doped into a YAG crystal. This can be analogous to a gun.

The Neodymium is the gun responsible for emitting the pulse that does the work and ‘YAG’ merely a 'HOLSTER' that is responsible for carrying the material.

Another prerequisite for a laser is the provision of a source of energy input to the active medium so that a major portion of the atoms are in an elevated energy state than their ground state. This state is termed as population inversion, as it is the inverse of the usual condition in which most of the atoms are in their lowest or ground state. The input of energy that brings about the population inversion is called as pumping. Gas lasers are usually pumped by electrical discharge between electrodes in gas. On the other hand, dye lasers are usually pumped by other lasers. Solid crystals are often pumped by incoherent light like the Xenon arc flash lamp.

The ultimate requirement, once population inversion in the active medium has been attained, is for a means of optical feedback that can promote stimulated emission and suppress spontaneous emission. The cavity of the laser acts like an optical resonator providing an ambience that creates such kind of an optical feedback. At each end of a beam path mirrors are placed, so that it can cause reflected light to pass to and fro via the active medium, in which the pump maintains a population inversion. Therefore, a light wave resonates through the active medium and every time hikes the total coherent light energy through stimulated emission. Spontaneous emission as it occurs randomly in all possible directions, rarely hits a mirror and are thus not amplified. Temperature spikes with increasing power or irradiance emitted, provided the radiated energy is absorbed by matter. At peak temperatures all matter gets converted into a gaseous state. At still higher temperatures, a part or the entire atoms of this gas gets ionized and release free electrons. Therefore, within the focal volume, there exists ions, free electrons and neutral atoms, all racing at high velocity and hitting each

other. This collision of electrons with unionized atoms and ions atoms give rise to electromagnetic radiations (Photons or light). This state of matter is termed as "Plasma" as it varies in its physical properties from normal gas.

The laser power level at which a plasma has been created is known as optical breakdown threshold. As the treatment energy is increased, the size of the plasma formed also increases, thereby resulting in a bigger, stronger acoustic wave. Once the energy is increased, it is important to focus the treatment beam further away from or posterior to the membrane to be penetrated. This is very important in procedures such as posterior capsulotomy to deter the possibility of the plasma entering the IOL and resulting in cracking or chipping of the intraocular lens. This also permits the accompanying shock wave to grow to its most effective size.

The following damage processes are responsible for photo disruptive effects:

1) Generation of UV light - induced photo chemical process
2) Acoustic transients
3) Ionization
4) High temperatures
5) Cavitation
6) Electric field stress

Effects of laser:

Thermal mechanism and photo disruptive mechanism

LASER	THERMAL MECHANISM		PHOTODISRUPTIVE MECHANISM	
TEMPERATURE	**37 to 55^{o}**	**55 to 180^{o}**	**Several hundred ^{o}C**	**Several thousand ^{o}C**
PROCESS	Heating	Denaturation & Coagulation of tissues	Carbonization evaporation, burning, volatization	Isolation, optical breakdown mechanical effects
BIOLOGIC EFFECT	None	Tissue shrinkage	Disintegration of structure	Disruption, tissue disintegration, decomposition, damage

Table 2: Effects of Laser

Nd: YAG LASER: WORKING MODES

In Ophthalmology, Nd:YAG laser is operated either in the free running, the Q-Switched or the mode - locked regime or continuous wave mode. Both continuous wave mode and free running working mode result in thermal effects in contrast to the high power lasers (mode – locked or Q- Switched) which are photo disruptive. [38]

HIGH POWER LASER:

Q- SWITCHED LASER:

Q-Switching is a method of obtaining high-peak-power, short-duration laser pulses by controlling the loop gain of the optical cavity of the laser.A Q-switch is essentially a very fast shutter located between the active medium and the HR mirror.

A temporary closing of the shutter within the cavity of the laser rod places maximum energy in the rod and creates conditions for high amplification if the pumping excitation is continued.

The sudden opening of the shutter results in a rapid buildup of the circulating

wavelength intensity as it moves from mirror to mirror, which reaches levels thousand times greater than the continuous wave laser. The beam which is couple out in 10-6 seconds easily reaches power levels of 10 -6 watts.

Once shutter is opened the stored energy in the laser cavity is converted into a circulating light wave power. This change is called Q - Switching.

A good Q-switch should reduce the loop gain to zero when closed and should introduce no loss in the cavity when opened. It should switch from one condition to the other as fast as possible, and the switching should be synchronized to external events. [37]

To couple - out; a very fast shutter is needed which is not possible mechanically, so we can have two types of shutters.

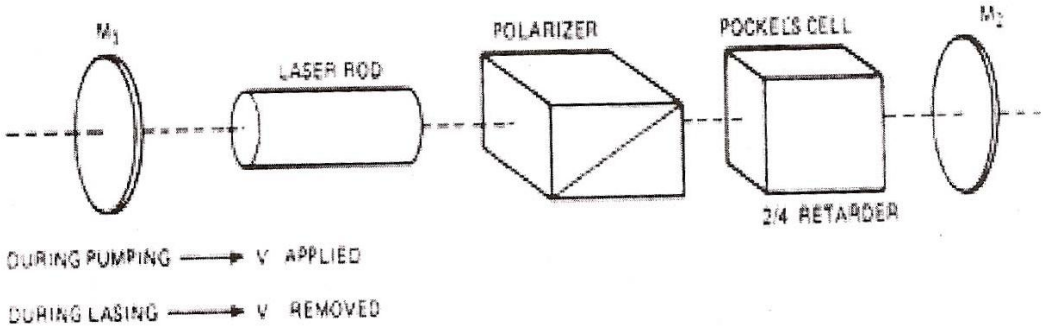


Figure 7: Bleachable dye- Q – switch

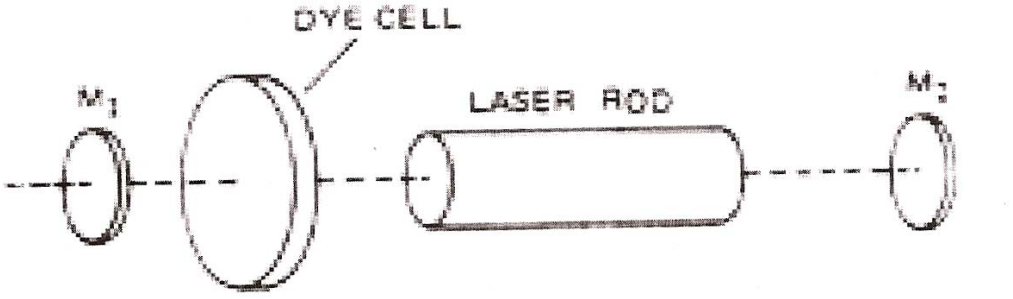


Figure 8: Electro optic Q-Switch

A) Pockel cell polarizes assembly:

This is an electrically switched optical assembly that is transparent to light in one state and opaque in the other. They have high dynamic loss (99%) and relatively high insertion losses (15%) because of the losses in the optical elements. Switching time is fast, typically less than a nanosecond, and synchronization is good.

B) Use of a bleachable dye:

A special organic dye either in a liquid solvent or in the form of a plastic film is interposed at the shutter. The dye is non - transmissive when the incident light is weak but when the intensities are sufficiently high, it bleaches and becomes transparent. The "bleaching" of the dye is the equivalent of Q-switching in the laser, and it can occur in a period less than a nanosecond. Bleachable dye Q-switches rate very high in dynamic loss (>99%) and insertion loss (a few percent at most), and their switching time is fast. They have virtually no synchronization at all.

Pocket cell polarizer is more efficient than the dye in converting the stored energy to laser output but has the inherent problem of being more complex and prone to malfunction.

Q - Switched pulse has a duration between 2 and 3 n sec.

Q - Switched Nd :YAG lasers have maximal output of 10- 20 mJ.

MODE LOCKING:

For mode locking three conditions are necessary.

First the laser medium must have a sufficiently broad transition to' create a large number of oscillating axial modes.

Second, the cavity should be relatively long so that separation between the modes is small.

Third, there must be a mechanism for synchronizing the phase relationship.

In lasers the phase relationship is synchronized by the shutters. The shutters may be electro optic or acoustic - optic in which case the shutter mechanism is called active mode locking. In ophthalmic practice the most common shutter is saturable dye called passive mode locking. The dye has the property of absorbing lower power high pulses, but the dye bleaches and becomes transparent on exposure to high power pulses. The pulses are amplified and reflected. In this manner the axial modes are synchronized or mode locked. The dye must be able to alternately bleach and recover within pico seconds.

Typically, each spike has a duration of 30 - 80 p sec. and mode locked units have a maximum output of 4.5 mJ.

Monomode (Fundamental Mode) Vs Multimode:

'Only a pure beam gives pure focus'. This rule means that several different laser outputs can be focused to a finest spot because it comes out with the narrowest beam size when emitted from the laser. Here, mode emission is accomplished with an aperture located in the laser cavity so that only part of the laser is used. A multimode beam does not have an aperture in the laser cavity. Therefore, all of the laser material is used and higher total energies are produced but also a wider beam with a faceted energy cross section and less concentrated focus is produced.

Clinical application exists for both the modes. Mono mode is used for the situations where precise focus is crucial in order to avoid some structures that might be contiguous of avoiding an intra ocular lens implant. On the other hand, Multimode is possible to hit tissues that might otherwise be too fine. An analogy might be to compare monomode with a rifle and multi-mode with a shot gun. [38]

LASER INSTRUMENTATION: [39,40]

Beam divergence:

For a given laser, retinal protection is afforded by beam divergence and by shield effect of plasma formation. Beam divergence is defined as "the angle formed by the cone of light conveying upon and then diverging from the focal point of delivery system." The smaller the beam divergence, the smaller is the final spot. For Nd:YAG lasers beam divergence varies from 0.5 to 3 m rad.

Pulsing:

Q- switching results in a single pulse typically between 2 and 20 n sec.

In mode locked lasers each spike has a duration of about 30 to 80 p sec.

Energy range:

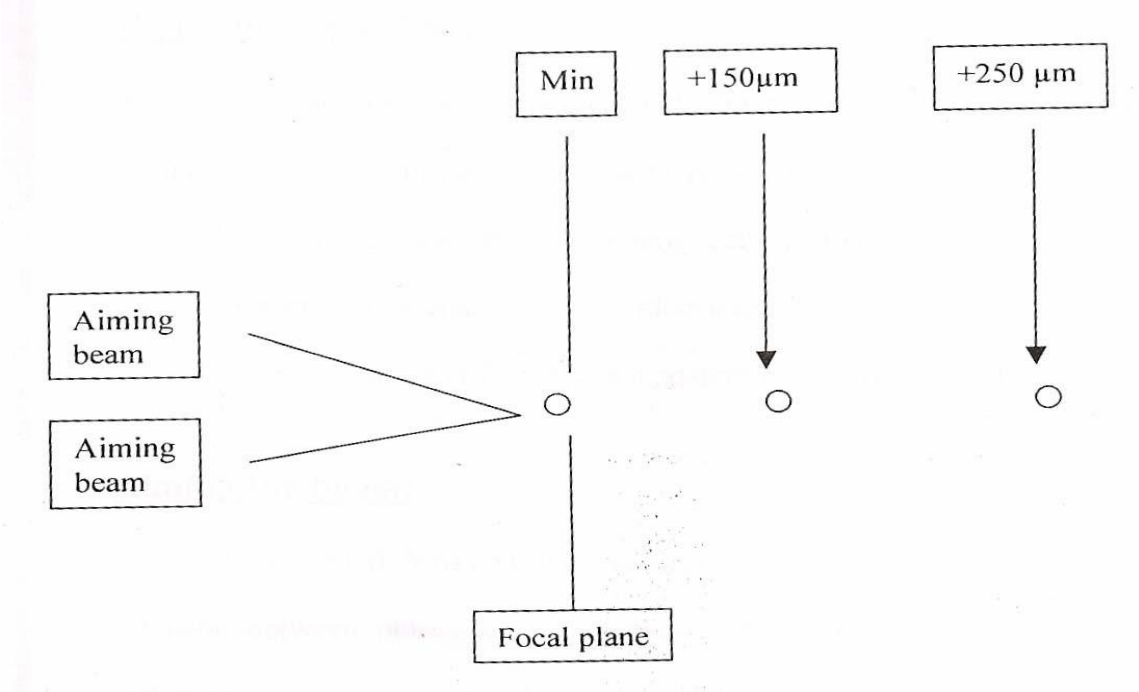
In fundamental mode maximal energy / pulse is 10 - 20 mJ. Mode locked Nd: YAG lasers have a maximum energy per pulse of about 5 mJ. Most applications can be performed with less than 5 mJ. The higher energy Q-switching are useful in cutting very dense material and in situations in which optical degradation of the quality of beam occurs such as corneal edema or scarring, turbidity of anterior chamber from pigment or blood, astigmatism caused by corneal scars, application through the peripheral cornea and use of some gonioscopic lenses. In these conditions energy has to be increased to 10 mJ or more.

Burst modes:

When the laser is set to fire a single Q- switched pulse or mode locked train most ophthalmic systems allow a firing rate between one and 10 times/sec (1 - 10Hz). Both systems can be designed to deliver a volley or burst or shots at a fixed rate.

Current models have burst repetition rate of 10 - 100Hz. The interpulse spacing is 0.1 sec for 10Hz, 20 m sec for 50 Hz and 10m sec for 100 Hz. 2 micro seconds for 500 K Hz. Burst duration should not exceed 160 m sec.

The burst mode capability should not be used initially to effect capsule dicission. It should only be used when increasing levels of single shot energy have been attempted and are not successful in opening the capsule.



Pulse to Pulse stability:

When a Nd:YAG pulse is delivered to the patient, the operator relies on the knowledge of the energy in the preceding pulse along with the pulse to pulse stability in order to predict the energy of next pulse to be emitted.

Posterior YAG offset:

An offset level which is greater than zero will reduce the risk of pitting the lens. As the energy of the treatment laser is increased it is recommended that a higher offset is selected. This is because at higher energy settings the plasma elongates anteriorly along the laser beam axis, increasing the incidence of pitting at the correct

focus position.

Normal position is 150 microns posterior YAG offset at about 12 - 1.5 mJ.

Aiming the beam:

A pulsed Nd: YAG system requires a separate aiming system because there is no emission between pulses and it's because of the invisible infrared wavelength. Most systems use continuous wave low power Helium - Neon (He-Ne) laser. To locate the focal point, the He - Ne emits a red beam at 632.8 nm. The He - Ne aiming beam is co-axial with Nd: YAG pathway.

The He - Ne beam may be transmitted as a single beam or by prism arrangements, may be used to modify the He - Ne beam into annulus.

Cooling:

Cooling of flash lamps and laser rod is by ambient air or internally recirculated cool water.

Controls:

The Bureau of Radiological Health Standards require a key that limits operator access to the laser, an audible warning is heard when the laser is armed and a shutter for the lasers which are closed when the laser is first activated and must be opened manually. YAG laser should never be operated without a He- Ne shutter open.

Energy can be monitored at the laser cavity or near the end of the delivery system. The trigger may be manipulated with a hand or a foot control.

As an approach to avoid posterior chamber intraocular lens markings during posterior capsulotomy, several modes have a mechanized system to shaft the He- Ne focus, a fixed interval in front of the expected Nd:YAG breakdown zone.

An integrated optical micrometer that measures anterior- posterior slit lamp travel with an accuracy of 10M has been introduced as another approach to avoid IOL markings. The surgeon can focus on the capsule and then move a measured distance posteriorly.

INDICATIONS OF ND:YAG LASER CAPSULOTOMY

1. Posterior capsular opacification (PCO) responsible for decreased acuity of vision and or excessive glare.
2. PCO with inadequate /very small YAG capsulotomy opening.
3. Capsular distension following retention of residual viscoelastic material between posterior surface of IOL and transparent posterior capsule (in capsulorhexis). It is very rare and suspected by myopic error of refraction in postoperative follow up.
4. Re-opacification (Post Nd:YAG capsulotomy).

CONTRAINDICATIONS OF ND:YAG LASER CAPSULOTOMY

ABSOLUTE:

1. Corneal leucomatous or macular grade opacity.
2. Corneal surface disorders.
3. Corneal edema
4. Uncooperative or unwilling patients.

RELATIVE:

1. Cystoid macular edema
2. Eyes with active inflammation

3. High risk group of patients for rhegmatogenous retinal detachment
    - Patients with previous history of rhegmatogenous retinal detachment.
    - High myopic patients having peripheral retinal degenerations, silent holes etc.

PREPARATION OF THE PATIENT FOR ND: YAG LASER CAPSULOTOMY

Before the treatment session

- Complete ophthalmic history and examination.
- Explain the procedure: Patient is detailed about purpose of the procedure, duration, painless nature and importance of maintenance of steady fixation. Signing of informed consent form.
- Anti-glaucoma medication if needed to be given 30-60 minutes before the procedure.
- Pupillary dilation is optional: Dilation if required should be done by a weak mydriatic like drugs (10% Phenylephrine or 0.5% or 1% Tropicamide).

