EFFECT OF NEODYMIUM : YTTRIUM ALUMINIUM GARNET (ND:YAG) LASER CAPSULOTOMY ON CORNEAL ENDOTHELIUM AT TERTIARY HOSPITAL , KOLAR

By

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MBBS

Dissertation submitted to the

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In partial fulfillment of the requirements for the degree of

MASTER OF SURGERY

IN

OPHTHALMOLOGY

Under the guidance of

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DEPARTMENT OF OPHTHALMOLOGY, SRI DEVARAJ URS MEDICAL COLLEGE, TAMAKA, KOLAR

MAY 2025

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EFFECT OF NEODYMIUM : YTTRIUM ALUMINIUM GARNET (ND:YAG) LASER CAPSULOTOMY ON CORNEAL ENDOTHELIUM AT TERTIARY HOSPITAL , KOLAR . ABSTRACT Background: A cataract is defined as opacification of the lens which may cause blurred and foggy vision of the eye. Posterior capsule opacification (PCO) is a very common complication arising from cataract surgery. Nd:YAG laser capsulotomy is quick & non-surgical method that gives instant vision improvement. Hence, the present study was conducted for assessing the effect of Neodymium: Yttrium Aluminum garnet (Nd:Yag) laser capsulotomy on corneal endothelium at tertiary hospital, Kolar. Aim and Objectives : 1. To assess the corneal endothelial cell density using specular microscopy before and after ND:YAG laser capsulotomy in patients with Posterior Capsular Opacification . 2. To study the corneal endothelial cell morphology before and after ND:YAG laser capsulotomy. 3. To measure IOP changes after the procedure Materials & methods: It was prospective research which took place in OPD of Ophthalmology at Sri Devraj Urs Medical College, Tamaka, Kolar, Karnataka June 2023 to August 2024. All consecutive patients visiting Ophthalmology Outpatient department of either sex and 35-65 years of age to undergo ND: YAG for capsule removal procedure for PCO are considered for this research. Microsoft excel using SPSS 22 version software is utilized for evaluating in frequency & proportions format. Results: Mean age of the patients was 51.8 years. Pre-treatment BCVA was<6/60, 6/60 to 6/24 and 6/18 to 6/6 in 15 percent, 45 percent and 40 percent of the patients respectively. After one-week post- treatment, BCVA was 6/60 to 6/24 and 6/18 to 6/6 in 8 percent and 92 percent of the patients respectively. After one-month post-treatment, BCVA was 6/60 to 6/24 and 6/18 to 6/6 in 5 percent and 95 percent of the patients respectively. While comparing between pre-treatment and post- treatment 1-week, significant improvement in BCVA was seen. Also, while comparing between pre-treatment and post-treatment 1-month, significant improvement in BCVA was seen. Significantly higher cumulative laser energy was needed for eyes with Fibrosis type of PCO in comparison to eyes with Elschnig pearls type PCO. Mean ECD pre-treatment was 2413.3 cells/mm2. It showed a subsequent significant reduction to 2298.5 cells/mm3 at one week follow- up and which further decreased to 2231.8 cells/mm2 and 2199.2 cells/mm2 at one week and 2128.3 cells/mm2 at one month follow-up, respectively. Mean CV at pre-treatment was 33.12 percent. It showed significant enhancement at one week follow-up (36.39 percent) and one month follow-up (37.92 percent). Mean hexagonal cells pre-treatment was 66.6 percent which showed significant reduction at one-week post-treatment (63.3 percent) and at one-month post-treatment (59.8 percent) (p-value < 0.05). Mean IOP at pre-treatment, one week and one month was 14.2 mmHg, 15.6 mmHg and 14.8 mmHg respectively. Significant results were obtained while comparing mean IOP at one week while returned to normal range at one month follow-up. Iritis/Uveitis and Intraocular lens pitting was seen in 4 percent and 5 percent of the patients respectively. Conclusion: The Nd:YAG laser capsulotomy is a safe, effective and non-invasive method for the treatment of PCO. However, it is not devoid of complications and can cause damage to the corneal endothelial cells. There is a significant decrease in corneal ECD following Nd:YAG laser capsulotomy along with transient alteration in IOP. Hence, in order to reduce the damage to corneal endothelial cells, it is necessary to minimize the laser energy delivered in the eye as much as possible. Damage to the corneal endothelial cells can also be reduced by ensuring that the posterior capsule is accurately focused, and the eye is stabilized by using a contact lens during the procedure. INTRODUCTION India, known for its vast size and diversity, has experienced a notable increase in its elderly population over the years. From 24.71 million in 1961, the number of elderly citizens rose to 138 million by 2021, which includes 67 million males& 71 million females. With aging comes a higher risk of health issues, & eye diseases are particularly prevalent in this group. Among these, cataract remains a leading concern. As mentioned by GBD, cataract is 2nd most common cause of MSVI globally.1 Cataracts accounted for 45.4% of global blindness & 38.9% MSVI in people with 50 years & older (in 2020). The burden was especially pronounced in South Asia, where cataracts were responsible for 63.1% of all blindness in this age group. Despite ongoing

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LIST OF ABBREVIATIONS

SL NO.	ABBREVIATION	FULL FORM
1.	IOP	Intra ocular pressure
2.	CME	Cystoid Macular Edema
3.	RD	Retinal detachment
4.	OCT	Optical Coherence Tomography
5.	CMT	Central Macular Thickness
6.	FLACS	Femtosecond laser cataract surgery
7.	MSICS	Manual small incision cataract surgery
8.	QOL	Quality of life
9.	IOL	Intra ocular lens
10.	SICS	small incision cataract surgery
11.	ECD	Endothelial cell density
12.	CV	Co-efficient of variation
13.	AAO	American association of Ophthalmology
14.	ACD	Anterior chamber depth
15.	CDVA	Corrected distance visual acuity
16.	LCVA	Low contrast visual acuity
17.	CCT	Central corneal thickness
18.	FECD	Fuch’s endothelial corneal dystrophy
19.	PMMA	Polymethyl methacrylate
20.	ECC	Endothelial cell count
21.	GBD	Global burden of disease
22.	DALY	Disability adjusted life years
23.	RLECS	Rabbit lens epithelial cells
24.	PCI	Partial coherence interferometry
25.	ARMD/AMD	Age Related Macular Degeneration
26.	RE	Right Eye
27.	LE	Left Eye
28.	SE	Spherical equivalent

ABSTRACT

Background:

A cataract is defined as opacification of the lens which may cause blurred and foggy vision of the eye. Posterior capsule opacification (PCO) is a very common complication arising from cataract surgery. Nd:YAG laser capsulotomy is quick & non-surgical method that gives instant vision improvement. Hence, the present study was conducted for assessing the effect of Neodymium: Yttrium Aluminum garnet (Nd:Yag) laser capsulotomy on corneal endothelium at tertiary hospital, Kolar.