At the laser table

- Review of about the procedure and the importance of fixation to the patient.
- Application of topical anesthetic drops, if Abraham or Peyman contact lens is to be used. Abraham contact lens is used to improve the laser beam optics and facilitate accurate focusing. This lens increases the convergence angle to 24° from 16°, decreases the area of laser at the posterior capsule to 14µm from 21µm and increases the beam diameter at both the cornea and the retina. It must be used with care because it is a modified posterior pole lens, if the Nd:YAG laser is not sent through the lens button but rather the peripheral

"carrier" portion of the lens, then the laser beam may be focused on the retina and cause damage.

- Adjustment of stool, table, chin rest for optimal patient comfort.
- Application of head strap to maintain forehead position.
- Darkening of the room (optional): to improve surgeon's visualization of the target and consequent accurate focusing of laser beam.
- Provision of fixation target for fellow eye. (Illumination target if room is darkened).
- Slight lamp beam should be narrow and obliquely angled. This helps in minimizing miosis and acts as an indicator for size of the pupil in ambient light situation

POSTERIOR CAPSULOTOMY TECHNIQUE

- Usually 1 to 2 mJ per pulse from Q – Switched Nd-YAG laser is sufficient to open posterior capsule. The energy setting per pulse may be increased in recalcitrant thick posterior capsules.
- Capsulotomy is preferably started in an existing area of separation between posterior capsule and IOL.
- Once the capsulotomy has started, further areas of separation develop easily.
- The shots are placed across the tension lines to achieve maximum opening per pulse.
- Cruciate opening is performed starting from 12'O'clock and progressing towards 6 'O' clock.
- Then progress laterally from central edges of initial vertical opening towards 3

‘O’ clock and 9 ‘O’ clock to complete the cruciate opening.

- Residual posterior capsular flaps if present in pupillary area should be directly fired with laser shots to cut them so that they retract and fall back towards periphery.
- To avoid creating large fragments because they may come in contact with corneal endothelium or angle of the anterior chamber.

The first shot is made superiorly in the location of some fine tension lines

The second shot is aimed inside the inferior edge of the initial opening

The next shot again is made at the 6 o’clock position of the capsulotomy border

The fourth shot is made across inferior tension lines to allow the capsulotomy to widen

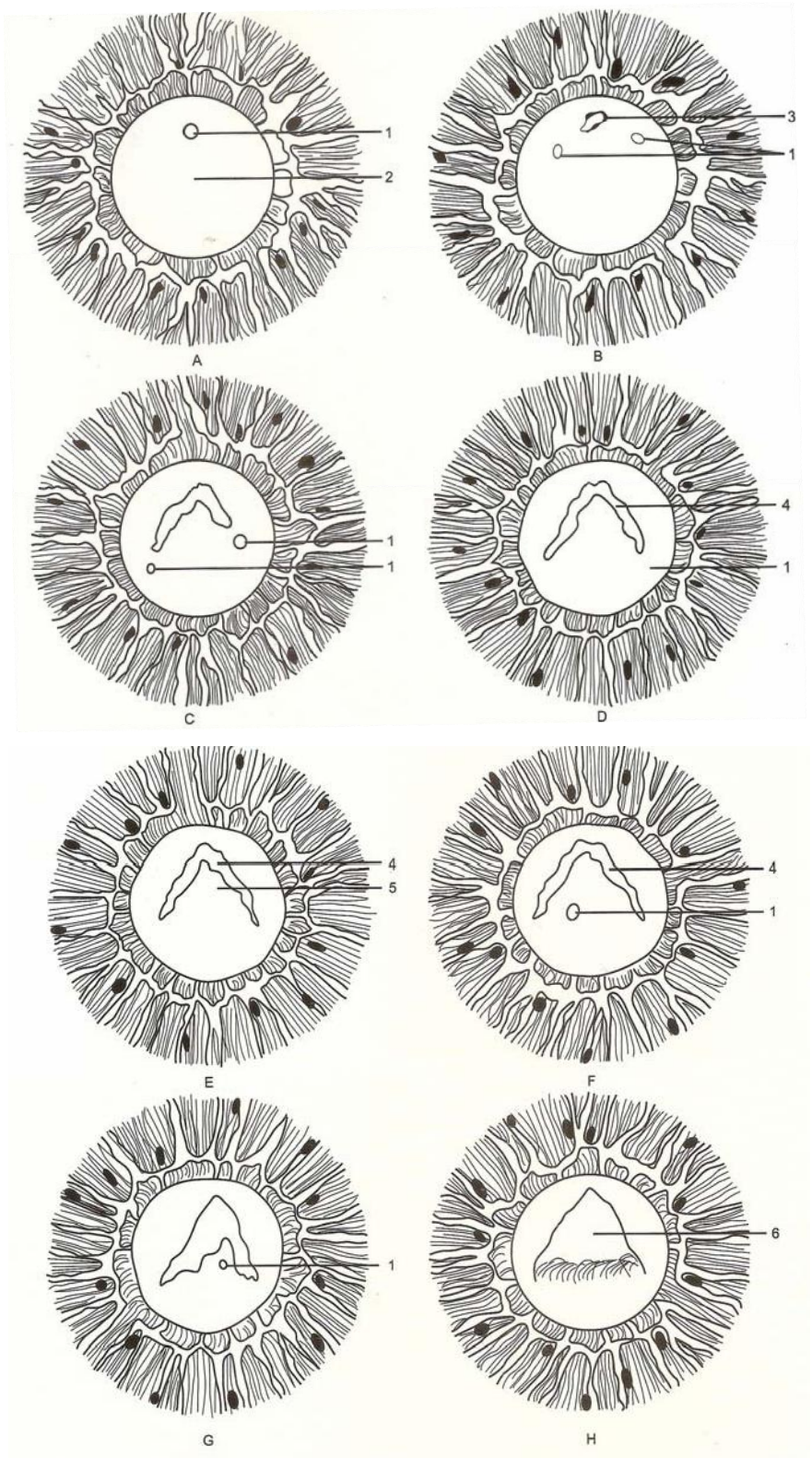
It is further widened by a shot at the 3 o'clock capsulotomy margin position

The opening now needs to be directed to the left, with a shot at the 9 o'clock

The cruciate opening has been accomplished. A shot is applied to the flap, to cut and push it towards the periphery

The capsulotomy is completed

Figure 9: Cruciate pattern capsulotomy



1. Laser shots
2. Opacified posterior capsule
3. Initial opening made
4. Inverted V shaped opening
5. Triangular capsular flap
6. Capsulotomy completed

Figure 10: Christmas tree pattern capsulotomy

Minimizing intraocular lens laser marks (pitting)

- Minimal energy of 1 mJ should be used to start.
- Use of contact lens to stabilize the eye, accurate focusing and improves laser optics.

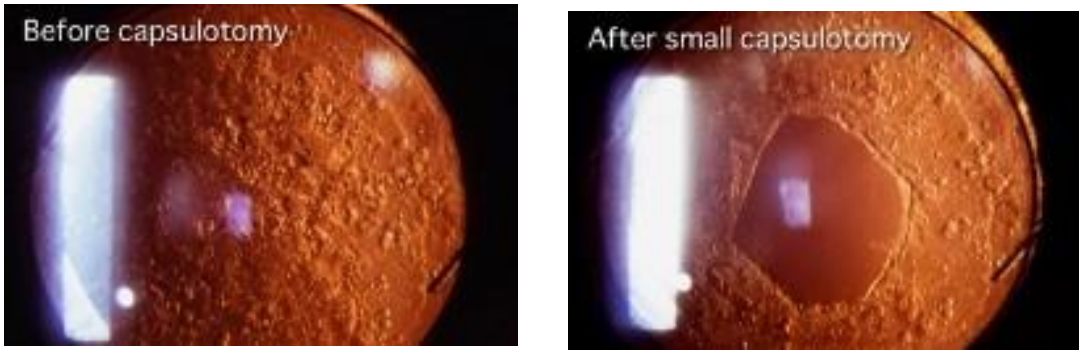


Figure 11: Before and after Nd: YAG laser capsulotomy

Post procedure care

Medication:

Topical beta-blocker or Apraclonidine if required can be used immediately after the procedure and continued for at least 1 week.

Topical steroids and cycloplegics are used to counter iritis postoperatively.

COMPLICATIONS

1.Transient elevation of intraocular pressure is the commonest complication observed after Nd: YAG posterior capsulotomy. Intra ocular pressure starts rising soon the procedure, reaches peak after three hours. In most treated eyes intraocular pressure returns to normal level within one week. The rise in IOP occurs due to blockage of trabecular meshwork out flow facility by cellular debris.

- Patients at high risk to develop high IOP:

  i. Primary open angle glaucoma (POAG).

  ii. Associated secondary glaucoma.

  iii. Sulcus fixated IOLs are at a higher risk to develop elevated intraocular pressure spike than in the bag intraocular lenses.

- Mayuri Borgohain, Gautam Paul in 2017 evaluated the visual outcome and the complications following Nd:YAG laser capsulotomy. It was found that raised intraocular pressure was the most common complication following the procedure which was seen in 30% patients, second most common was the presence of iritis in 19 %, followed by intraocular lens pitting 12% and rupture of anterior hyaloid membrane in 8 % of patients. They concluded that high skill, apt patient selection, proper focusing of laser, less number of shots, postponing by at least 3 months after cataract surgery can reduce the incidence of complications. These can also be minimized by minimizing energy and number of precisely focused shots. [41]

- Manav Deep Singh, Nidhi Sharma, Shikha Jain in 2015 studied on the intraocular pressure spikes and their prevention following Nd: YAG laser capsulotomy. They found that limiting the use of energy (<50mJ/sitting) during the procedure may prevent post laser IOP spikes and obviate the use of ocular hypotensive drugs. [42]

- Eyyup Karahan, Ibrahim Tuncer,1 and Mehmet Ozgur Zengin in 2014 evaluated the effect of Nd:YAG posterior laser on capsulotomy size, refraction, intraocular pressure, and macular thickness. They found that patients who underwent a larger capsulotomy have a higher hyperopic shift and IOP elevation. Higher

elevation of IOP in larger capsulotomy showed that the size of the Nd:YAG capsulotomy is a serious factor in Nd:YAG capsulotomy regardless of the used energy probably due to released inflammatory products. However, macular thickness was the same in large and small capsulotomy groups. Larger posterior capsulotomies may also lead to retinal tear and subsequent retinal detachment. [43]

- Rahul Bhargava, Prachi Kumar, Hemant Phogat, Kulbhushan Prakash Chaudhary in 2015 evaluated on whether any correlation exists between the amount of laser energy applied and complication rates following Nd :YAG laser capsulotomy.They found that the incidence of anterior segment inflammation on post-operative day one was 9.9%. Overall, 1.9% of the patients had a history of prior uveitis. Mean total laser energy in the subgroup with uveitis (n = 47) was 64.9 ± 24.8 mJ as compared to 42.0 ± 26.4 mJ in eyes without uveitis (n = 427). The incidence of IOP elevation was 12.6%. Overall, 1.3% patients had medically controlled glaucoma prior to capsulotomy. Mean IOP on the post-operative day one was 21.5 ± 6.6 mmHg. Mean laser energy in the subgroup with IOP elevation (n = 60) was 57.8 ± 26.8 mJ as compared to 42.3 ± 26.6 mJ in eyes with no IOP elevation (n = 414) ($P < 0.001$). IOP returned to normal limits at 2 weeks in most patients following topical treatment with 0.5% Apraclonidine eye drops twice daily. [44]
- Farooq Q, Mohammad Aslam, Ali Raza and Kanwal Zareen Abbasi in 2015 conducted a study to find the relationship between the amount of laser energy used and the significant rise of intraocular pressure (>5mmHg) in Nd-YAG laser posterior capsulotomy. They concluded that some rise of IOP does occur in most of the cases undergoing YAG- capsulotomy as occurred in their 65 out of 90

patients (72.2%) and 30 (45%) of these had a significant rise (>5mmHg) worth monitoring. Those receiving higher amount of laser energy were more prone to develop IOP elevations in early post laser period. The pressure rise was noted in the first four hours in most of the cases, although it could rise as late as 24hours post laser application. [45]

- Eyyup Karahan, Duygu Er, and Suleyman Kaynak in 2014 studied the complications associated with Nd:YAG laser capsulotomy, and the effect of capsulotomy size and used total energy on such complications. They concluded that capsulotomy size was important, as patients subjected to lower amounts of laser energy for perhaps a smaller capsulotomy, may benefit from fewer complications of RD, IOP rise and perhaps to less CME. They also found that some complications especially rise in IOP and macular thickness seemed to be unavoidable after Nd: YAG laser capsulotomy. Using less total energy and performing smaller capsulotomies were practical choices to decrease complications after Nd: YAG capsulotomy. [46]
- Darshana Rathod, Anuja Gharat, Anamika Agrawal and Sujith Murade in 2016 studied on the intraocular pressure variation after Nd:YAG laser capsulotomy. They concluded that the mean IOP in Aphakic patients was 15.9 mm of Hg, in ACIOL patients 18.4 mm of Hg and in PCIOL patients 17.09 mm of Hg. The average baseline IOP of all patients was 17.19 mm Hg. This IOP was found to rise in 1 hour to 19.8 mm of Hg and 3hr to 19.71 mm of Hg. However, at 24 hours,1 week and 6 weeks though IOP was elevated it was not significant. This meant that immediate post procedure till 3 hours intraocular pressure was found to rise significantly. They also suggested that mean energy less than 2 mJ or more than 2 mJ at any time interval has no effect on IOP variation. Also, the

number of pulses applied for the ND YAG laser posterior capsulotomy had no significance on the IOP changes. They even concluded that the size of capsulotomy less than or more than 4 mm had no correlation with rise in IOP at 3 hours. [47]

2. Cystoid macular edema: a rare complication with an incidence varying from 0.04 to 2.3% Disruption of anterior hyaloid face during the procedure may increase the likelihood of development of cystoid macular edema (CME).

3. IOL pitting occurs in 15% to 33% of the cases.

4. Rhegmatogenous retinal Detachment: Incidence of rhegmatogenous retinal detachment after Nd: YAG capsulotomy varies between 0.1 and 3.6% However; incidence of retinal detachment after surgical capsulotomy (Primary or Secondary) varies between 2.3 and 6.1%, hence Nd: YAG laser capsulotomy is a relatively safer alternative to surgical capsulotomy.

5. Endophthalmitis: may rarely set in after Nd: YAG capsulotomy due to release of previously sequestered Propionibacterium acnes into vitreous.

Other less common complications:

i. Iritis persisting for 6 months following laser capsulotomy has been reported in less than 1% of eyes.

ii. Macular holes have rarely been reported to develop after capsulotomy.

iii. Hyphema.

iv. Peripheral retinal haemorrhage.

v. IOL dislocation: Rarely seen in silicone lenses.

vi. Re-opacification of the capsulotomy opening: It is reported to occur in 0.7% of cases after initial Nd: YAG capsulotomy. It is caused by hyper proliferation of lens epithelial cells around the capsulotomy opening. This leads to narrowing of the opening. It is managed by repeat Nd:YAG capsulotomy.

MATERIALS AND METHOD

Source of data

This is prospective, cross sectional, follow up study of 50 eyes of 50 patients with posterior capsular opacification following cataract surgery.

All patients were out patients in the Department of Ophthalmology of Shri. B. M. Patil Medical College Hospital and Research Centre during the study period between October 2018 to April 2020.

Method of collection of data

SAMPLE SIZE CALCULATION

With 95% confidence level and margin of error of ±10%, a sample size of 50 subjects will allow the study of the intraocular pressure changes following Nd:YAG laser capsulotomy with finite population correction(N=100).[47]

By using the formula:

$$n = \frac{z^2 p(1-p)}{d^2}$$

where

Z = z statistic at 5% level of significance

d is margin of error

p is anticipated prevalence rate

Statistical analysis

All characteristics were summarized descriptively. For continuous variables, the summary statistics of mean ± standard deviation (SD) were used. For categorical data, the number and percentage were used in the data summaries and diagrammatic presentation. Chi-square (χ^2) test was used for association between two categorical variables.

The formula for the chi-square statistic used in the chi square test is:

$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

The subscript "c" are the degrees of freedom. "O" is observed value and E is expected value. C= (number of rows-1)* (number of columns-1)

The difference of the means of analysis variables between more than two independent groups was tested by ANOVA and F test of testing of equality of Variance.

ANOVA

Source	d.f.	SS	MS	F
Treatment	$a-1$	SS_{treat}	$\frac{SS_{treat}}{a-1}$	$\frac{MS_{treat}}{MS_{error(a)}}$
Error (a)	$N-a$	$SS_{error(a)}$	$\frac{SS_{error(a)}}{N-a}$	
Time	$t-1$	SS_{time}	$\frac{SS_{time}}{t-1}$	$\frac{MS_{time}}{MS_{error(b)}}$
Treat x Time	$(a-1)(t-1)$	$SS_{treat\ x\ time}$	$\frac{SS_{treat\ x\ time}}{(a-1)(t-1)}$	$\frac{MS_{treat\ x\ time}}{MS_{error(b)}}$
Error (b)	$(N-a)(t-1)$	$SS_{error(b)}$	$\frac{SS_{error(b)}}{(N-a)(t-1)}$	
Total	$Nt-1$	SS_{total}		

The sources of the variation include treatment; Error (a); the effect of Time; the interaction between time and treatment; and Error (b). Error (a) is the effect of subjects within treatments and Error (b) is the individual error in the model. All these add up to the total.

If the p-value was < 0.05, then the results were considered to be statistically significant otherwise it was considered as not statistically significant. Data were analysed using SPSS software v.23 (IBM Statistics, Chicago, USA) and Microsoft office 2007.

Notification of cases:-

Patients with significant PCO after cataract extraction were included for the study. A total number of 50 eyes were studied. The data collected were categorized into sex, age, type of PCO, time interval between cataract surgery and PCO development, energy levels used, number of laser shots used, capsulotomy size, visual acuity before and after Nd: YAG laser, IOP values,post laser medications given and other complications noted during the follow up periods.

Detailed history was elicited regarding the duration of symptoms and treatment previously taken. Ocular examination included visual acuity, intraocular pressure measurement, and fundoscopy.

Slit lamp examination of cornea, anterior chamber, position of IOL and type of PCO based on morphology was done.

Once the posterior capsule opacification was determined to be the cause of loss of vision, Nd: YAG laser posterior capsulotomy was advised. Relevant patient details were recorded in the proforma. Informed written consent was obtained from all the patients after explaining the need, risk, complication and other available treatment options in their vernacular language. Visual acuity and IOP was recorded. Fundus examination was done to rule out any retinal pathology. After dilating the pupil with 10% Phenylephrine or 0.5% or 1%

Tropicamide eye drops,Q- Switched Nd: YAG laser was performed under topical anesthesia. Abraham lens was used whenever required to stabilize the eye. Power setting and number of exposures were varied depending on the thickness of the posterior capsule. The goal was to achieve an opening slightly larger than the pupillary size in room light with as few exposures as possible.

Visual acuity and IOP were recorded immediately, after 1 hour,2 hours, and 1week following the procedure. Antibiotic steroid eye drops four times a day for 1week were prescribed. Anti-glaucoma drugs, Tab. Acetazolamide 250 mg twice a day was advised whenever needed.

The cases were carefully followed up and looked for any incidence of IOL pitting, IOL crack, iritis, rise in IOP, hyphaema, vitritis, RD, CME, iris bleed and reopacity.

The following parameters were studied

- Visual acuity
- IOP
- Complications like hyphema, aqueous flare, IOL pitting, IOL crack, iritis, vitritis, RD, CME, iris bleed, reopacity etc.

INCLUSION CRITERIA:

- Patients of either sex, forty years or above, who come with postoperative visually significant PCO after cataract extraction. Visually significant PCO is defined as a decrease in the best corrected post-operative vision by two lines in Snellen’s distant vision chart.

EXCLUSION CRITERIA:

- Patients with congenital / developmental or traumatic cataract.
- Patients with anterior segment pathology like corneal scar, corneal irregularity, corneal edema, keratitis, conjunctivitis.
- Patients with glaucoma or uveitis
- Patients with suspected cystoid macular edema.
- Non cooperative patients who are not willing for the procedure and who are not available for follow up for the required period of time
- Patients with vitreous opacity or haze, myopic degeneration or optic atrophy.

Pre laser preparation: - All patients were dilated with 10% Phenylephrine or 0.5% or 1% Tropicamide eye drops. Topical anesthetic drops were instilled.

Preliminary examination:-

- Preliminary examination under torch light and visual acuity testing by Snellen's chart was done for all patients participating in the study
- Slit lamp examination to study the morphology of PCO
- Tonometry
- Direct and indirect ophthalmoscopy

Procedure:-

After adequate pupillary dilation and topical anesthesia, patient was made to sit at the YAG laser set up with chin rested against the chin rest. Abraham contact lens was used whenever required to stabilize the eye. The minimal amount of energy necessary to obtain breakdown and rupture the capsule is preferred. Usually 1 to 2 mJ per pulse from Q – Switched Nd-YAG laser is sufficient to open posterior capsule. The energy setting per pulse may be increased in recalcitrant thick

posterior capsules.

The capsule was examined for wrinkles that indicate tension lines. Shots placed across tension lines results in the largest opening per pulse because the tension causes the initial opening to widen.

In the cruciate pattern, the first spot was placed superiorly and peripherally at 12 o' clock position and extended towards 6 o'clock. Then to complete the cross, shots were extended from the center to 3 o'clock and 9 o' clock. Laser spots unavoidably can hit the IOL because of the close apposition of capsule and lens. A Christmas tree approach can also be tried, in this the first spot starts at 12 o'clock and is swept down towards 4:30 and 7:30.This will avoid the risk of central lens damage.

Post laser treatment

- Antibiotic –steroid eye drops 4 times a day for 1week were prescribed.
- Anti-glaucoma drugs, Tab Acetazolamide 250 mg twice a day was advised whenever needed.

Follow up

After laser, visual acuity and IOP were recorded immediately post laser (i.e.0 hours), 1 hour,2hours and 1week. During the follow up, patients were examined for complications like hyphema, aqueous flare, IOL pitting, IOL crack, iritis, raise in IOP, vitritis, RD, CME, iris bleed and reopacity.

RESULTS

During the study period, 50 eyes of 50 pseudophakic patients who attended OPD with significant posterior capsular opacification (PCO) were assessed and consent was taken. The following observations were made which are depicted below in tabular and graphical formats.

Table 3: Distribution of Cases according to Age

Age(years)	N	%
≤40	5	10
41-60	15	30
>60	30	60
Total	50	100

Descriptive Statistics	Range	Mean	SD
Age(years)	40-83	62.3	12.4

In this study, out of 50 patients, 30 (60%) were above 60 years of age,15 were in the age group of 41-60 years (30%) and 5 patients (10%) were less than or equal to 40 years. The age group ranged from 40 -83 years with a mean of 62.3 (+/- 12.4).

Graph 1: Distribution of Cases according to Age

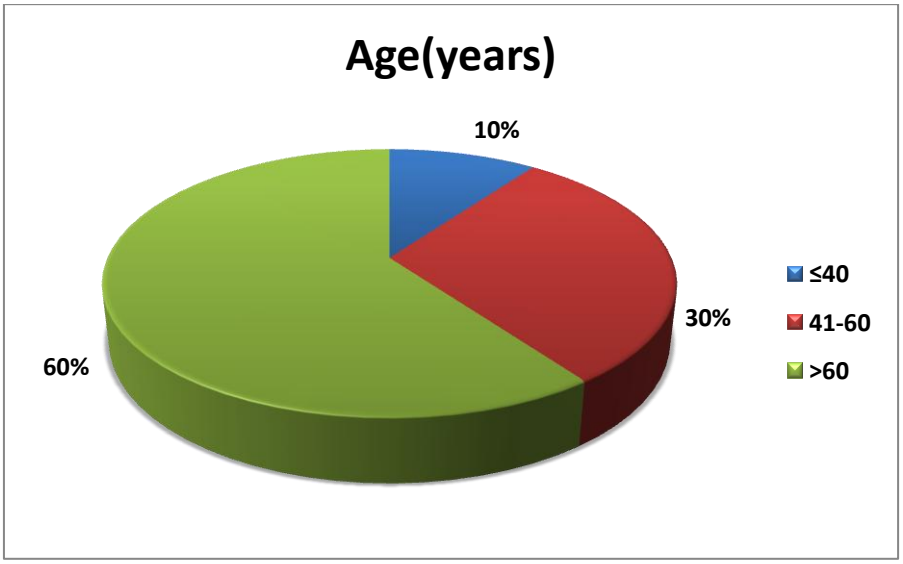
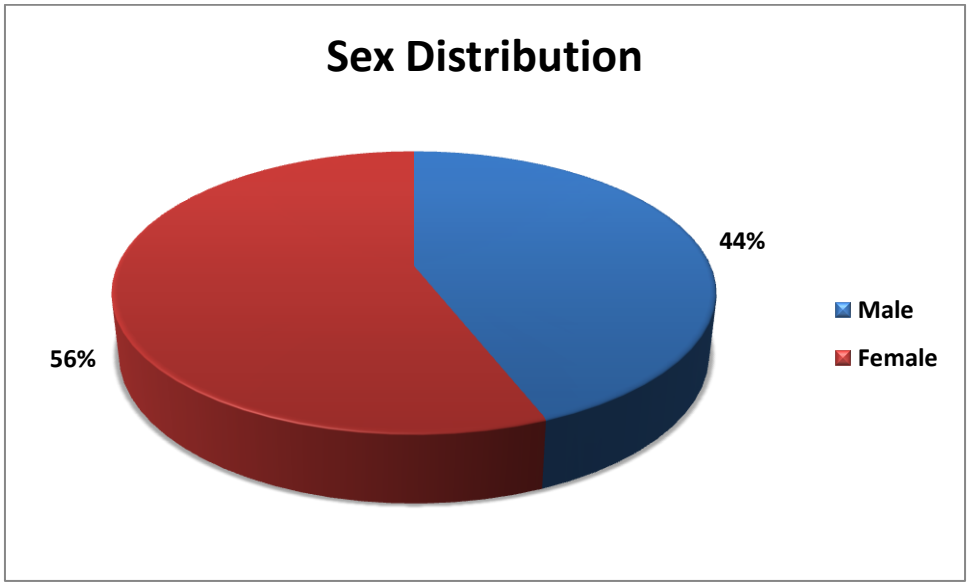


Table 4: Distribution of Cases according to Sex

Sex	N	%
Male	22	44
Female	28	56
Total	50	100

Graph 2: Distribution of Cases according to Sex

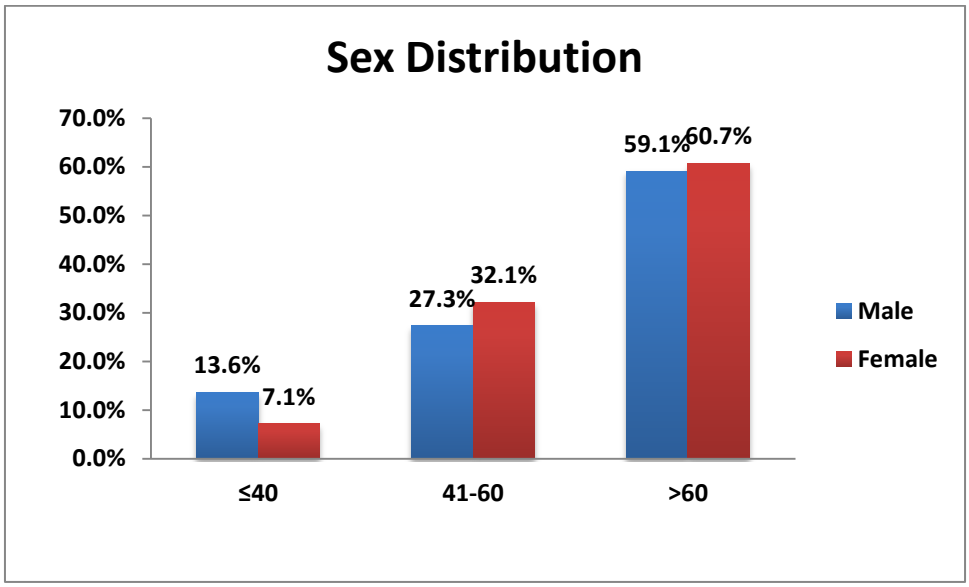


Among the 50 patients assessed, majority were females i.e.56% (28) than males 44% (22).

Table 5: Association of Age and Sex

Age(years)	Male		Female		p value
	N	%	N	%	
≤40	3	13.6%	2	7.1%	0.477
41-60	6	27.3%	9	32.1%	
>60	13	59.1%	17	60.7%	
Total	22	100.0%	28	100.0%	

Graph 3: Association of Age and Sex



This shows that majority of patients in male (59.1%) as well as female (60.7%) groups were more than 60 years of age.

Table 6: Distribution of Cases according to Duration from Surgery

Duration From Surgery (Years)	N	%
<1	3	6
≥1 & <2	19	38
≥2 & <3	18	36
≥3	10	20
Total	50	100

Descriptive Statistics	Range	Mean	SD
Duration From Surgery (Years)	0.5-5	2.0	1.0

Graph 4: Distribution of Cases according to Duration from Surgery

The interval between cataract extraction and capsulotomy ranged from 0.5 to 5 years with a mean of 2 years (+/-1).

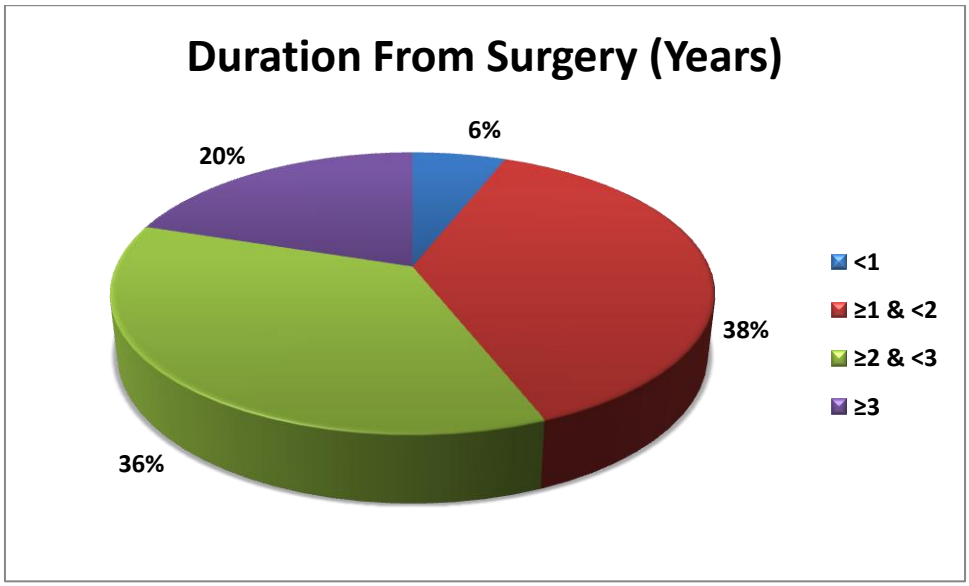
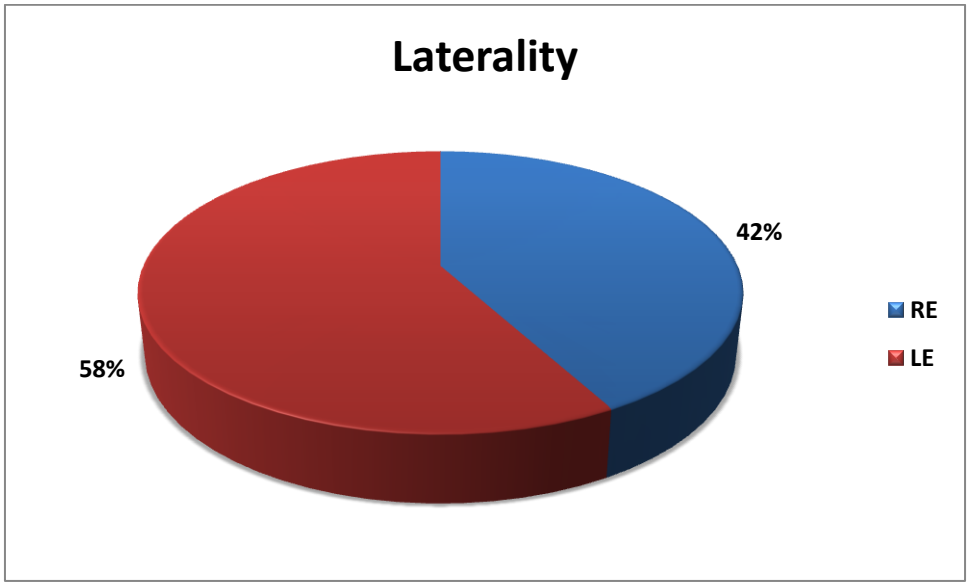


Table 7: Distribution of Cases according to Laterality

Laterality	N	%
Right eye(RE)	21	42
Left eye(LE)	29	58
Total	50	100

Graph 5: Distribution of Cases according to Laterality



Majority of subjects had PCO in left eye (58%) than right eye (42%)

Table 8: Distribution of Cases according to No. of Shots

No. of Shots	N	%
1	4	8
2	16	32
3	19	38
4	11	22
Total	50	100

Descriptive Statistics	Range	Mean	SD
No.of Shots	1-4	2.6	0.7

The number of shots required for capsulotomy ranged from 1 to 4 with a mean of 2.6(+/-0.7). Majority of patients, i.e.19 patients (38%) received 3 shots followed by 16(32%) patients who received 2 shots during laser.