Aim and Objectives :

1. To assess the corneal endothelial cell density using specular microscopy before and after ND:YAG laser capsulotomy in patients with Posterior Capsular Opacification .
2. To study the corneal endothelial cell morphology before and after ND:YAG laser capsulotomy.
3. To measure IOP changes after the procedure

Materials & methods:

It was prospective research which took place in OPD of Ophthalmology at Sri Devraj Urs Medical College, Tamaka, Kolar, Karnataka June 2023 to August 2024. All consecutive patients visiting Ophthalmology Outpatient department of either sex and 35-65 years of age to undergo ND: YAG for capsule removal procedure for PCO are considered for this research. Microsoft excel using SPSS 22 version software is utilized for evaluating in frequency & proportions format.

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Conclusion: The Nd:YAG laser capsulotomy is a safe, effective and non-invasive method for the treatment of PCO. However, it is not devoid of complications and can cause damage to

the corneal endothelial cells. There is a significant decrease in corneal ECD following Nd:YAG laser capsulotomy along with transient alteration in IOP. Hence, in order to reduce the damage to corneal endothelial cells, it is necessary to minimize the laser energy delivered in the eye as much as possible. Damage to the corneal endothelial cells can also be reduced by ensuring that the posterior capsule is accurately focused, and the eye is stabilized by using a contact lens during the procedure .

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INTRODUCTION

INTRODUCTION

EFFECT OF NEODYMIUM : YTTRIUM ALUMINIUM GARNET (ND:YAG) LASER CAPSULOTOMY ON CORNEAL ENDOTHELIUM AT TERTIARY HOSPITAL , KOLAR

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Cataracts accounted for 45.4% of global blindness & 38.9% MSVI in people with 50 years & older (in 2020). The burden was especially pronounced in South Asia, where cataracts were responsible for 63.1% of all blindness in this age group. Despite ongoing global efforts to combat this condition, the impact remains significant—there has been a 91.2% rise in DALYs lost because of cataracts globally, along with a 32.2% rise in adjusted rates.[2]

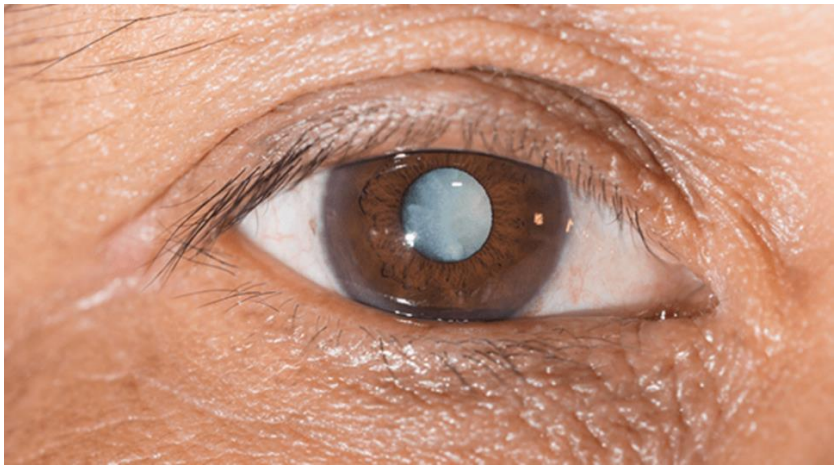


Fig 1 : eyes showing cataractous lens

At present, an estimated 15.2 million adults aged 50 and above are blind due to cataracts, while another 78.8 million suffer from moderate & severe vision impairment (MSVI) caused by the condition, on a global scale. South Asia bears the highest burden, accounting for 5.9 million cases of cataract-related blindness & 27.2 million cases of cataract-induced MSVI. Cataract surgery fortunately is cost-effective health interventions. In India, manual small-incision cataract procedures are affordable, while phacoemulsification surgery with bit expensive than the latter—making both procedures highly efficient compared to many other important surgical &global health interventions.[2, 3]

Phacoemulsification, FLACS, & MSICS are the primary conventional operative techniques for cataract treatment. Additionally, extracapsular & intracapsular cataract extraction methods remain convenient options for Ophthalmologists.[4- 6]

PCO-Posterior capsular opacification, commonly designated be "subsidiary-cataract," that visually impairing problem after modern cataract operation. This has been developed in approximately 18% -50% of individuals within five years post-operative procedure in 44% of babies & children. In spite of technological advancements in operative procedures, the persistence of PCO is affected by kind of intraocular lens used and several yet unidentified factors. The condition arises from the development & movement of RLECs, leading to clouding of posterior-capsule, which causes vision impairment& a reduced QoL. [10]

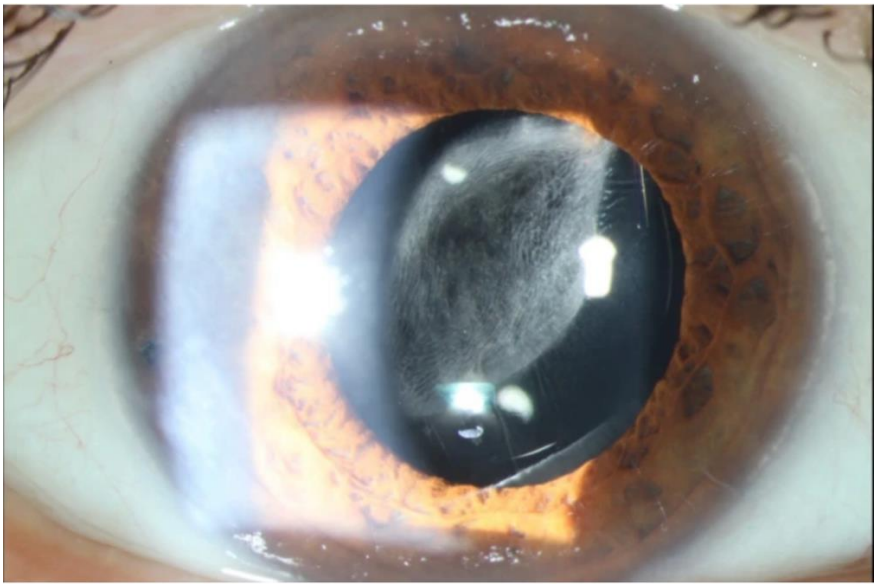


Fig 2 : Posterior capsular opacification 6 months after surgery

PCO may progress through either a regenerative (Elschnig's pearls and Soemmering ring types) or fibrotic process. Regenerative PCO often leads to visual decline because of the development of Elschnig pearls, causing decreased central vision, impaired contrast sensitivity, monocular double vision & glare. Treatment is typically recommended for symptomatic individuals to restore visual clarity and enhance overall QoL.[10]

Grade	Severity	PCO
Grade 0	None	No evidence of PCO
Grade 1	Trace	Few discrete epithelial pearls
Grade 2	Mild	Multiple discrete epithelial pearls
Grade 3	Moderate	Multiple coalescent epithelial pearls
Grade 4	Severe	Thick sheet of epithelial pearls