Graph 6: Distribution of Cases according to No. of Shots

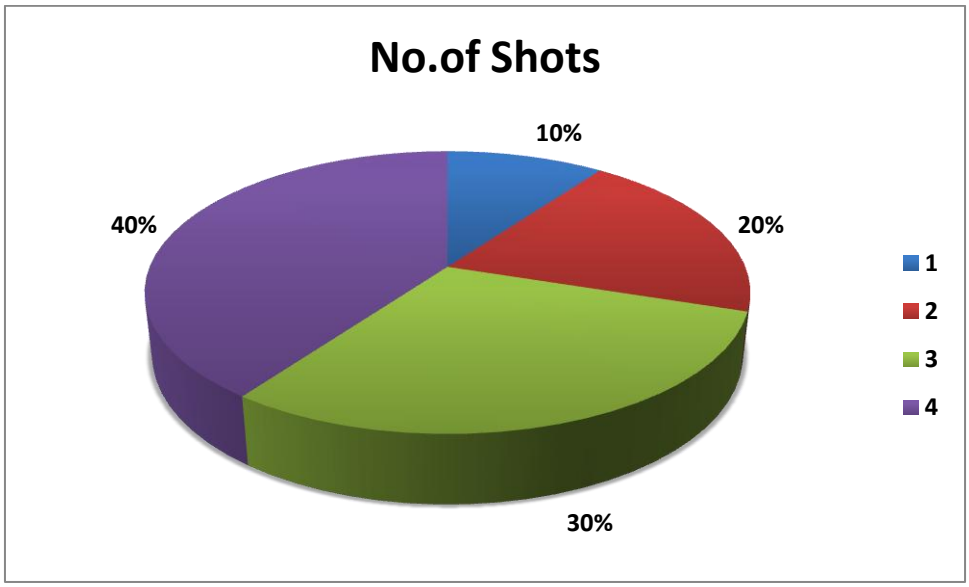


Table 9: Distribution of Cases according to Capsulotomy Size

Capsulotomy Size(mm)	N	%
3	28	56
4	20	40
5	2	4
Total	50	100

Descriptive Statistics	Range	Mean	SD
Capsulotomy Size(mm)	3-5	3.4	0.5

The capsulotomy size ranged from 3 to 5mm with a mean of 3.4(+/-0.5). Majority of patients in this study, i.e.56% had a capsulotomy size of 3mm.

Graph 7: Distribution of Cases according to Capsulotomy Size

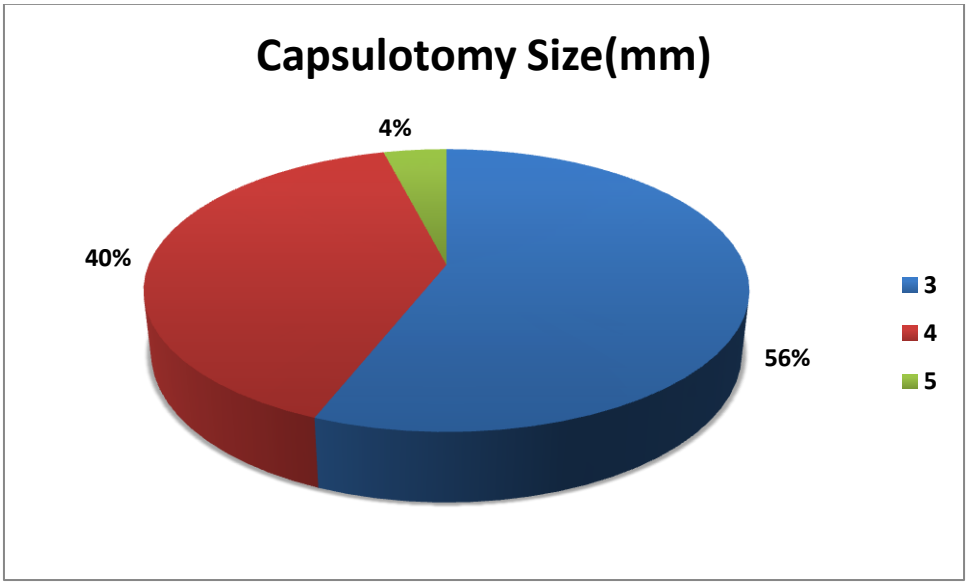
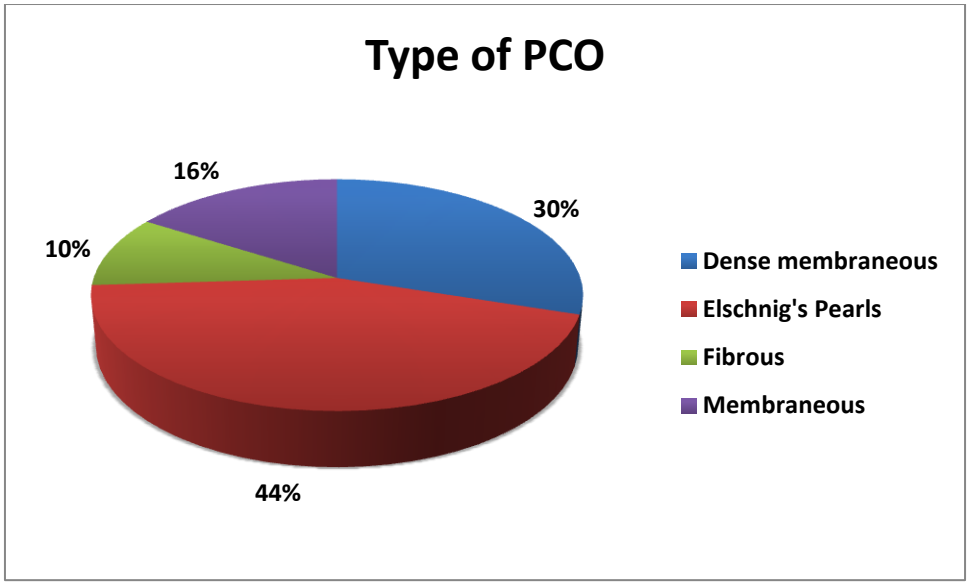


Table 10: Distribution of Cases according to Type of PCO

Type of PCO	N	%
Dense membranous	15	30
Elschnig's Pearls	22	44
Fibrous	5	10
Membranous	8	16
Total	50	100

Graph 8: Distribution of Cases according to Type of PCO



In this study 44% of patients had Elschnig's pearl type of PCO,30% had dense membranous type,16% had membranous type,10% had fibrous type.

Table 11: Distribution of Cases according to Energy

Energy (mJ)	N	%
0.5-1.0	3	6
1.1-2.0	7	14
2.1-3.0	21	42
3.1-5.0	7	14
>5.0	12	24
Total	50	100

Descriptive Statistics	Range	Mean	SD
Energy(mJ)	0.6-16.2	2.4	0.9

The energy required for capsulotomy ranged from 0.6 to 16.2mJ with a mean of 2.4(+/-0.9). Majority of patients, ie.42% received energy levels in the range of 2.1-3mJ for capsulotomy

Graph 9: Distribution of Cases according to Energy

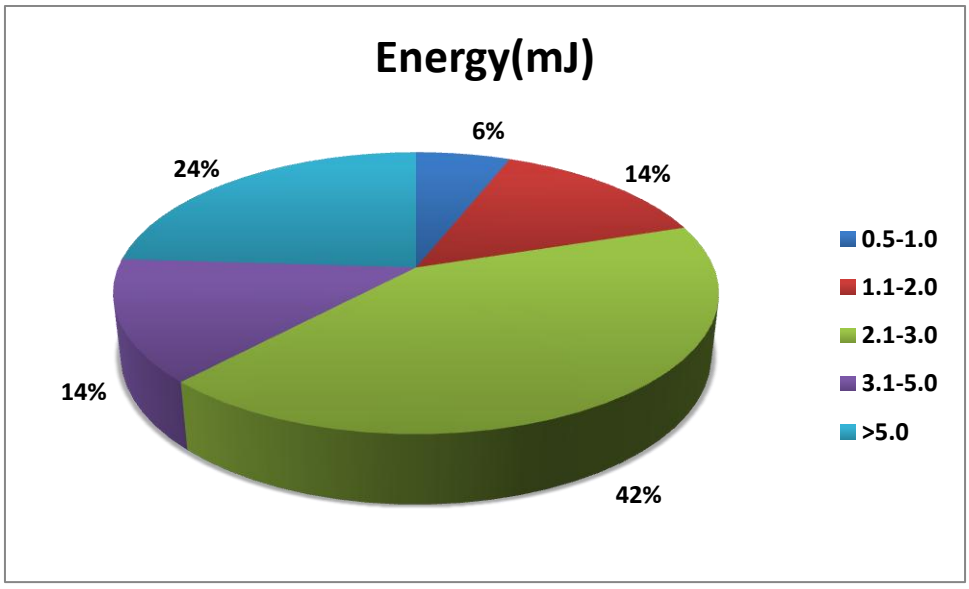


Table 12: Energy levels (mJ) and type of PCO

Energy levels (mJ)	Dense Membranous		Elschnig's Pearls		Fibrous		Membranous	
	N	%	N	%	N	%	N	%
0.3 - 2	0	0	4	8	0	0	6	12
2.1 - 4	0	0	17	34	2	4	2	4
4.1 - 6	5	10	1	2	1	2	0	0
6.1 - 8	6	12	0	0	1	2	0	0
>8	4	8	0	0	1	2	0	0
Total	**15**	**30**	**22**	**44**	**5**	**10**	**8**	**16**

Our study showed that the highest amount of energy(>8mJ) were used in majority of Dense membranous type of PCO (8%).The lowest amount of energy(≤2mJ) were used in majority of membranous type of PCO (12%).

Table 13: Number of shots and type of PCO

Shots	Dense Membranous		Elschnig's Pearls		Fibrous		Membranous	
	N	%	N	%	N	%	N	%
1	0	0	0	0	0	0	4	8
2	0	0	13	26	0	0	3	6
3	6	12	8	16	4	8	1	2
4	9	18	1	2	1	2	0	0
Total	**15**	30	**22**	44	**5**	10	**8**	16

Above table shows that the highest number of shots, i.e.4 were used in majority of Dense membranous type of PCO (18%).The least number of shots i.e. 1 was used in majority of membranous type of PCO (8%).

Table 14: Mean IOP according to time

IOP(mmHg)	Range	Mean	SD
Pre Laser	8-18	12.6	2.6
0 Hours	8-20	13.4	2.9
1 Hour	8-26	14.1	3.6
2 Hour	10-28	15.2	4.5
1 Week	10-22	13.2	2.9

P value from Pre-op to 2hours= <0.001(HS)

In our study the mean IOP according to time from pre-laser to 2 hours post laser was highly significant with p value <0.001 and the mean IOP reduced to baseline or near baseline IOP levels at 1 week.

Graph 10: Mean IOP according to time

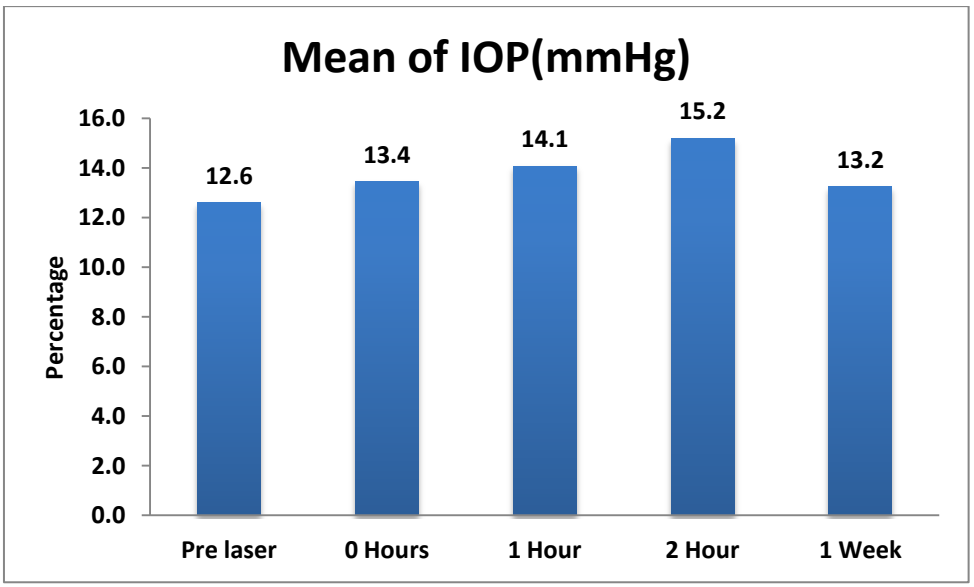


Table 15: Mean IOP according to Energy

IOP(mmHg)	Energy (mJ)					p value
	0.5-1.0	1.1-2.0	2.1-3.0	3.1-5.0	>5.0	
Pre Laser	11.71±1.89	12±2.87	13.36±2.34	14.36±1.34	16±4.24	0.239
0 Hours	12.29±2.14	12.8±3.16	13.45±2.7	14.45±1.6	17±4.24	0.101
1 Hour	12.29±2.14	13.6±3.75	13.64±2.66	14.64±3.56	18±5.66	0.087
2 Hour	12.57±2.76	14.8±4.34	14.36±1.96	15.36±1.96	18±5.66	0.008*
1 Week	11.71±1.38	13.4±2.84	13.09±2.59	14.09±1.9	16±4.24	0.034*

Note: * significant at 5% level of significance (p<0.05)

In our study it was found that the mean IOP according to energy was raised with increasing amount of energy. At 2 hours and 1-week post laser, the mean IOP was significantly increased with greater amount of energy. The IOP values returned to baseline or near baseline values at end of 1 week.

Graph 11: Mean IOP according to Energy

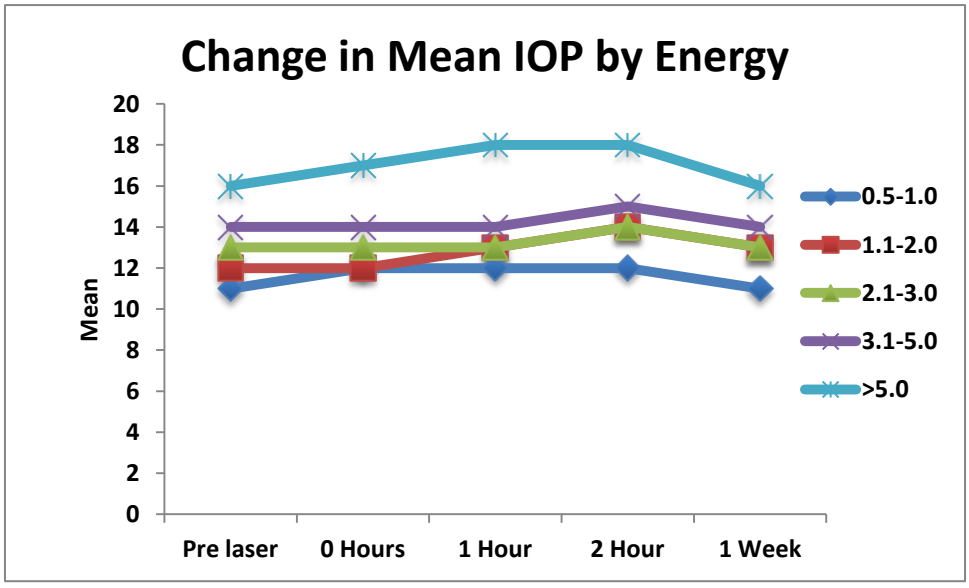


Table 16: Mean IOP according to Number of Shots

IOP(mmHg)	No. of Shots				p value
	1	2	3	4	
Pre Laser	11.71±1.89	12±2.87	13.36±2.34	16±4.24	0.206
0 Hours	12.29±2.14	12.8±3.16	13.45±2.7	17±4.24	0.409
1 Hour	12.29±2.14	13.6±3.75	13.64±2.66	18±5.66	0.383
2 Hour	12.57±2.76	14.8±4.34	14.36±1.96	18±5.66	0.385
1 Week	11.71±1.38	13.4±2.84	13.09±2.59	16±4.24	0.045*

Note: * significant at 5% level of significance ($p<0.05$)

The mean IOP according to number of shots was raised with increasing number of laser shots. At 1 week the mean IOP was significantly increased with greater number of shots. The IOP values returned to baseline or near baseline values at end of 1 week.