Fig 3 : Grading and severity of PCO

The 1064 nanometer-Nd:YAG laser capsulotomy has well-established history of effectively regaining sight clarity also reducing risk of complications. Across recent decades, involvement of optometrists in performing laser procedures has expanded significantly beginning in Oklahoma, which became the first state to include laser surgeries within the optometric scope of practice in 1998. Currently, 10 states in the U.S. authorize optometrists to carry out capsulotomies & other anterior segment laser treatments. While no adverse events related to laser procedures performed by optometrists have been documented in the literature, there also remains a lack of published studies specifically evaluating the safety and efficacy of such procedures—such as YAG capsulotomy—when conducted by optometrists.[11, 12]

Aron-Rosa (1981) introduced the use of laser anterior capsulotomy prior to extracapsular cataract surgery, claiming it could produce capsular flaps that effectively support intraocular lens placement. However, the actual advantage of this method over conventional surgical capsulotomy remains uncertain. Additionally, it has been noted that the technique may lead to pupil constriction and increased viscosity of the cortical lens material, potentially complicating lens removal during surgery.[13]

The leading use of the YAG laser is its ability to execute posterior capsulotomy quickly and painlessly using a slit lamp. To minimize the risk of complications, it's crucial to use the lowest effective energy level and ensure precise focus. Inaccurate targeting leads to minor injury to the IOL, and in some instances, lens fractures have been reported. However, unless numerous damage points are present, visual quality is generally unaffected, and the release of free monomer is believed to be minimal. Additionally, the YAG laser can efficiently sever vitreous bands and adhesions involving intraocular lenses. Some reports also suggest that the laser may help relieve cystoid macular edema in certain cases by cutting vitreous strands between the lens and surgical wound.[14]

Nd:YAG laser capsulotomy is quick & nonsurgical method that gives instant vision improvement. While it is generally considered safer & less invasive than operative methods, it still holds the potential for complications. Latest research, have explored how the extent of the capsulotomy & levels of laser energy consumed impacts the occurrence of post-capsulotomy complications.[11- 13]

Fig 4 : Nd:YAG laser machine

The size of the capsulotomy plays a crucial role, as patients undergoing procedures with lower laser energy, possibly resulting in smaller capsulotomies, may experience fewer complications such as RD, IOP, & potentially less CME. The risk of IOL displacement may also be lower, particularly with plate-haptic silicone IOLs. One study shows, in spite similar energy levels being used in small & large capsulotomy groups, patients with smaller capsulotomies exhibited less hyperopic shift, lower IOP increase, & less macular thickness increase.[15]

Another key factor is the amount of laser energy applied. Ari et al. observed, higher energy levels led to more significant increases in intraocular pressure (IOP) and macular thickness. In contrast, Steiner et al. suggested that it was not the energy level itself but rather the number of laser pulses and the overall energy output that did not significantly contribute to the risk of developing CME.[15,16]

The primary concern with a misdirected Nd:YAG technique for cornea has been seen as potential damage to endothelial cells & layer of cornea. Disorder of stromal layer triggers a tissue repair response which leads to fibrotic changes, while endangers endothelial cellular layer can leading to cornea damage for rest of the life. Therefore, this study is crucial in developing methods to minimize endothelial cell destruction and reduce overall corneal damage.

Given the limited research available on the impact for Nd:YAG technique of capsulotomy upon endothelial cells of cornea, the research has been conducted for evaluation of the endothelial cells of cornea density & shape earlier and later the process.

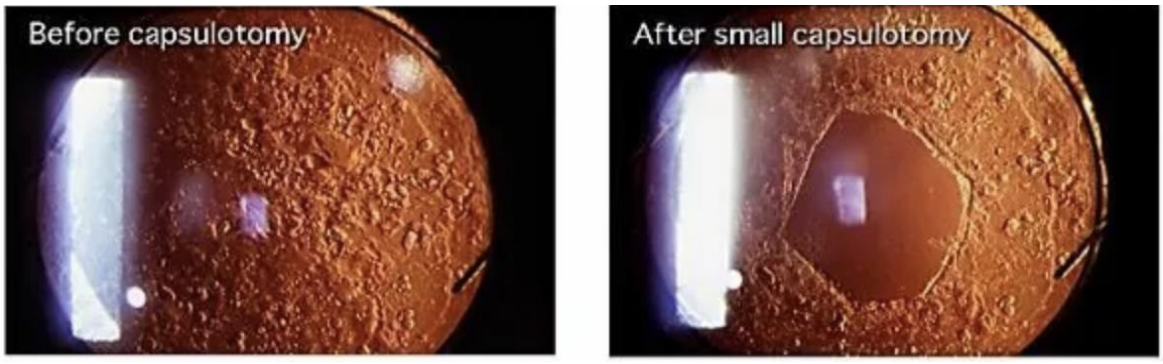


Fig 5 : Before and after pictures of Nd:YAG capsulotomy on a PCO patient

AIMS & OBJECTIVES

AIMS AND OBJECTIVES

- To assess the corneal endothelial cell density using specular microscopy before and after ND:YAG laser capsulotomy in patients with Posterior Capsular Opacification .

- To study the corneal endothelial cell morphology before and after ND:YAG laser capsulotomy .

- To measure IOP changes after the procedure

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The eye's crystalline lens is clear framework that refracts light to focus images at retina which enables accommodation. Cataract occurs when the lens becomes opaque, impairing vision. While aging is the leading factor, other factors like tobacco use and UV radiation exposure can also contribute to cataract formation.

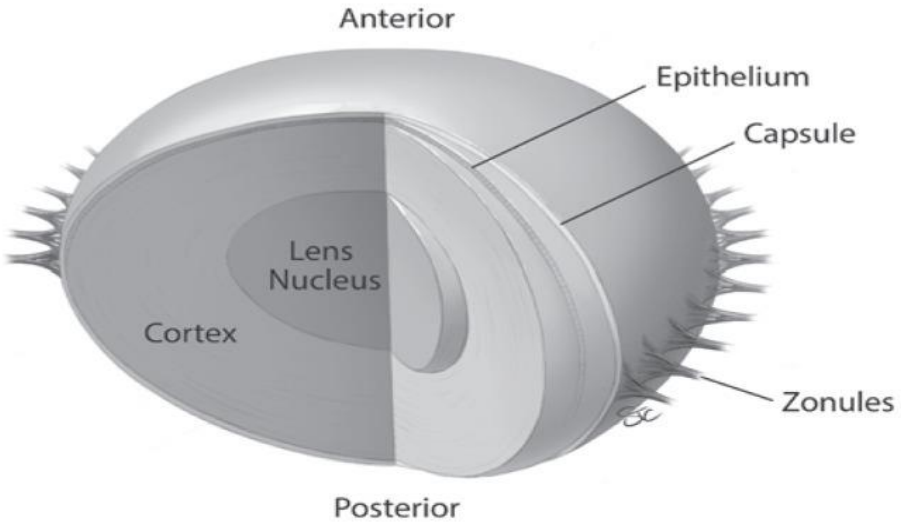


Fig 6 : Sectional view showing the layers of the lens

Solley proven treatment for a cataract is cataract surgery, once it becomes visually significant. The term "visually significant" has evolved with time and is now commonly defined as having a clarity of sight of 20/40 &lower. During the beginning phases of cataract operation, the term "visually significant" likely referred to an advanced or mature cataract, where loss of sight was severe and nearing blindness.[17]