Graph 12: Mean IOP according to Number of Shots

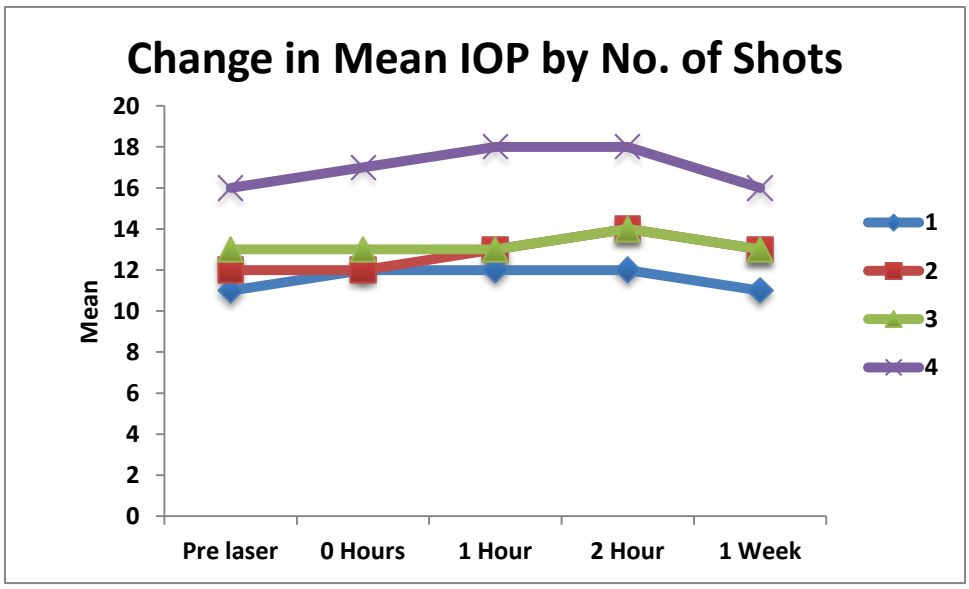


Table 17: Peak value of IOP attained

Peak value of IOP(mmHg)	N	%
10	3	6
12	13	26
14	14	28
16	7	14
18	6	12
20	1	2
22	2	4
26	2	4
28	2	4
Total	50	100

Among the 50 study partcipants,28% patients had a peak value of IOP as 14mmHg.

Graph 13: Peak value of IOP attained

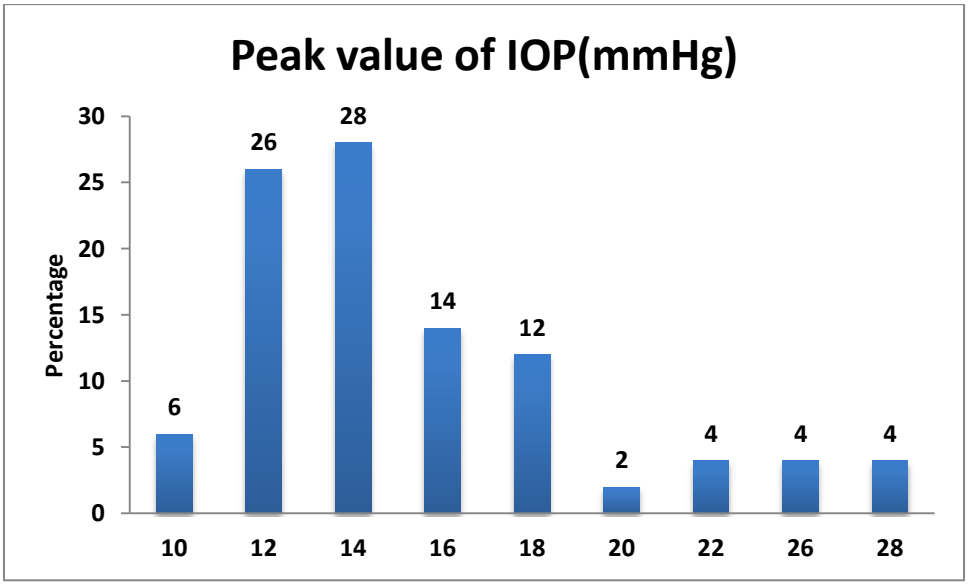


Table 18: Distribution of peak IOP reaching time

Peak IOP reaching time	N	%
0 Hours	22	44
1 Hour	7	14
2 Hour	14	28
1 Week	7	14
Total	50	100

Above table shows that 22 patients attained peak value of IOP at 0 hours, followed by14 patients at 2 hours, followed by 7 patients each, at 1 hour and 1-week post procedure.

Graph 14: Distribution of Peak IOP reaching time

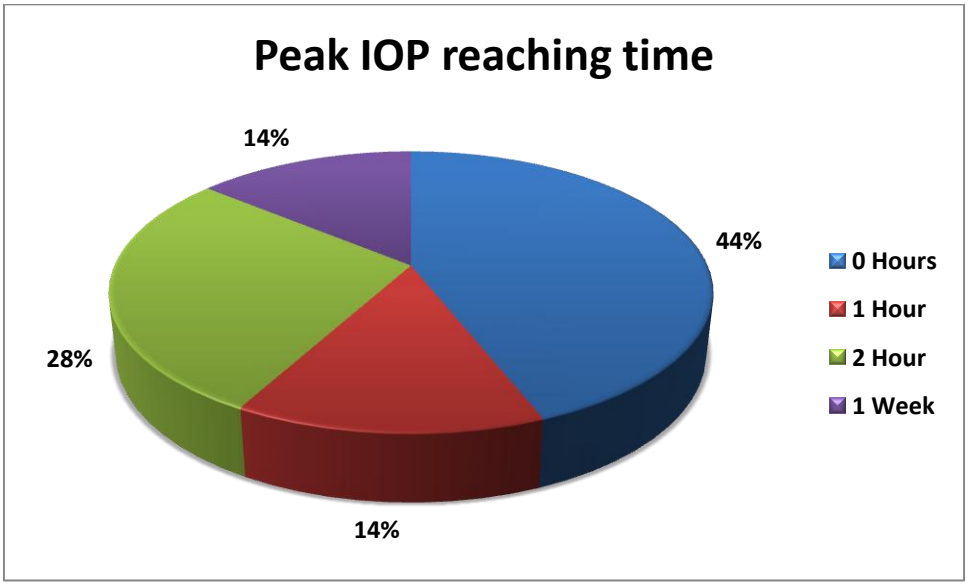


Table 19: Distribution of Pre-Laser Visual Acuity

Visual Acuity	N	%
Pre-laser		
6/12P	1	2
6/24	4	8
6/36	8	16
6/36P	9	18
6/60	10	20
6/60P	5	10
CF 1M	4	8
CF 2M	3	6
CF 3M	2	4
CF 4M	2	4
CF 5M	1	2
CF-CF	1	2

In this study among 50 patients, pre laser vision was counting fingers in 13,6/60p in 5,6/60 in 10,6/36p in 9,6/36 in 8,6/24 in 4 and 6/12p in 1 respectively.

Graph 15: Distribution of Pre-Laser Visual Acuity

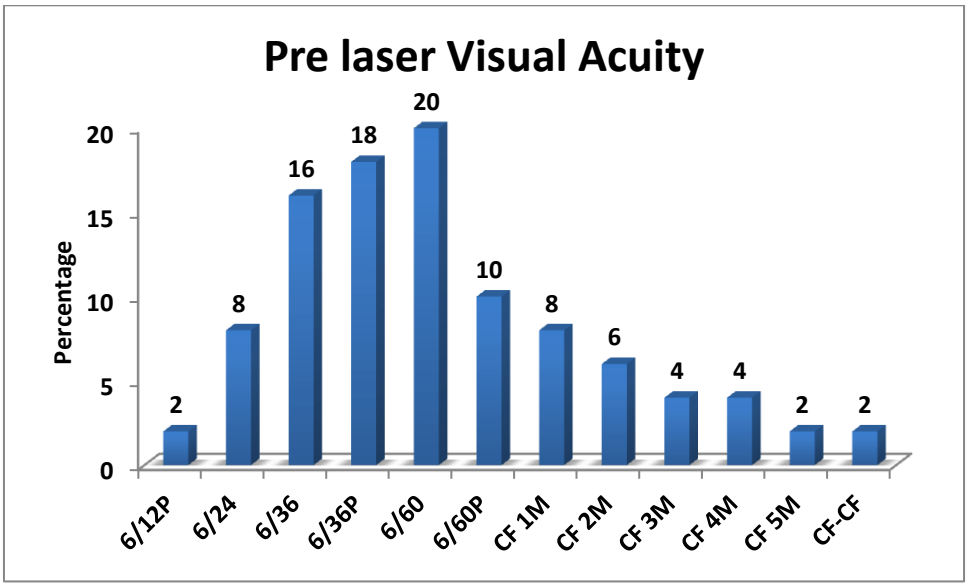


Table 20: Distribution of Best corrected visual acuity(BCVA) at 1-week post laser

BCVA	N	%
1 Week		
NI	1	2
6/6	2	4
6/9	3	6
6/9P	11	22
6/12	9	18
6/12P	7	14
6/18	5	10
6/18P	10	20
6/24	1	2
6/24P	2	4

In our study at 1 week, majority of eyes i.e. 11 eyes (22%) improved to 6/9p.2(4%)eyes showed improvement to 6/6,3(6%) improved to 6/9,9(18 %) improved to 6/12,7(14%) improved to 6/12p,5(10%) improved to 6/18,10(20%) improved to 6/18p,1(2%) improved to 6/24 and 2(4%) improved to 6/24p.

Graph 16: Distribution of Best Corrected Visual Acuity (BCVA) at 1-week post laser

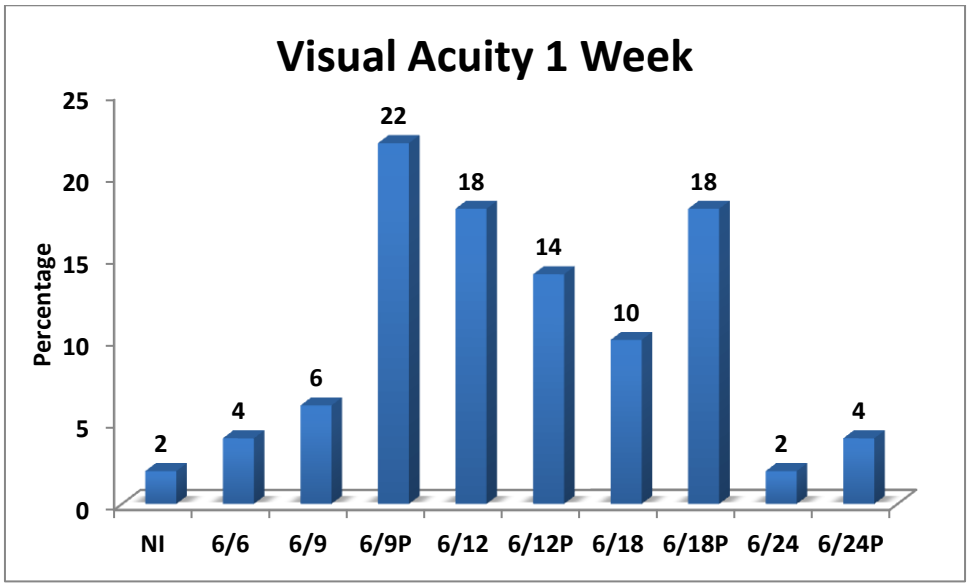


Table 21: Improvement in Visual Acuity

	Pre-laser		Post laser BCVA at 1 week	
Visual Acuity	**N**	**%**	**N**	**%**
6/6	0	0	2	4
6/9P	0	0	11	22
6/9	0	0	3	6
6/12P	1	2	7	14
6/12	0	0	9	18
6/18P	0	0	9	18
6/18	0	0	5	10
6/24P	0	0	2	4
6/24	4	8	1	2
6/36P	9	18	0	0
6/36	8	16	0	0
6/60P	5	10	0	0
6/60	10	20	0	0
Counting fingers	13	26	0	0

In our study at 1 week, majority of eyes i.e. 11 eyes (22%) improved to 6/9p.2(4%)eyes showed improvement to 6/6,3(6%) improved to 6/9,9 (18 %) improved to 6/12,7(14%) improved to 6/12p,5(10%) improved to 6/18,10(20%) improved to 6/18p,1(2%) improved to 6/24 and 2(4%) improved to 6/24p.

Table 22: Distribution of Post Laser Medications

Post Laser Medications	N	%
T.ACETAZOLAMIDE(T.DIAMOX)	5	10
OFLOXACIN-DEXAMETHASONE e/d(OFLOX-D e/d)	40	80
NSAID e/d	27	54
OTHERS	2	4

Among the 50 patients post laser,80% received Ofloxacin-Dexamethasone eye drops,54% received NSAID eye drops,10% received oral Acetazolamide and only 4% received other topical drops like Prednisolone acetate 1% and Timolol eye drops 0.5%.

Graph 17: Distribution of Post Laser Medications

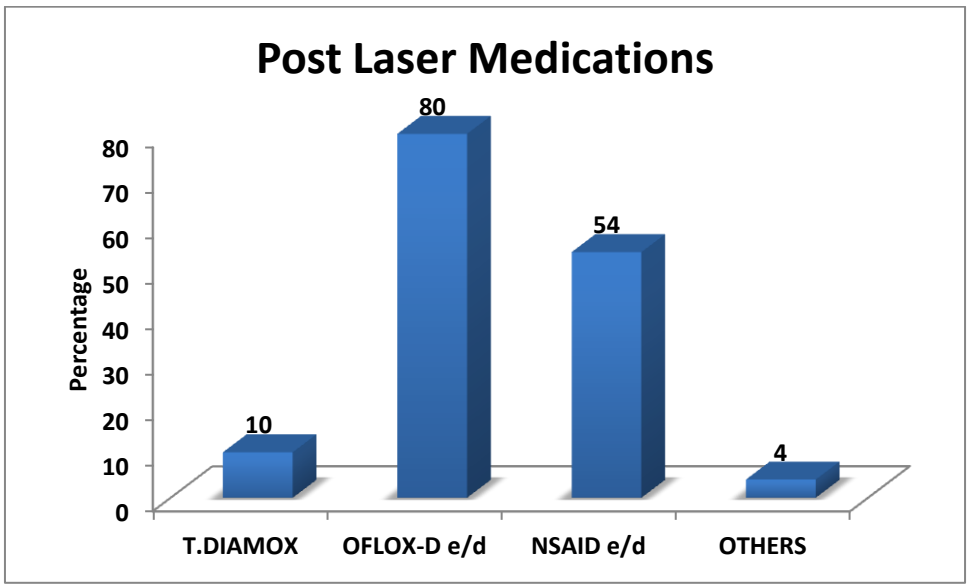


Table 23: Slit Lamp Findings

Slit Lamp Findings	**N**	**%**
Cracking	0	0
Pitting	1	2
Iris Bleed	0	0
Iritis	2	4
Vitritis	1	2
Re -Opacity	0	0
RD	0	0
CME	0	0
Others	0	0

Among the 50 patients studied, only 2% had IOL pitting, iritis was noted in 4% and vitritis in 2%.

DISCUSSION

Posterior capsular opacification (PCO), otherwise known as after cataract, is the most common delayed post-operative complication of an uneventful cataract surgery. With the current popularity of extra capsular surgeries like small incision cataract surgery (SICS) and phacoemulsification, there has been an improvement in preventing and treating after cataracts. Post-operatively, posterior capsular opacification significantly impedes the success of cataract surgery giving rise to more concern about the post-operative optical function of the human eye. The pulsed Nd:YAG laser has revolutionized the approach to after cataract membranes. Although laser capsulotomy has many advantages in comparison to surgical capsulotomy, it has been found to be associated with complications. Elevation of intraocular pressure is the most common complication noted after Nd:YAG laser capsulotomy.

In our study of 50 patients who underwent Nd:YAG laser capsulotomy for PCO, majority were females i.e.56% (28) than males 44%(22). Shivcharan L et al [48] (2012) in his study stated that 60% of his patients were female and 40% were male patients with PCO.Mohammad Younas Khan et al in his study [49] stated that of the 58 patients in his study, 19(32.8%) were male and 39 (67.2%) were female in patients with PCO. Our study correlates with these studies.

In our study, out of 50 patients,30 (60%) were above 60 years of age,15 were in the age group of 41-60 years (30%) and 5 patients (10%) were less than or equal to 40 years. The age group ranged from 40 -83 years with a mean of 62.3 (+/- 12.4). Prajna NV et al [50] in his study proposed that maximum number of patients were in the age

group between 51 to 60 years with mean age 63.31 years. Dharmaraju et al (2016) [51] concluded that out of 100 patients ,78% were in 50 to 60 years of age.

Jagat Ram et al [52]in is study of 377 patients reported that the mean time for developed of visually significant PCO is 30 months. Dangel et al. [53], reported an average time of onset of opacification following cataract extraction to be 27 months. Jafar Dowood et al [54] reported opacification occurred during the period of 3-18 months with a mean of 16.3 months. We found that in our study, the interval between cataract extraction and capsulotomy ranged from 6 to 60 months with a mean of 24 months (+/-12 months).

In the present study 44% of patients had Elschnig's pearl type of PCO,30% had dense membranous type,16% had membranous type,10% had fibrous type. K. Sridhar et al[55] stated that Elschnig's Pearl type of PCO is the most common type (65%) than Fibrous type (20%) and Mixed type (15%).Suresh K Pandey et al [56] proposed that out of 560 patients, 314(56.07%) patients presented with Elschnig Pearls, 237(42.33%) had capsular fibrosis and 9(1.60%) had capsular wrinkling. Our study correlates with both the studies. However, Rafiq M et al [57] reported 62% eyes with fibrous type of PCO and 35% eyes with pearl type of PCO.

Majority of patients, ie.42% received energy levels in the range of 2.1-3mJ for capsulotomy. Gore VS [58] reported in 2012 that the laser power setting required is between 1 to 2.5 mJ or if mode is locked then between 3to5 mJ. Mahtab Alam Khanzada et al [59] reported the energy level required ranged from 1.5 to 5 mJ and mean was 3.2 mJ. Our study showed that the highest amount of energy(>8mJ) were used in majority of Dense membranous type of PCO(8%).The lowest amount of energy(≤2mJ) were used in majority of membranous type of PCO(12%).Among 50

patients it was observed that the highest number of shots,i.e.4 were used in majority of Dense membranous type of PCO(18%).The least number of shots i.e. 1 was used in majority of membranous type of PCO(8%).In a retrospective study on 215 eyes with PCO, Bhargava et al found that different PCO subtypes required different initial and total laser energy levels as well as number of laser shots depending on thickness of the posterior capsule (1.8, 3.1 and 2.7 mJ for membranous, fibrous, fibro‑membranous opacities respectively)[44] They recommended lower single pulse energy levels rather than higher total energy in order to minimize the rate of complications.

Farooq Q, Mohammad Aslam, Ali Raza and Kanwal Zareen Abbasi in 2015 [60] conducted a study to find the relationship between the amount of laser energy used and the significant rise of intraocular pressure (>5mmHg) in Nd-YAG laser posterior capsulotomy. They concluded that some rise of IOP does occur in most of the cases undergoing YAG- capsulotomy as occurred in their 65 out of 90 patients (72.2%) and 30 (45%) of these had a significant rise (>5mmHg) worth monitoring. Those receiving higher amount of laser energy were more prone to develop IOP elevations in early post laser period. The pressure rise was noted in the first four hours in most of the cases, although it could rise as late as 24hours post laser application. In our study it was found that the mean IOP according to energy was raised with increasing amount of energy. At 2 hours the mean IOP was significantly increased with greater amount of energy. The IOP values returned to baseline or near baseline values at end of 1 week.

In our study, the mean IOP according to number of shots was raised with increasing number of laser shots. At 2 hours the mean IOP was significantly increased with

greater number of shots. The IOP values returned to baseline or near baseline values at end of 1 week. Mayuri Borgohain, Gautam Paul in 2017 [61] evaluated the visual outcome and the complications following Nd:YAG laser capsulotomy**.** They concluded that high skill, apt patient selection, proper focusing of laser, less number of shots, postponing by at least 3 months after cataract surgery can reduce the incidence of complications. These can also be minimised by minimising energy and number of precisely focused shots. N.K.Shetty et.al in their study in 2016 [62] observed that in the patients who received more no of shots, the IOP rise persisted even after 7 days and these patients were observed for 7 days and then started on anti-glaucoma medication. Darshana Rathod,Anuja Gharat,Anamika Agrawal and Sujith Murade in 2016[63] studied on the intraocular pressure variation after Nd:YAG laser capsulotomy. However, they reported that the number of pulses applied for the Nd:YAG laser posterior capsulotomy had no significance on the IOP changes**.**

Eyyup Karahan, Duygu Er, and Suleyman Kaynak in 2014 [64]studied the complications associated with Nd:YAG laser capsulotomy, and the effect of capsulotomy size and used total energy on such complications. They concluded that capsulotomy size was important, as patients subjected to lower amounts of laser energy for perhaps a smaller capsulotomy, may benefit from fewer complications of RD, IOP rise and perhaps to less CME.In our study since the capsulotomy size were 3-5mm, we could not find any significant association between capsulotomy size and IOP.

V Murali Krishna et al (2015) [65] stated that there is a transient peak rise of IOP within 1-3 hour and 1.5- 4 hour after laser capsulotomy respectively and return to baseline value within 1 week in their study. The sudden pressure rise is caused by

impaired aqueous outflow and rapid onset suggest that the reduced outflow mostly due to clogging of trabecular meshwork by capsular debris, acute inflammatory cells, heavy molecular weight protein or a combination of these mechanisms. In our study the mean IOP according to time from pre-laser to 2 hours was highly significant with p value <0.001 and the mean IOP reduced to baseline or near baseline IOP levels at 1 week. L Werner et al [66] concluded their study that 59% patients show rise in IOP that was ≤5 mm Hg and none of the patients show elevated IOP after 1 week.Wasserman *et al* [67] in his study of 367 Nd:YAG laser posterior capsulotomies and associated changes in intraocular pressure (IOP), corneal endothelial cell integrity, and visual acuities stated that there is a transient IOP rise that occurred within 1 hour of the capsulotomy.

Shani et al [68] stated that in their study, 97% cases had shown improvement in visual acuity. Visual acuity improved to 6/6 in 16 cases, 6/9 in 36 cases, 6/12 in 16 cases, 6/18 in 10 cases, 6/24 in 8 cases, 6/36 in 7 cases, and 6/60 in 4 cases. In this study among 50 patients, pre laser vision was counting fingers in 13,6/60p in 5,6/60 in 10,6/36p in 9,6/36 in 8,6/24 in 4 and 6/12p in 1 respectively. At 1 week, majority of eyes i.e. 11 eyes (22%) improved to 6/9p,2(4%)eyes showed improvement to 6/6,3(6%) improved to 6/9,9(18 %) improved to 6/12,7(14%) improved to 6/12p,5(10%) improved to 6/18,10(20%) improved to 6/18p,1(2%) improved to 6/24 and 2(4%) improved to 6/24p.Congdon et al [69] reported improvement in best corrected visual acuity after Nd: YAG laser capsulotomy. Wajeeha Rasool, Ali Raza et al [70] showed that prior to Nd: YAG laser capsulotomy only 7% (14) patients had good best corrected visual acuity (6/18). After one week follow-up there was significant improvement of 6/18 in 73% patients. Buehl et al [71]

investigated in a prospective interventional case series, regarding the difference in the vision before and after Nd: YAG capsulotomy and reported the gain in vision after Nd: YAG capsulotomy

Among the 50 patients studied, only 2% had IOL pitting,4 % had transient iritis and 2% had transient vitritis. Iritis and vitritis was transient and was found to subside on follow up at 1 week with use of steroid eye drops. Other complications like IOL cracking, retinal detachment, cystoid macular edema etc. were not observed. Aurangzeb S, Faheemullah S, Jai R A et al [72] found prevalence of 7% for IOL damage during YAG laser posterior capsulotomy highest in group 3 than in group 1(4.49%), group 2(4.1%) and group 4 (1. 27%).Josef et al [73] reported complications after Nd: YAG capsulotomy among which iritis was found in 1% of the eyes. Keates et al. [74] found iritis persisting in 0.4% and vitritis persisting in 0.7% after a 6-month postoperative period. Gore et al. [75] reported that transient anterior chamber reaction may be seen post-laser treatment, however persistent iritis or vitritis is rare. Chambless, in a study with an average follow-up period of 7 months, found persistent anterior uveitis in 1.4% of the patients [76].

SUMMARY

This was a hospital based, prospective follow up study conducted between October 2018 to April 2020.A sample of 50 patients attending the Ophthalmology Out Patient Department at Shri B.M. Patil Medical College and Research centre diagnosed with visually significant posterior capsule opacification (PCO) after cataract extraction, willing for Nd:YAG laser capsulotomy were selected. The aim of the study was to study the intraocular pressure changes following Nd:YAG laser capsulotomy in patients diagnosed with posterior capsular opacification. Following an informed written consent, selected patients underwent Nd: YAG laser capsulotomy. These patients were further followed up at 0 hour,1 hour,2 hours and 1 week post laser for IOP changes, visual acuity improvement and associated complications.

The present study showed that the incidence of PCO was more in females than males. Maximum number of the patients with significant PCO was in the age group of more than 60 years. Majority of subjects in our study had PCO in left eye (58%) than right eye (42%).The interval between cataract extraction and capsulotomy ranged from 6 months to 60 months with a mean of 24 months (+/-12 months). The mean of the energy level used for capsulotomy was 2.4mJ (+/-0.9). The number of laser shots required, ranged from 1 to 4 with a mean of 2.6(+/-0.7). In the current study, majority i.e. 44% of patients had Elschnig pearl type followed by dense membranous type of PCO (30%). Our study showed that the higher amount of energy was used in majority of Dense membranous type of PCO (8%).The lowest amount of energy(≤2mJ) were used in majority of membranous type of PCO (12%).The highest number of shots, i.e.4 were used in majority of Dense membranous type of PCO

(18%).The least number of shots i.e. 1 was used in majority of membranous type of PCO (8%).

We observed that post laser, there was a significant rise of mean IOP with increasing time, energy and number of shots and it reduced to baseline or near baseline levels at the end of 1 week. Visual acuity before Nd: YAG laser was in the range of counting fingers to 6/12p. After laser, the best corrected visual acuity(BCVA) at 1 week, was in the range of 6/24p to 6/6. Post laser, among the 50 patients,80% received Ofloxacin-Dexamethasone eye drops,54% received NSAID eye drops,10% received oral Acetazolamide and only 4% received other topical eye drops like Prednisolone acetate 1% and Timolol 0.5%. The present study also showed that out of 50 eyes, other complications such as transient iritis occurred in 4% of eyes, IOL pitting and transient vitritis was encountered in 2% cases each.

CONCLUSION

Nd:YAG laser is the effective and universally accepted procedure for treatment of posterior capsular opacity. It is a safe, economical, non-invasive technique and avoids all the complications of surgical capsulotomy. This study shows the effectiveness as well as reports the minimal complications following Nd:YAG laser posterior capsulotomy. There is a low, but definite risk of some complications such as those observed in this present study like raised IOP, IOL pitting, iritis and vitritis. Cystoid macular edema, retinal detachment and other serious complications reported by other authors were not observed. Transient elevation of intraocular pressure is the most common complication observed after Nd: YAG laser posterior capsulotomy. The rise in IOP occurs due to blockage of trabecular meshwork out flow facility by cellular debris and capsular remnants. In this study, the mean IOP post laser was found to significantly increase with increasing time, energy levels and number of laser shots. In most treated eyes, intraocular pressure returns to baseline or near baseline IOP levels at the end of one week. Hence, regular follow up of all patients is necessary. It can be concluded from our study that good skill, proper patient selection, precise focusing of laser, lesser number of shots and minimising energy levels can reduce the incidence of complications. Thus, Nd:YAG laser capsulotomy as a treatment modality for posterior capsular opacification (PCO) is well suited for a country like ours, where a large number of back log of cataract cases are operated by small incision cataract surgery (SICS) procedure with PCIOL implantation.

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ANNEXURE I

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

B.L.D.E (Deemed to be University)
SHRI.B.M.PATIL MEDICAL COLLEGE HOSPITAL & RESEARCH CENTRE
VIJAYAPUR – 586103

IEC/NO: 286/2018
17-11-2018

INSTITUTIONAL ETHICAL COMMITTEE

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this college met on 13-11-2018 at 03-15 PM scrutinize the Synopsis of Postgraduate Students of this college from Ethical Clearance point of view. After scrutiny the following original/corrected and revised version synopsis of the Thesis has accorded Ethical Clearance.

Title : A clinical study on the intraocular pressure changes following ND: Yag laser capsulotomy.

Name of P.G. Student : Dr Mariam Mercy Varghese
Department of Ophthalmology,

Name of Guide/Co-investigator: Dr.Sunil.G.Biradar, Professor of Ophthalmology,

DR RAGHAVENDRA KULKARNI
CHAIRMAN
Institutional Ethical Committee
BLDE(D) Shri B.M. Patil
Medical College, BIJAPUR-586103.

Following documents were placed before E.C. for Scrutinization:

1) Copy of Synopsis/Research Project
2) Copy of Informed consent form.
3) Any other relevant documents.

ANNEXURE – II

SAMPLE INFORMED CONSENT FORM

B.L.D.E.D.U.'s SHRI B.M. PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTRE, VIJAYAPURA – 586103, KARNATAKA

TITLE OF THE PROJECT: **"**A clinical study on intraocular pressure changes following Nd:YAG laser capsulotomy**"**

.

PRINCIPAL INVESTIGATOR: Dr. Mariam Mercy Varghese

Postgraduate student, Department of Ophthalmology
B.L.D.E.(DU) University's
Shri B.M. Patil Medical College & Research Centre, Solapur Road, VIJAYAPURA - 586103

PG GUIDE: Dr. Sunil. G. Biradar M.S.,
Professor and Head of Department Ophthalmology,
B.L.D.E. (DU) University's
Shri B.M. Patil Medical College & Research Centre, Solapur Road, VIJAYAPURA-586103

INFORMED CONSENT

I son/daughter of

hereby state that I involve myself voluntarily as a subject in the study," Intraocular pressure changes following Nd:YAG laser capsulotomy" conducted by Dr. Mariam Mercy Varghese a prospective follow up study. I understand that I will undergo Nd:YAG Laser Capsulotomy. The benefits of the procedure and the risks involved like intraocular pressure rise, intraocular lens pitting, lens cracking, iritis, vitritis, retinal detachment, cystoid macular edema etc. have been explained to me to the best of my understanding in my own language.

I am aware of the post-operative tests that will be carried out on me and have been explained about the risks involving the same. By signing below, I agree that the physician has answered all of my questions and that I understand and accept the risks, benefits and also understand the costs involved. I willingly give consent to take part in the study.

Any other risks involved-

Date:

Signature of the subject:

Address:

Signature of the investigator:

Dr. Mariam Mercy Varghese

RISK AND DISCOMFORTS:

I understand that I may experience some pain and discomfort during the examination or during my treatment. This is mainly the result of my condition and the procedures of this study are not expected to exaggerate these feelings which are associated with the usual course of treatment.

I understand and accept the risks like intraocular pressure rise, intraocular lens pitting, lens cracking, iritis, vitritis, retinal detachment, cystoid macular edema. I am also informed regarding the costs involved

BENEFITS:

I understand that my participation in the study, "A Clinical Study on intraocular pressure changes following Nd:YAG laser capsulotomy**"** will help to improve vision in patients who develop posterior capsular opacification after cataract extraction. It will also aid in the appropriate and targeted management of patients who develop raised intraocular pressure following Nd:YAG laser capsulotomy who are at risk of progressing to glaucoma. I understand and accept these benefits.

CONFIDENTIALITY:

I understand that the medical information produced by this study will become a part of hospital records and will be subject to confidentiality. Information of sensitive and personal nature will not be part of the medical record, but will be stored in the investigations research file.

If the data are used for publication in the medical literature or for teaching purpose, no name will be used and other identifiers such as photographs will be used only with special written permission. I understand that I may see the photograph before giving the permission.

REQUEST FOR MORE INFORMATION:

I understand that I may ask more questions about the study to **Dr. Sunil. G. Biradar** in the Department of Ophthalmology who will be available to answer my questions or concerns. I understand that I will be informed of any significant new findings discovered during the course of the study, which might influence my continued participation. A copy of this consent form will be given to me to keep for careful reading.

REFUSAL FOR WITHDRAWAL OF PARTICIPATION:

I understand that my participation is voluntary and that I may refuse to participate or may withdraw consent and discontinue participation in the study at any time without prejudice. I also understand that **Dr. Mariam Mercy Varghese** may terminate my participation in the study after she has explained the reasons for doing so.

INJURY STATEMENT:

I understand that if I promptly report about any injury which occurred to me due to my participation in this study, the appropriate treatment would be available to me. But, no further compensation would be provided by the hospital. I understand this by my agreement to participate in this study and it's not waiving of any of my legal rights.

I have explained to _____the purpose of the research, the procedures required and the possible risks to the best of my ability.

_____ _____

Dr. Mariam Mercy Varghese. Date

(Investigator)

STUDY SUBJECT CONSENT STATEMENT:

I confirm that Dr. Mariam Mercy Varghese has explained to me the purpose of research, the study procedure that I will undergo and the possible discomforts as well as benefits that I may experience in my own language. I have been explained all the above in detail in my own language and I understand the same. Therefore, I agree to give consent to participate as a subject in this research project.