Anatomy and Physiology :

Most cataracts in adults develop due to aging, other causes may include ultraviolet light exposure, diabetes, smoking, use of corticosteroid, & alternative medications that cause oxidative stress. Cataracts in children can be hereditary, idiopathic, or associated with

systemic disorders, metabolic conditions, or pregnancy-related infections. Cataracts with aging results from oxidative damage to the lens & anatomically classified into cortical, nuclear, & posterior subcapsular types. The rate of nuclear cataracts is13.1%, cortical 8.2% & posterior subcapsular 3.4% making nuclear cataract most common of the three and posterior subcapsular least common the most. In nuclear cataract with lens aging, new fibers are added that press the nucleus, that leads to nuclear sclerosis. Cortical cataracts are more likely to necessitate surgery. These typically present as opacities in the cortex, often referred to as cortical spokes. Posterior subcapsular cataracts involve opacity in the posterior cortex.[18- 21]

Approximately, 50% of congenital cataracts are hereditary, with many of the associated genes playing a role in lens development, including those for alpha, beta, and gamma crystalline, along with lens cytoskeletal proteins. Another contributing factor comprises metabolic disorders, trauma, maternal infections, &injurious substances. Posterior subcapsular cataracts are often linked to corticosteroid use, while medications such as busulfan, amiodarone, and phenothiazine have also been shown to cause cataracts. Cataracts resulting from trauma require special attention, as they often involve more than just the lens, with almost50% of trauma affecting eye posteriorly .[18]

Fig 7: Congenital cataract in left eye in a baby

Indications

Cataract's initial symptoms depend on its specific type. Nuclear cataracts typically cause reduced distance vision, difficulty recognizing faces, and trouble distinguishing coloration. Nuclear cataracts individuals may still maintain good Snellen acuity. Cortical cataracts can lead to difficulty reading, glare, &sensitivity to light. Posterior subcapsular cataract individuals may experience unusual visual symptoms, such as poor vision in bright light but better vision in low light conditions, also trouble with reading &daytime driving. If not treated, development of hyper-mature senile cataracts is seen, potentially causing issues like glaucoma, uveitis,& lens dislocation, that results in significant vision impairment or even total vision loss. The signs of congenital cataracts rely on their stage of development. White cataracts are often noticeable to parents, while pediatricians may observe a lack of symmetry in the red reflex, along with indicators of weak eyesight such as unable to focus on light, lack of tracking, and not making eye contact.[18]

As stated by the AAO, the objective of diagnosis is to establish whether optical defects are caused by cataracts, assess the clinical significance of any cataract present, and exclude other conditions that may lead to subnormal vision.[18]

For evaluating, following measures are considered:

- Thorough detailed data collected from patient
- Visual examination along with rectification
- Glare testing
- Checking the proper working of pupillary muscles
- Evaluating ocular configuration
- External examination

- IOP has been checked
- Slit-lamp biomicroscope, lens, vitreous humor
- Ophthalmoscopy done for retina, macula & optic nerve
- Additional tests include OCT for assessing retinal/ anterior region conditions. If cataract density obstructs the view of the posterior segment, a B-scan ultrasound may be performed.[18]

Differential Diagnosis

Glaucoma

Diabetic Retinopathy

Age-related macular degeneration

Glaucoma has been an eye problem which cause gradual trauma to optic nerve, potentially leading to vision loss. While it is commonly linked to increased IOP, optic disc damage can also occur with normal IOP. During early phases, patients are typically asymptomatic, but over time, they begin to lose peripheral& central vision. This loss of vision is irreversible with highest incidence in African Americans. [18]

Diabetic retinopathy impacts persons with insulin as well as non-insulin dependent diabetes. Typical signs include fluctuating vision, floaters, flashes of light (photopsia), and progressive vision loss. In the non-proliferative stage, examination may reveal microaneurysms, retinal bleeding, & hard exudates. In the increasing stage, findings can include growth of fibrous tissue growth & abnormal new blood vessels, & macular edema. [18]

AMD: Dry AMD typically leads to gradual vision decline, increased reliance on brighter lighting or magnification tools, and may cause scotomas along with difficulty reading or driving. Drusen deposits are often visible during eye examination. In contrast, wet AMD is

characterized by central vision disturbances, which can be identified clinically through distorted lines on an Amsler grid test. [18]

Cataracts can develop in individuals with coexisting state like diabetic retinopathy, glaucoma, or AMD. Managing these comorbidities properly is of utmost importance.[22]

CATARACT SURGERY

Generic terms for cataract extraction—intracapsular & extracapsular.

Intracapsular removal entails removal of complete lens along with the capsule. This method is now largely obsolete in developed countries—used only in rare, specific cases—because of its inferior visual outcomes and increased risk of surgical & postoperative complications compared to modern techniques. However, it is still frequently practiced in developing countries, as it requires simpler, less expensive equipment, minimal reliance on support services or consistent electricity, and can be performed with relatively limited training. [22]

Extracapsular extraction includes eliminating the lens with preservation of the capsular bag in situ. This remaining capsule serves as a barrier in middle of the anterior &posterior segments and typically provides support to facilitate implantation of an intraocular lens implant. In while manual extracapsular extraction, involves removal lens nucleus in one piece, which necessitates a relatively large surgical incision.[22]

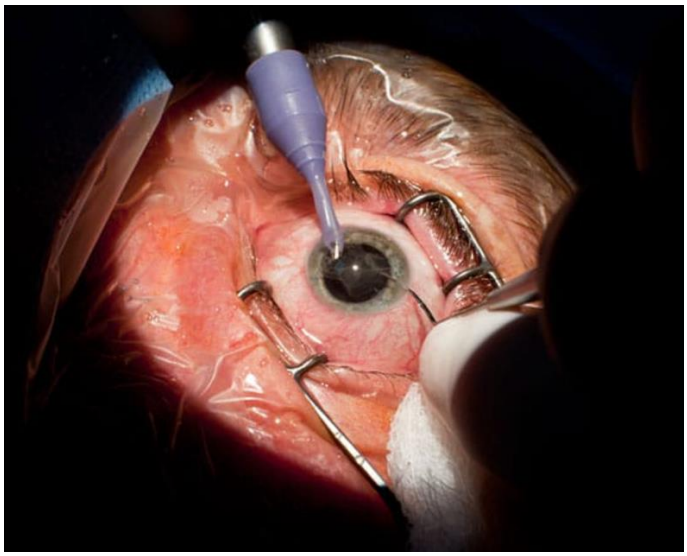


Fig 8 : Phacoemulsification cataract surgery

POSTERIOR CAPSULE OPACIFICATION (PCO)