_____ _____

(Participant) Date

ANNEXURE - III

PROFORMA FOR CASE TAKING

DEPARTMENT OF OPHTHALMOLOGY

B.L.D.E UNIVERSITY'S SHRI B.M.PATIL MEDICAL COLLEGE HOSPITAL &RESEARCH CENTRE, VIJAYPUR-586103

Name:

Age: Sex:

OPD NO:

Occupation:

Date of examination:

Date of procedure:

Date of surgery:

Presenting Complaints:

History of present illness:

Past history:

Family history:

Treatment history:

General physical examination

Local examination:

Ocular Examination:

	OD	OS
Lids & adnexa		
Conjunctiva		
Cornea		
Anterior chamber		
Iris		
Pupil		
Lens		
Type of Posterior capsular opacity		
Intraocular pressure		
Visual acuity		
Pin hole		
Fundus examination		
B scan (if performed)		
Optical coherence tomography (if performed)		

Diagnosis:

TREATMENT:

Nd YAG laser **OD** **OS**

Energy used		
Number of shots		
Capsulotomy size		

Post laser medication:

1. Tab Acetazolamide 250mg yes/no
2. Antibiotic steroid eye drops yes/no
3. NSAID eye drops yes/no
4. Any other treatment yes/no

Follow up:

	Post procedure	After 1 hour	After 2 hours	After 1 week
Visual acuity				
Pin hole				
Intraocular pressure				

Slit lamp examination	Post procedure	After 1 hour	After 2 hours	After 1 week
Anterior chamber reaction				
IOL cracking				
IOL pitting				
Iris bleeding				

Iritis				
Vitritis				
Re-opacity				
Retinal Detachment				
Cystoid macular edema				
Other complications				

Fundus examination:

	Post procedure	After 1 hour	After 2 hours	After 1 week

ANNEXURE - IV

COLOUR PLATES

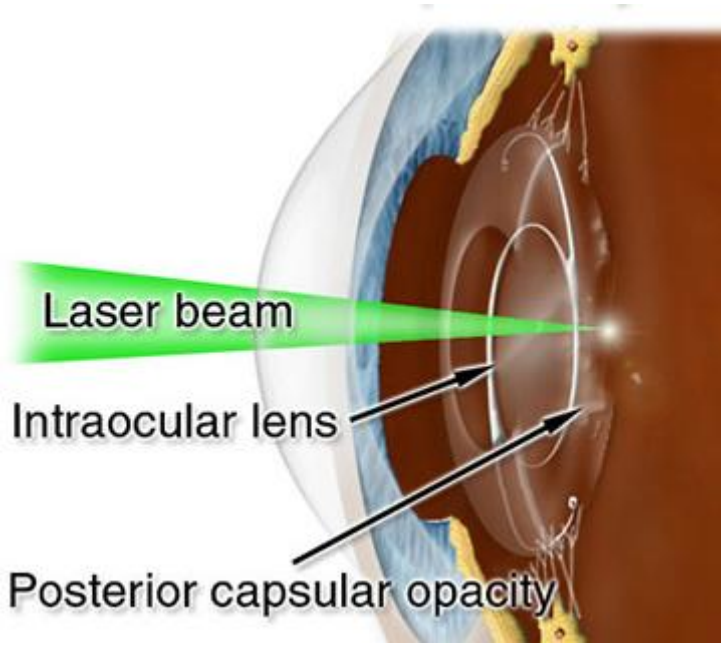
PATIENT ASSESSMENT SEQUENCE

1. Measurement of visual acuity.
2. Slit lamp evaluation.
3. IOP recording by Goldmann applanation tonometry.
4. Instilling dilating drops.
5. Evaluation of fundus.
6. Performing Nd:YAG laser capsulotomy.
7. Post laser IOP recording by Goldmann applanation tonometry.

ITEMS USED DURING THE STUDY:

0.5% Proparacaine hydrochloride eye drops, Tropicamide and Phenylephrine eye drops, Volk 90 D lens, Volk 20 D lens and Abraham lens.

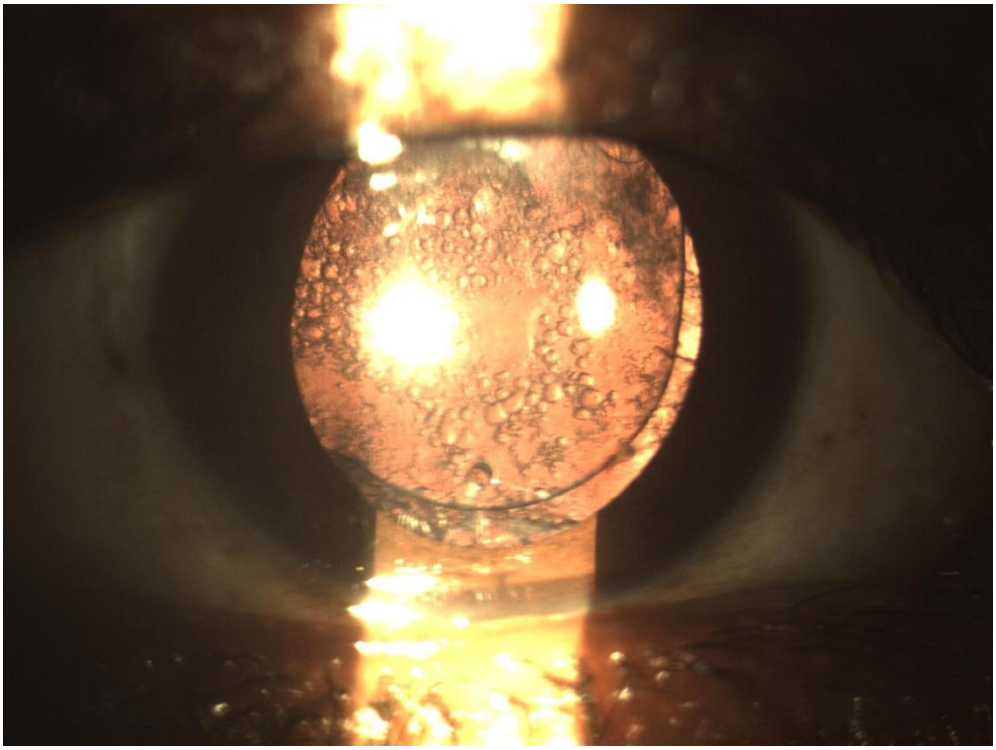
ABRAHAM LENS



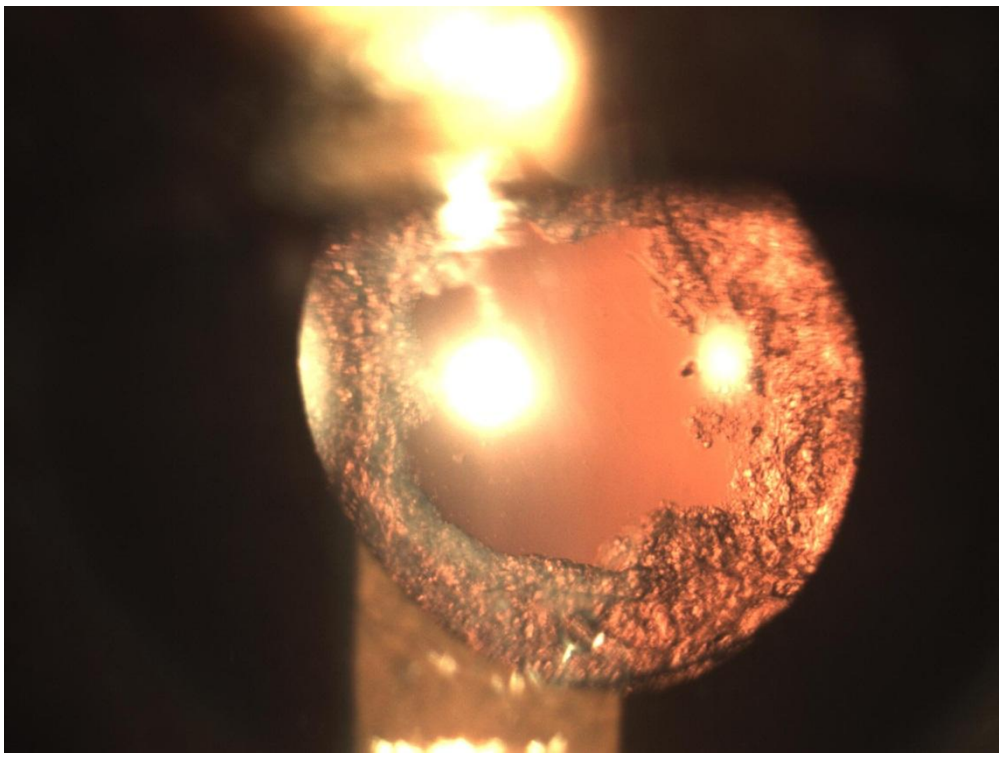
YAG LASER CAPSULOTOMY

ND:YAG LASER

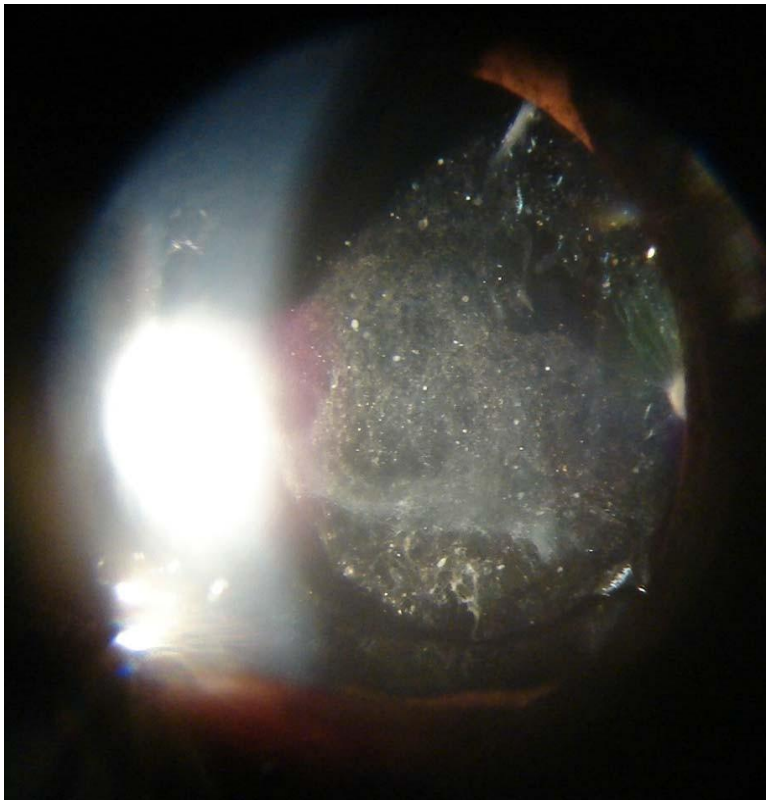
PERFORMING ND:YAG LASER CAPSULOTOMY



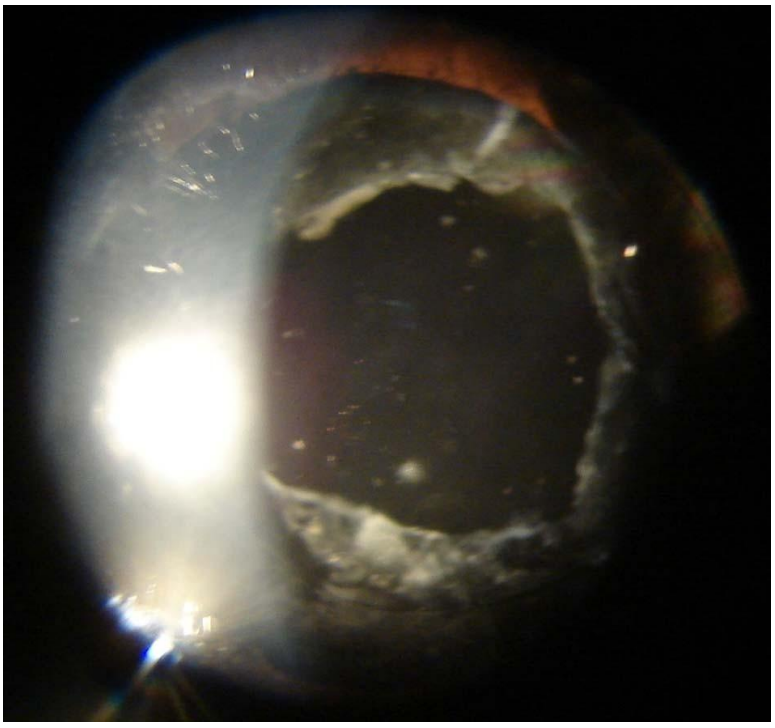
1.a.PRE LASER ELSCHNIG PEARLS TYPE OF PCO



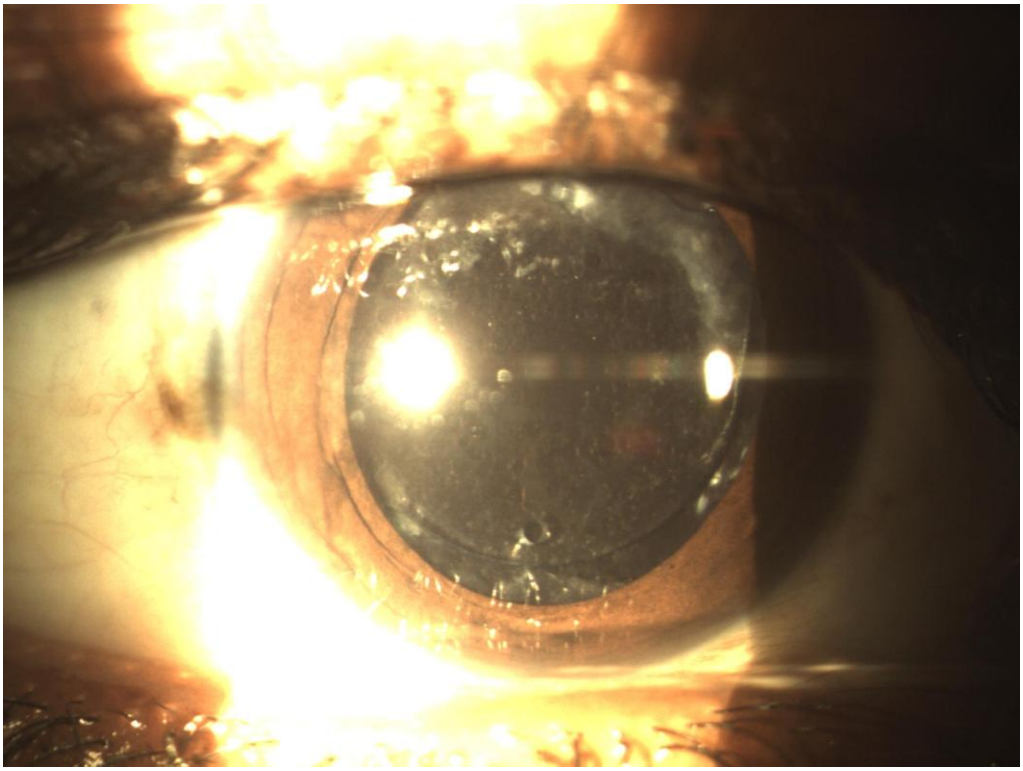
1.b.POST LASER



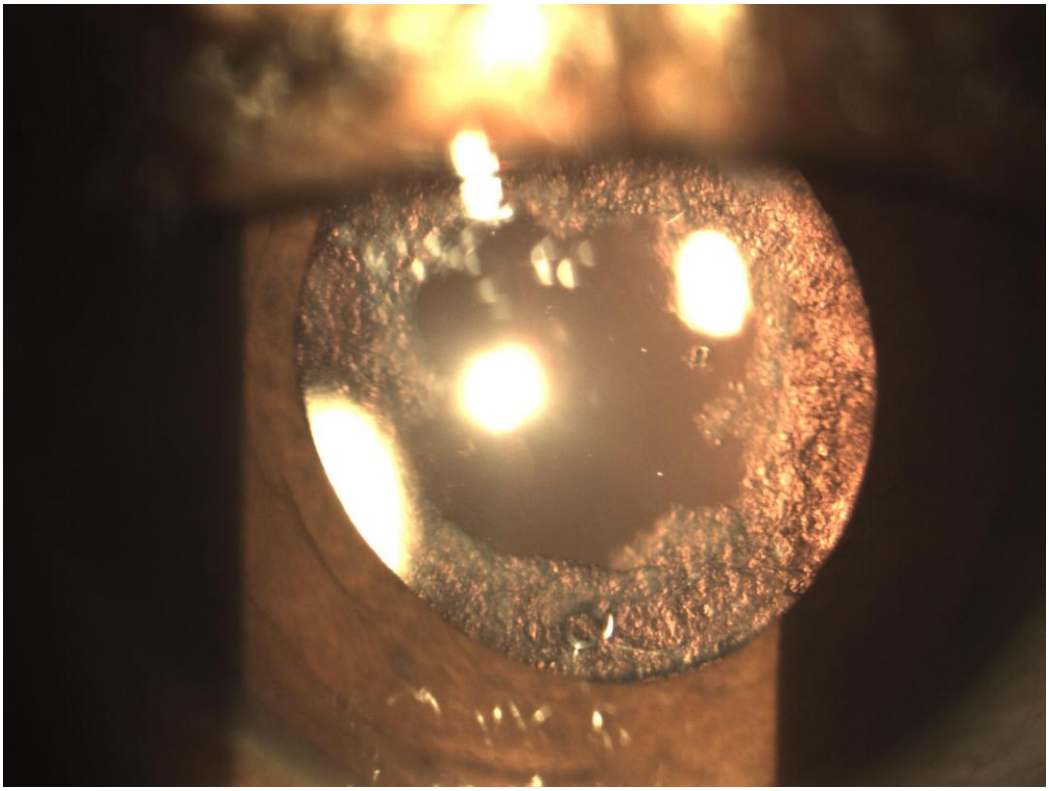
2.a.PRE LASER DENSE MEMBRANOUS TYPE OF PCO