PCO has the highest frequency of long-term complication following cataract surgery. Research have reported its occurrence in 20.7% of cases within two years & in 28.5% within five years post-surgery. In the beginning of 1980s, Aron-Rosa & Fankhauser introduced YAG for capsulotomy as management for posterior capsule opacification. Such laser method proved as a successful alternative to surgical discission, reducing the complications like loss of vitreous gel& endophthalmitis.[24]

The enhancement of sharpness of vision following YAG laser capsulotomy in people having notable PCO is successfully established. In addition to visual acuity, enhanced glare tolerance & contrast perception are also considered valuable outcomes for most individuals. While YAG laser capsulotomy is broadly regarded as proper criteria& generally safe therapy for posterior capsule opacification, & risk of vision-loss. Potential complications include retinal edema, retinal detachment, injury to IOL, elevated IOP, glaucoma, bleeding from retina, inflammation of iris, vitreous damage, cornea trauma, inflammation of vitreous, pupillary block, fluid accumulation of cystoid macular, hyphema, IOL shift, & worsening of

endophthalmitis. Recent studies have focused on how the dimension of capsulotomy& the total energy applied may influence the risk of these complications.[24]

MECHANISM OF LASERS

Optical Breakdown, plasma formation & photo disruption

Non-linear phenomenon that occurs when light of laser is intensely concentrated in both time continuum, resulting in extremely elevated-power density & irradiance known as visual malfunction. This process happens abruptly, often producing a visible spark with a click, along with significant detriment to the target area. This leads to the formation of an ionized state known as plasma. Plasma is typically generated when irradiance levels reach between 1010 & 1012 watts/square centimeter.[25, 26]

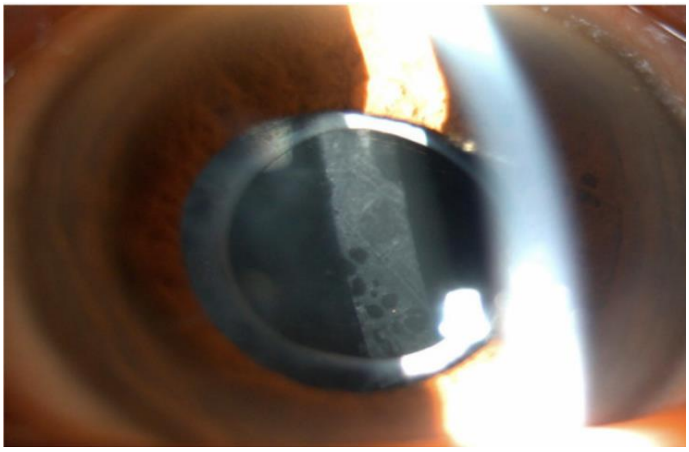


Fig 9 : laser shot spots on posterior capsular opacification

Ionization:

2 various methods for visual malfunction by "Q- switched" & "Mode locked" Nd:YAG laser.

"Q–switched" leading to ionization formation primarily due to thermionic emission. "Mode-locked" because of ionization of many photons.

Growth:

Free moving e^- can absorb photon (ph)& gain energy, causing it to accelerate. When this high-energy electron collides with another atom, it can ionize the atom, releasing a second free electron—though each now has less energy individually. These newly freed electrons can then absorb additional photons, speeds up, & strike with other atoms, releasing extra electrons. This chain reaction continues & is known as inverse 'Bremsstrahlung', the technical term for the procedure of absorption of photon & speeding-up of e^- in the existence of atoms or ions.[25,26]

Plasma shielding:

Once plasma is generated, it begins to absorb and scatter incoming laser light, effectively protecting the deeper structures in the path of the beam. Along with absorption, the scattering of light occurs through a procedure referred to as Brillouin-scattering. In 'Stimulated Brillouin scattering', this effect is enhanced light interacts with thermally generated acoustic waves & altered the frequency to match the characteristic photon frequency of the material. At higher irradiance levels, the laser can actually induce these acoustic waves itself, leading to increased scattering through stimulated Brillouin scattering.

Mechanism of damage:

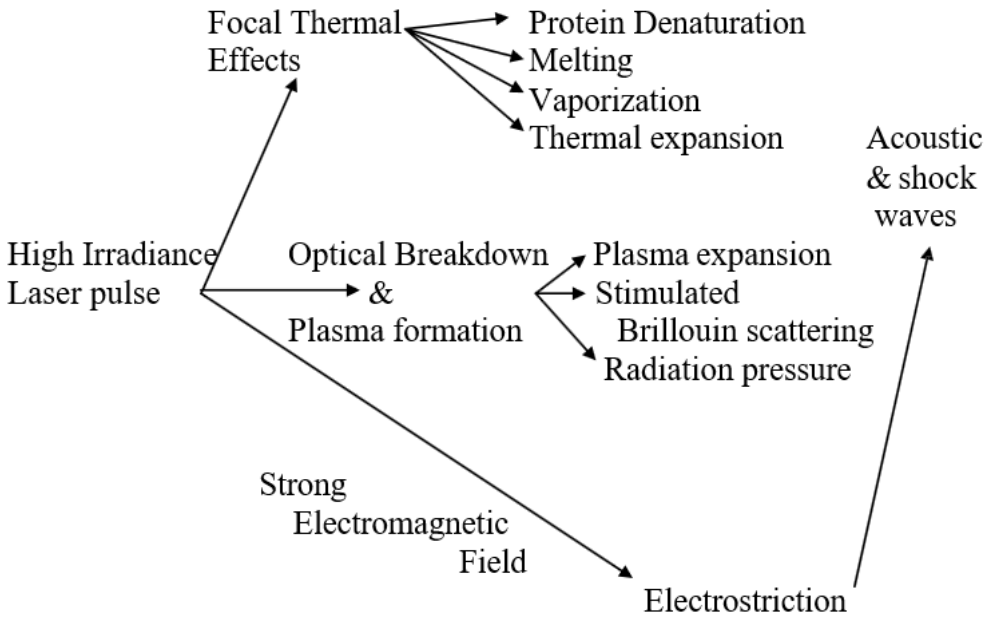


Fig 10 : Flowchart showing the mechanism of damage

Thermal mechanism:

The temperature of the micro plasma can locally reach as high as 15,000°C. This intense heat causes the vaporization &dissolution of solids &liquids in a compact area around the focal-point. In biosystem, heat-induced degradation of proteins &nucleic acids is estimated to occur within a diameter of 0.2 mm when one millijoule thump is applied. [25, 26]

Pressure waves:

Several mechanisms contribute to the generation of pressure waves from the optical breakdown zone. One key factor is the rapid expansion of plasma, which creates a supersonic shock wave. Another less powerful source of both supersonic & sonic got stirred due to Brillouin scattering, where laser forms force wave which disperses it. Heat at the focal point

leads to phase changes, such as vaporization & melting, as well as thermal expansion, which generate acoustic waves. If laser's electric field is strong enough, it can deform target by electrostriction & through radiative forces, which results from the transfer of momentum from photons till the atom at time of opposite to bremsstrahlung. After shock pulse, cavity formation & the development of a vapor bubble occurs. Cavitation starts within 50 to 150 nanoseconds after its failure in water, rapidly expanding for first 20 microseconds to a increase the dimension around 0.6 mm at three hundred microseconds. It then collapses in 300-650 microseconds. The velocity of cavity propagation is approximately 20 meters per second at 300 micrometers from the breakdown. Cavitation happens rapidly & should be distinguished from development of bubble. Constant bubbles are likely composed of H_2&O_2gas. [25, 26]

Spark Emission:

Visible spark as energy release in the form of photons when e^- reunites with ions (a process called bremsstrahlung).This emission follows blackbody-like spectrum, covering visible light, U, &in few cases, X-ray wavelengths. The spark serves as a helpful indicators to identify areas where it degrades. [25, 26]

Nd:YAG LASER-SYSTEM CONFIGURATION

This laser technique used for capsulotomies posteriorly involves choosing suitable lasers. A comparison of key methods like Q-switched technique & mode-locked Nd:YAG technique, as well as Argon photocoagulators, is essential for this purpose. [25, 26]

The variation among Q-switched technique & mode-locked Nd:YAG technique lie how laser is pulsed. "Q-switched" lasers utilize shutter, known by Pockel's-cells, to create pulses with a width of ten- twenty nanoseconds. On the other hand, "Mode-locked" lasers rely on inactive-

dye cell. As dye cells degrade over time & eventually lose potency, dye for mode-locked Nd:YAG is replaced from time to time. [25, 26]

Table 1 : Laser configuration and set up.

Laser Parameters	Argon Photocoagulato	Nd:YAG Q-switched	Nd:YAG Mode locked
Wavelength(mm)	488–545	1064	1064
Energy-dose(mj)	50 –500	4 – 15	3 – 6
Pulse-duration(sec)	0.01–1.0	10-8	10-11
Peak-power(W)	2	106	108
No. of-Shots	1 – 100	1 – 20	1 – 50
Spot-size-on target(mm)	0.1 – 1	0.05	0.05

When the Nd:YAG laser is activated, safety features are engaged. To verify settings, the laser can be test-fired with the shutter closed, and the aiming beam can be visualized. Then, the shutter is opened, and the laser is fired for treatment. YAG beam aimed by using mirrors to slit lamp gathering, & a Galilean telescope expands the beam to generate a less f-number & a narrow-beam diameter in eyes of the patient. The He:Ne beam follows the same path, helping to visually locate the Nd:YAG laser's aim point. The slit lamp functions as usual, with some systems allowing separate modifications of the slit lamp's light source, improving the representation of ocular framework. To safeguard the surgeon's eyes, a band-reject filter tuned to the 1064 nanometer wavelength of the Nd:YAG laser is employed. [25, 26]

COMPLICATIONS ASSOCIATED WITH Nd:YAG LASER CAPSULOTOMY

- IOL Movement & Refractive Changes
- IOL Damage/Pitting
- Inflammation to iris/Uveitis
- Elevated IOP
- Fluid accumulation of Cystoid Macular
- Removal of retina & tear
- Other Complications[27]

A Peyman or central Abraham contact lens can be used during Nd:YAG laser procedures to stabilize the eye, enhance laser beam optics, and ensure precise focusing. The Abraham Nd:YAG laser lens modifies the beam by increasing the convergence angle from 16 to 24 degrees, reducing the laser impact area on the posterior capsule from 21 µm to 14 µm, and enlarging the beam diameter at both the cornea and retina. As this is a modified posterior pole lens, it must be used with caution. If the laser is mistakenly delivered through the peripheral carrier part instead of the central lens button, it may inadvertently focus on the retina and result in retinal damage .[27]

Fig 11 : Abraham capsulotomy lens

Following Nd:YAG laser posterior capsulotomy, it is advisable to use topical agents like brimonidine, apraclonidine, or beta-blockers to help prevent post-procedure elevations in intraocular pressure (IOP). In patients who are at higher risk—particularly those with preexisting glaucomatous optic nerve damage—IOP should be carefully monitored, typically within 1 hour after the procedure and, if necessary, again at 4 hours. This protocol helps detect and manage potential IOP spikes promptly, reducing the risk of pressure-related complications.[26,27]

SPECULAR MICROSCOPY :

Specular microscopy is a noninvasive diagnostic tool that captures detailed, high-resolution images of the corneal endothelium—a vital cell layer responsible for maintaining corneal clarity and overall ocular function. This technique is particularly useful in several clinical settings: it aids in assessing endothelial cell health prior to high-risk surgeries, comparing the effects of different surgical procedures on the endothelium, evaluating the impact of laser treatments during refractive surgeries, and examining donor corneas before transplantation. By providing a clear view of endothelial cells, specular microscopy supports better understanding of corneal conditions and helps guide effective treatment planning, ultimately enhancing patient care.[28]

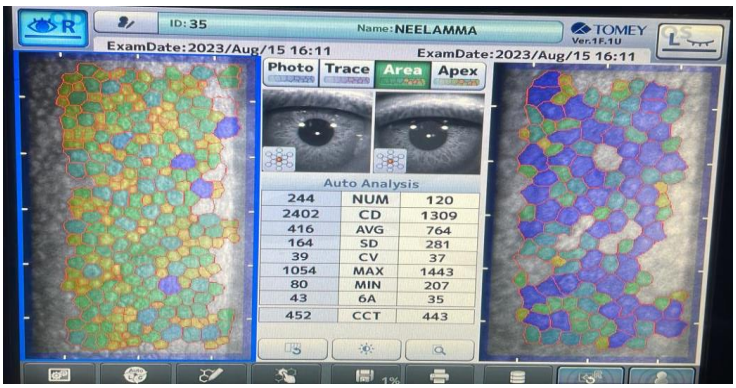


Fig 12 : Specular microscopy reading showing LE – reduced endothelial cell density

Aron-Rosa D et al. (1980) reported utilization of the Nd:YAG to build breach at capsule posteriorly following lens implant surgery. The laser is utilized to open opacified posterior capsule in pseudophakic eyes. Pigmented & non-pigmented visual structures were effectively incised without resulting in harmful heat response or requiring an incision in the eye. The laser releases energy instantaneously, causing complete ionization of the source & generating plasma, then, fluid shock wave at the boundary of energy-zone. Laser's thermal conditions should stay under 2×10^{-3} °C, ensuring ocular safety. Additionally, the process does not require anesthesia which avoids introducing foreign materials within the oculus. The laser's high precision aim, narrow beam size (50 microns), and selective pulsing make it extremely precise, virtually eliminating the risk of eye or intraocular lens damage.[28]