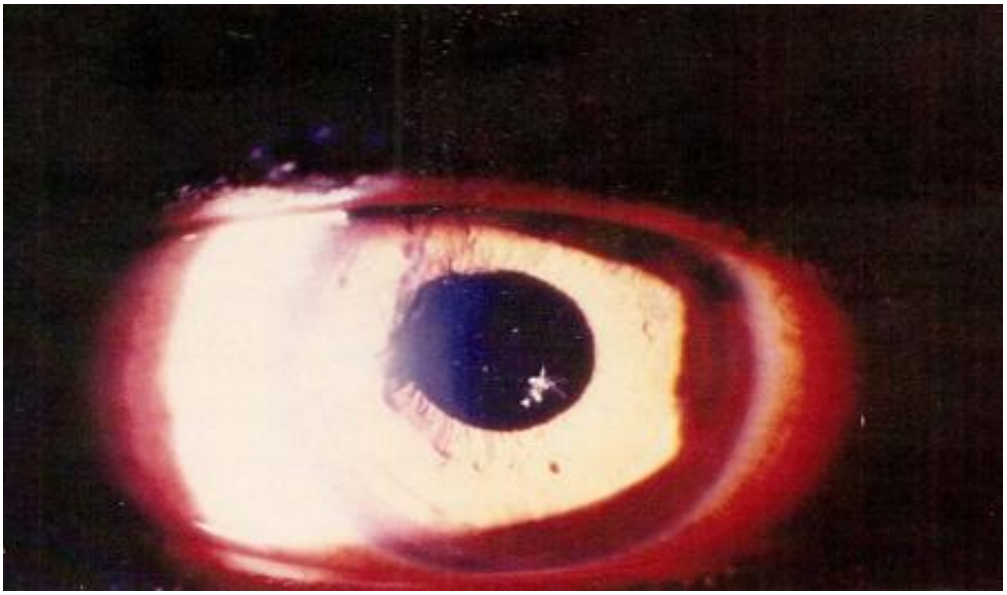
2.b.POST LASER



3.a.PRE LASER MEMBRANOUS TYPE OF PCO



3.b.POST LASER



IOL PITTING

ANNEXURE V

KEYS TO MASTER CHART

RE : RIGHT EYE

LE : LEFT EYE

M : MALE

F : FEMALE

SL.NO: SERIAL NUMBER

IOL : INTRAOCULAR LENS

PCO : POSTERIOR CAPSULAR OPACIFICATION

OP : OUT PATIENT

YR : YEAR

M : MONTHS

V/A: VISUAL ACUITY

P/H: PIN HOLE

IOP: INTRAOCULAR PRESSURE

CF1M : COUNTING FINGERS AT 1 METRE

CF-CF: COUNTING FINGERS CLOSE TO FACE

NI: NO IMPROVEMENT

DM: DENSE MEMBRANOUS

EP: ELSCHNIG PEARLS

M : MEMBRANOUS

F : FIBROUS

A: ABSENT

P: PRESENT

NR: NORMAL RETINA

RD: RETINAL DETACHMENT

CME: CYSTOID MACULAR EDEMA

T. DIAMOX : T. ACETAZOLAMIDE

OFLOX-D E/D : OFLOXACIN DEXAMETHASONE EYE DROPS

ANNEXURE VI

MASTER CHART

S.NO	NAME	OP NO.	AGE	SEX	DURATION	LATERALITY	VISUAL ACUITY	IOP(MMHG)		PCO	V/A AFTER YAG			
					from surgery		V/A,P/H	RE	LE		O HOURS	1 HOUR	2HOUR	1 WEEK
1	SANGAPPA	360281	75	M	1 YR	RE	CF1M,NI	14	16	DM	6/24P	6/24P	6/24P	6/24P,NI
2	B.G.BADIGER	366862	82	M	3 YRS	LE	6/60,6/24	10	12	EP	6/12P	6/12P	6/12P	6/12,6/9P
3	SIDAPPA ARAKERI	381397	79	M	2 YRS	RE	6/60,NI	8	10	EP	6/18P	6/18P	6/18P	6/12P,6/9P
4	SHARANAMMA.G	400312	60	F	1YR	LE	CF3M,6/60	8	10	DM	6/24P	6/24P	6/24P	6/18P,6/9P
5	NEELAWWA.H	408703	70	F	1.5 YRS	RE	CF1M,CF3M	10	10	DM	6/36P	6/36P	6/36	6/18P,6/12P
6	C.S.DASHYAL	408303	83	M	4 YRS	LE	6/24P,6/24	8	10	EP	6/18P	6/18P	6/18P	6/18P,6/12P
7	SANGAPPA BADIGER	410196	70	M	1 YR	LE	6/36P,6/36	8	12	EP	6/24P	6/24P	6/24	6/9,6/6
8	CHINNAWA TALWAR	4665	68	F	3M	RE	6/36P,NI	18	10	DM	6/24P	6/24P	6/24P	6/18P,6/9P
9	NANAGOUDA.M	45865	48	M	2 YRS	RE	6/36P,6/36	16	12	DM	6/24	6/24	6/24P	6/18P,6/12
10	LAXMIBAI MANE	48932	60	F	3 YRS	RE	CF2M,CF3M	10	10	EP	6/18P	6/18P	6/18P	6/9P,6/6
11	NINGAPPA	97246	70	M	3 YRS	RE	CF1M,NI	12	14	M	6/60P	6/60P	6/60P	6/24P,6/18P
12	VIMALABAI	115390	75	F	2.5 YRS	LE	CF 1M,NI	14	16	DM	6/60	6/60	6/60	6/36,6/18P
13	SHANTAWWA	115585	62	F	1 YR	RE	6/60,6/36	14	14	EP	6/24P	6/24P	6/24P	6/9P,6/9
14	GOURABAI	4016	45	F	2 YRS	RE	6/36P,NI	12	14	EP	6/36	6/36	6/24P	6/36,6/18
15	MALLAMA ALUR	126370	68	F	2 YRS	LE	6/60P,NI	18	18	DM	6/36	6/36	6/36	6/24,6/12P
16	A.R.SHIRGUPPI	126948	80	M	2.5 YRS	RE	6/36P,NI	16	14	EP	6/36	6/36	6/36	6/36,6/18
17	DHAREPPA.S	14953	60	M	2 YRS	LE	CF5M,6/60	16	16	DM	6/60	6/60	6/36P	6/36,6/18
18	NIMBEWWA	153077	60	F	3.5 YRS	LE	6/36P,NI	10	12	DM	6/36P	6/36P	6/24P	6/18P,6/12P
19	SIDAPPA	152211	70	M	2 YRS	LE	6/24P,NI	18	20	EP	6/24	6/24	6/24	6/18,6/12
20	MADEVI	154412	68	F	1 YR	RE	6/60P,NI	18	16	M	6/36P	6/36P	6/36P	6/24P,6/12
21	GURUBAI BIRADAR	162245	70	F	6M	RE	6/36P,NI	14	12	M	6/24P	6/24P	6/24	6/24,6/9P
22	S.R.MATHAPATHI	196266	63	M	2 YRS	RE	CF-CF,NI	14	12	EP	6/60P	6/60P	6/60P	6/36P,6/12P
23	NURJAN WALIKAR	197452	58	F	1.5 YRS	LE	6/36P,NI	16	16	DM	6/24P	6/24P	6/24P	6/24,6/18P
24	BAGIRATHI	202042	70	F	2 YRS	RE	6/36,6/24	16	18	M	6/36	6/36	6/24P	6/24P,6/18P
25	PADMAVATHI.H	213157	65	F	1.5 YRS	RE	6/24P,NI	14	16	M	6/24P	6/24P	6/24	6/18P,6/18
26	JAKKAPPA HANAMI	331723	70	M	2 YRS	LE	CF2M,NI	10	12	DM	6/36	6/36	6/36	6/36,6/12
27	BAGAWWA	366027	45	F	1 YR	LE	6/36,NI	10	10	EP	6/36	6/36	6/36	6/36,6/24P
28	SHANTA TELI	373289	65	F	3 YRS	RE	6/36,6/24	12	12	EP	6/24	6/24	6/18	6/24,6/12

29	BASAMMA PARAPUR	374937	65	F	1.5 YRS	RE	6/60,6/24	16	14	EP	6/36	6/36	6/24	6/18,6/9
30	SADASHIV	384635	45	M	2 YRS	RE	6/24P,NI	14	14	EP	6/18	6/18	6/18	6/18,6/9
31	SHANTAMMA	409658	66	F	2.5 YRS	RE	6/60P,6/60	14	12	EP	6/36	6/36	6/36	6/24P,6/18P
32	PARVATI	413250	52	F	2 YRS	RE	CF2M,NI	10	10	F	6/36P	6/36P	6/24P	6/24,6/18P
33	MAHADEVI	416932	63	F	1.5 YRS	LE	6/60,NI	14	14	M	6/36P	6/36	6/36	6/36,6/24P
34	SHIVARAJ	459724	42	M	1.5 YRS	RE	6/60P	12	14	EP	6/36	6/36	6/36	6/24P,6/9P
35	ANNAPURNA	460953	78	F	2 YRS	RE	6/36P,NI	8	10	EP	6/36	6/36	6/36	6/24P,6/9P
36	PRAMOD	462536	40	M	1 YR	LE	6/36P,NI	12	12	F	6/24P	6/24P	6/24	6/12P,6/9P
37	CHANNAYYA PURANIK	468062	80	M	3 YRS	RE	6/36,NI	16	14	F	6/24P	6/24	6/24	6/36,6/12
38	UNAVVA HALLI	474882	65	F	1.5 YRS	RE	6/60P,NI	14	12	F	6/36	6/36	6/24P	6/12P,6/12
39	ANNAPURNA	7666	40	F	1.5 YRS	LE	6/36,NI	10	10	DM	6/24P	6/24P	6/24P	6/18P,6/9P
40	SHANTABAI	9487	60	F	2 YRS	RE	6/36,NI	12	12	EP	6/24P	6/24P	6/24P	6/24,6/18P
41	JUNABAI	23317	56	F	1.5 YRS	LE	6/60,NI	10	10	M	6/36P	6/36P	6/36	6/36,6/12P
42	SANTESH	59953	40	M	3 YRS	RE	6/60,NI	12	12	F	6/24P	6/24P	6/24P	6/24P,6/18P
43	SANGANGOUDA	65923	66	M	1.5YRS	LE	CF4M,NI	14	14	EP	6/60	6/60	6/60	6/36P,6/24
44	TANGEWWA	92808	80	F	5 YRS	LE	CF4M,6/60	8	10	DM	6/36	6/36	6/36	6/18P,6/12
45	VIJAYAKUMAR	104195	60	M	2 YRS	LE	6/60,NI	12	12	M	6/36	6/36	6/36	6/24,6/12P
46	RACHAYYA	114040	64	M	4.5 YRS	RE	CF3M,NI	8	8	DM	6/36P	6/36P	6/36P	6/36,6/18P
47	NEELAWWA	115482	65	F	1.5 YRS	RE	6/36P,NI	12	14	EP	6/24P	6/24P	6/24P	6/24P,6/12
48	GOPAL RAJAPUT	135076	49	M	8 M	LE	6/60P,NI	10	10	DM	6/36P	6/36P	6/24	6/12P,6/9P
49	MOHIN BANGER	150463	40	M	1 YR	LE	6/60,6/36	8	12	EP	6/24	6/24	6/24	6/24,6/9P
50	SAVITA BAJANTRI	156041	40	F	2 YRS	RE	6/60,6/36P	8	14	EP	6/24	6/24	6/24	6/24,6/18

S.NO	IOP(MM HG) AFTER YAG				NO.OF SHOTS	ENERGY	CAPSULOTOMY SIZE	POST LASER MEDICATIONS			
	0 HOURS	1 HOUR	2HOUR	1 WEEK		(mJ)	IN MM	T.DIAMOX	OFLOX-D e/d	NSAID e/d	OTHERS
1	16	16	18	12	4	16.2	4		YES	YES	
2	12	12	14	16	3	2.5	3		YES		
3	10	10	14	14	3	2.5	4		YES		
4	10	10	12	10	3	4.9	4		YES		
5	12	12	28	10	4	7.7	4				YES
6	8	8	14	10	2	2.2	3		YES		
7	14	14	16	12	2	2.2	3		YES		
8	20	20	26	16	3	4.9	3		YES		YES
9	16	26	28	14	4	7.7	3		YES		
10	10	10	12	10	3	2.5	4		YES		
11	18	22	26	16	3	2.5	4	YES	YES	YES	
12	16	16	18	16	4	7.7	5	YES	YES		
13	14	14	14	14	2	1.8	3				
14	14	14	14	14	2	2.2	3				
15	18	20	22	20	4	7.7	4		YES		
16	16	16	16	18	2	2.2	4				
17	16	18	20	18	4	7.7	4	YES	YES		
18	12	12	12	12	3	4.9	4		YES		
19	20	22	22	22	3	2.4	3	YES	YES		
20	18	18	18	16	2	2.2	4		YES		
21	14	14	14	16	1	1.8	4				
22	16	16	18	16	2	3	4	YES	YES		
23	16	16	16	18	4	16.2	5		YES		
24	16	16	16	14	1	0.6	3				
25	12	14	14	14	2	1.8	3				
26	14	14	14	12	3	10.2	4		YES	YES	
27	10	10	10	12	3	2.4	3		YES	YES	
28	12	12	12	10	2	2.2	3		YES	YES	
29	16	16	16	14	2	1.8	3		YES	YES	
30	12	12	12	12	2	1.8	3			YES	
31	14	14	14	14	3	2.5	3		YES	YES	
32	12	14	14	10	3	10.2	4		YES	YES	
33	14	14	14	14	1	0.6	3			YES	
34	12	14	14	14	2	3	4		YES	YES	
35	8	10	10	10	2	2.2	3		YES	YES	
36	12	12	12	14	3	2.5	3		YES	YES	
37	16	16	16	14	3	2.5	3		YES	YES	
38	14	14	14	14	4	7.7	3		YES	YES	
39	10	10	10	12	3	4.9	4		YES	YES	
40	12	12	12	12	3	2.5	3		YES	YES	
41	12	12	12	10	1	0.6	3		YES	YES	
42	14	14	14	12	3	4.9	3		YES	YES	
43	16	16	16	12	4	4.3	3		YES	YES	
44	12	12	12	10	4	7.7	4		YES	YES	
45	12	12	12	12	2	1.8	4		YES	YES	
46	12	12	12	10	4	16.2	4		YES	YES	
47	12	12	12	10	4	1.8	3			YES	
48	10	10	10	10	3	4.9	3		YES	YES	
49	12	14	14	10	2	2.2	3		YES	YES	
50	8	10	10	10	3	2.5	3		YES	YES	

S.NO	CRACKING	PITTING	IRIS BLEED	IRITIS	VITRITIS	RE -OPACITY	RD	CME	OTHERS
1	A	A	A	P	A	A	A	A	A
2	A	A	A	A	A	A	A	A	A
3	A	A	A	A	A	A	A	A	A
4	A	A	A	A	A	A	A	A	A
5	A	A	A	A	A	A	A	A	A
6	A	A	A	A	A	A	A	A	A
7	A	A	A	A	A	A	A	A	A
8	A	A	A	A	A	A	A	A	A
9	A	A	A	A	A	A	A	A	A
10	A	A	A	A	A	A	A	A	A
11	A	A	A	A	A	A	A	A	A
12	A	A	A	A	A	A	A	A	A
13	A	A	A	A	A	A	A	A	A
14	A	A	A	A	A	A	A	A	A
15	A	P	A	A	A	A	A	A	A
16	A	A	A	A	A	A	A	A	A
17	A	A	A	A	A	A	A	A	A
18	A	A	A	A	A	A	A	A	A
19	A	A	A	A	A	A	A	A	A
20	A	A	A	A	A	A	A	A	A
21	A	A	A	A	A	A	A	A	A
22	A	A	A	A	A	A	A	A	A
23	A	A	A	A	P	A	A	A	A
24	A	A	A	A	A	A	A	A	A
25	A	A	A	A	A	A	A	A	A
26	A	A	A	A	A	A	A	A	A
27	A	A	A	A	A	A	A	A	A
28	A	A	A	A	A	A	A	A	A
29	A	A	A	A	A	A	A	A	A
30	A	A	A	A	A	A	A	A	A
31	A	A	A	A	A	A	A	A	A
32	A	A	A	A	A	A	A	A	A
33	A	A	A	A	A	A	A	A	A
34	A	A	A	A	A	A	A	A	A
35	A	A	A	A	A	A	A	A	A
36	A	A	A	A	A	A	A	A	A
37	A	A	A	A	A	A	A	A	A
38	A	A	A	A	A	A	A	A	A
39	A	A	A	A	A	A	A	A	A
40	A	A	A	A	A	A	A	A	A
41	A	A	A	A	A	A	A	A	A
42	A	A	A	A	A	A	A	A	A
43	A	A	A	A	A	A	A	A	A
44	A	A	A	A	A	A	A	A	A
45	A	A	A	A	A	A	A	A	A
46	A	A	A	P	A	A	A	A	A
47	A	A	A	A	A	A	A	A	A
48	A	A	A	A	A	A	A	A	A
49	A	A	A	A	A	A	A	A	A
50	A	A	A	A	A	A	A	A	A