Kozobolis VP et. Al (1998) assessed the corneal changes following Nd:YAG laser procedures, which includes 3 groups-A: pupillary membranectomy, B: iridotomy, & C: capsulotomy, over a 6-month follow up visits. The study involved specular microscopy to measure corneal thickness, the % of hexagonal cells, cell density, & cell-area, both before & after the procedures. Corneal scars were observed in groups-A & B. Notable reduction in cell density was seen by the 1stmonth. However, in Group-A & C, notable loss of endothelial cells was recorded at the 6thmonth. The aspect of dark spots in the endothelium was primarily associated with the total energy provided during the procedure. While Nd:YAG laser treatments did not cause prompt, noticeable endothelial cell loss, they may trigger an elevated loss of endothelial cells over time.[29]

Findl O et. Al (1999) investigated the alterations inside lens location induced via YAG removal capsule across three IOL styles. The prospective study involved measuring ACD using dual-beam PCI among thirty-two individuals in PCO, earlier& instantly after capsulotomy carried out under mydriasis. The subjects were categorized in 3-categories

depending upon lens. Outcomes revealed that capsulotomy causes reverse displacement of the IOL in all subjects, with an average shift of 25 microns (ranging from 9-55 microns). This backward movement was most evident in oculus having plate-haptic Intraocular lens, as compared with the other two types of IOLs. The accuracy of ACD analysis by PCI was 4µm. The study also found that changes in ACD were promptly correlated with dimension of capsulotomy, & not with pre-operative lens-capsule distance.[30]

Seong GJ & colleagues (2000) studied the prophylactic effects of 0.2percent of brimonidine for inhibiting increased IOP in individuals undergoing YAG capsulotomy posteriorly. 81 patients i.e 81 eyes were arbitrarily allocated to2 groups: first group received 0.2% drop of brimonidine, while the other received a vehicle, both administered 1 hour before the procedure and immediately after capsulotomy. IOP measurements were taken preoperatively and at 1, 2, 3, & 24 hours postoperatively. The brimonidine- group showed a decline in Intraocular pressure from baseline by 3rdpost-operative hr, while the other group exhibited an elevation in IOP. In the brimonidine group, 7.3% (3/41) of individuals experienced increase in IOP by 5 mmHg or more, as compared to vehicle group with 20.0% (8/40). Increase in IOP with 10 mm Hg or more took place in 2.4% (1/41) of brimonidine- group, as compared to vehicle group with 7.5% (3/40). The study concluded that a single drop of 0.2% brimonidine administered pre-operatively & instantly following capsulotomy is both effective & secure in avoiding IOP increase seen post YAG laser posterior capsulotomy.[31]

Barnes EA & colleagues (2004)examined the alterations in intraocular pressure (IOP) at 1 & 3-hours post-YAG capsulotomy in glaucoma individuals with pseudophakia. This research aimed to investigate the consequences of apraclonidine & acetazolamide on such pressure changes. Individuals going through YAG posterior capsulotomy were arbitrarily assigned for no treatment, 250mg of oral acetazolamide, & 1% topical apraclonidine in under 1-hrprior to

the method. Intra Ocular Pressure measurements were recorded 1 & 3 hours postoperatively. Data from 76 eyes (one per patient) were analyzed: 29 received no treatment, 24 were given oral acetazolamide, and 23 received apraclonidine. Among the untreated group, 20.7% (6 out of 29) experienced an intraocular pressure increase of ≥5 mmHg, while 3% (1 out of 29) had increase of 10 mmHg or more. No pressure elevation of ≥5 mmHg was observed among patients treated with acetazolamide,& One patient with apraclonidine had a pressure rise of ≥5 mmHg, but none exceeded 10 mmHg. While analyzing treated to untreated patients, the rate & intensity of pressure elevation were significantly decreased (P = 0.01). All medically significant pressure rises occurred within the 1sthour after the procedure. The study concluded that medically relevant post-YAG pressure increase happens in 20% of glaucoma individuals going through capsulotomy without therapy, but topical apraclonidine & oral acetazolamide effectively decreases the rate& severity, with both treatments showing similar efficacy.[32]

Auffarth GU et. al (2004) performed an investigation comparing the rate of YAG laser capsulotomy following cataract operation, based on IOL material used (hydrophilic acrylic, PMMA, silicone, &hydrophobic acrylic) in 4 European countries: Germany, Italy, France &Spain. This investigation involved a retrospective cohort study, in 16 surgical centers followed by examining the charts of 1,525 patients with age of 50 - 80 years who experienced cataract surgery in 1996 or 1997. The follow-up period was at least three years, during which the researchers tracked YAG laser capsulotomy occurrences. Outcome showed a notable disparity in the rate of opacification in the back region &YAG technique among four IOL groups. The average duration to Nd:YAG laser treatment following cataract surgery has been 2.48 years. Duration for removal of capsule using YAG was lesser among hydrophobic group then in silicone, and then in PMMA & lastly in hydrophilic acrylic group with 7.1%, 16.2%, 19.3%, & 31.1%. The study concluded that hydrophobic acrylic Intraocular Lens had a lesser rate of PCO &YAG laser treatment distinguished to various Intraocular Lens materials,

suggesting that this type of Intraocular Lens may lessen the need for postoperative laser treatment in patients with age-related cataracts.[33]

Rajappa N et. al (2013)performed a prospective, non-comparative research to evaluate corneal endothelial changes before &post YAG laser posterior capsulotomy in individuals having PCO. The research involved 200 adults .i.e. 200 eyes having PCO, scheduled to undergo YAG laser capsulotomy. 1 & 12 weeks follow up was done to assess the outcome of the laser on the corneal endothelium. Using computerized morphometry, researchers measured various parameters of the corneal endothelium, including central corneal thickness, cell dimension, form, concentration, hexagonality, &coefficient of variation, before and after procedure using non-contact specular microscopy. Chi-square & t-tests analysis were used, with significance of $P < 0.05$. Before laser treatment, the ECD ranges between 1659- 2792 cells/square millimeter, with average 2298.7 cells in every mm^2. The mean post-treatment, ECD has been 2178.1 cells in every mm^2 ($P < 0.0001$) at 1^{st} week, & 2121.3 cells in every mm^2 at 12^{th} week. The reduction in ECD was significant, with a loss of 120.6 cells/mm^2 (7.78%) at 1 week and 177.4 cells/mm^2 (7.78%) at 12 weeks. The hexagonality of the corneal cells, which ranges between 49% -84% (with mean-72.22%) before the procedure, decreased slightly after treatment. statistically significant At 1 week, hexagonality was seen as 71.42% ($P < 0.005$) at 1^{st} week, & 70.22% at 12^{th} week. Despite the significant betterment in vision (90% of individuals showing at least a two-line improvement on the Snellen chart), the study found a considerable decrease in endothelial cell density. Authors concluded that while YAG laser capsulotomy is non-surgical & efficient method for treating Posterior capsular opacification, it can result in significant endothelial cell damage, emphasizing the need for careful monitoring of corneal health after the procedure.[34]

Bhargava R et. al (2015)performed a study to investigate the factors influencing the laser energy levels needed for YAG laser capsulotomy & whether these energy levels were correlated with complications. Research included 474 individuals and various factors were evaluated, such as, type of PCO, IOL material & fixation, age & complication rates in relation to the energy levels applied for the capsulotomy. The average patient's age was 55.6 ± 8.7 years, with 22.9 ± 4.5 months of follow-up duration. The study determined that neither the type of intraocular lens (IOL) material ($P = 0.173$) nor the age of the patient ($P = 0.246$) had a significant impact on the total laser energy needed for capsulotomy. In contrast, significantly higher energy levels ($P < 0.001$) were required for treating fibro-membranous & fibrous forms of PCO. Complications like pitting of IOL, uveitis, increased IOP, CME, &RD, are commonly seen with higher energy levels. Specifically, individuals with RD had mean total energy -77.7 ± 17.7 milliJoule, compared to 43.4 ± 26.9 millijoule remaining patients. Retinal detachment had greater prevalence in patients with higher axial lengths ($P < 0.001$). In conclusion, the study found that the type of posterior capsule opacification profoundly influenced the laser energy levels needed for capsulotomy, while Intra ocular lens material & fixation did not. Additionally, complications like Intra ocular lens pitting, increased in Intraocular pressure, uveitis, retinal detachment, & CME were frequent when higher laser energy was used, highlighting the need for careful management of energy levels during the procedure.[35]

Khambhiphant B et. al (2015)examined alterations in Intraocular lens location after YAG capsule removal posteriorly through assessing changes in ACD& refractive parameters, which includes spherical equivalent & astigmatic cylinder. The study included 47 pseudophakic eyes from 29 individuals with posterior capsule opacification. ACD & refraction were calculated earlier &post procedure, at 1stweek& three months, using IOL Master®. The findings revealed no changes within anterior chamber depth or spherical equivalent at both 1 week & 3 months post-laser treatment. Intraocular lens movement was observed in two directions: backward in

29 eyes and forward in 18 eyes. Although alterations in cylindrical refraction were noted at 1st week, these changes diminished by 3 months following capsulotomy. The baseline cylinder was -1.16, which changed to -1.00 at 1 week and -1.14 at 3 months. Such alterations were consistent with both 1-piece &3-piece IOL. The study found that YAG capsule removal posteriorly had no affect chamber strength& sphere-shaped counterpart. While there was a small change in cylinder refraction at 1 week, this effect diminished by 3 months and was unlikely to be clinically significant.[36]

Yotsukura E & colleagues (2016) examined Nd:YAG capsule removal posteriorly at vision among individuals of PCO who had CDVA. Eyes requiring Nd:YAG capsule removal for PCO had focus for this research, even when patients had CDVA of at least 20/20. Various parameters were measured before and after the capsulotomy, including CDVA, 10% LCVA, wavefront aberrations among third to sixth sequence, & stray light for retina. The research comprised of 16 eyes from 16 individuals (ten males & 6 females). After YAG laser capsulotomy, CDVA, LCVA &retinal straylight showed statistically significant improvement. Moreover, the RMS values of 3rd -order Zernike coefficients (S3) & total HOAs from 3rd-6thorders showed a significant reduction. A significant correlation between straylight & total higher-order aberrations& between straylight & S3 before capsulotomy was seen. Patient-reported complaints are solved following the procedure. Investigation concluded that YAG laser capsulotomy caused significant recovery in vision despite posterior capsule opacification and sharp vision. The measurement of straylight could be a helpful tool to assess when YAG laser capsulotomy is essential, particularly those experiencing optical disturbances despite normal vision.[37]

Soni P et. al (2016) evaluated the optical outcomes after Nd:YAG laser capsulotomy. Cases were collected from patients who attended the ophthalmology OPD at Nehru Chikitsalay in

Gorakhpur between May 2015 and June 2016. Patients were chosen according to specific inclusion criteria, & outcomes were observed accordingly. The study highlighted that PCO is a common complication after SICS with Intraocular lens placement, with an incidence rate of 13.25%. However, the authors noted that this incidence of PCO in their study (13.25%) did not accurately reflect the true overall incidence of the condition.[38]

Cevher S et. al (2017) performed research for outcome Nd:YAG for capsule removal upon CMT, refraction, & RNFL thickness. The study analyzed 42 eyes from 42 individuals undergoing Nd:YAG laser capsulotomy. Researchers assessed SE, CMT, cylindrical refractive power, & retinal nerve fiber layer thickness both pre-operatively &post-operative at 1st day, 1stweek 1, & 1stmonth.The results indicated that SE values & CMT remained stable, with no significant changes observed within the 1stmonth following treatment. However, during the follow-up the average and nasal RNFL thickness values significantly increased, while cylindrical power refraction significantly reduced. The study concluded that Nd:YAG for capsule removal was reliable & flourishing method for PCO. Research also found that cylindrical power refraction and RNFL thickness values changed significantly following the procedure.[39]

Farhood & Qasim(2018) conducted a prospective non-comparative case series to analyze result for Nd:YAG for capsule removal laser posterior capsule removal on ECC among individuals having clinically significant PCO at Ibn Al Haitham Teaching Eye Hospital. Thisinvestigation65 eyes from 65 patients, comprising 61.5% males and 38.5% females, who were treated between June 2016 and February 2017.The researchers measured the cornea cell quantity using Topcon SP 3000 prior to YAG laser treatment, & at 1 & 4 weeks post-treatment. The mean endothelial cell count before the laser treatment decreases from2047 cells/square millimeter to 1938 cells/square millimeter, at 1stweek & 1916 cells/square

millimeter at 4 weeks. The disparity between pre-laser &1–4-week endothelial cell counts was statistically significant, with a reduction of 109 cells at 1 week and 131 cells at 4 weeks (p = 0.04).The study found that YAG laser posterior capsulotomy effectively treats PCO, but may cause damage to the corneal endothelium, as evidenced by a significant reduction in ECC.[40]

Agarwal G et al. (2019) performed prospective interventional research to assess& contrast corneal endothelial cell loss post YAG laser capsulotomy in two patient groups, distinguished by different laser energy levels. The investigation engaged 100 eyes from 100 patients with clinically diagnosed PCO differentiate in 2-groups of 20 each.

- Group A-: Treated with single-pulse energy -1.6 millijoule & total-energy <ten milli Joules.
- Group B-: Treated with single-pulse energy of 2.2 mJ and total-energy <20 mJ.

Endothelial cell counts were measured pre-treatment and at multiple time points post-treatment: 2 hours post-treatment, two days, two weeks, two months, & six months. Unpaired t-test revealed that the disparity in ECC prior & following laser capsulotomy was statistically significant in the 2 groups. Post-treatment (6-months), the mean endothelial cell loss was:

- Group A: 175.68 ± 72.42 cells/mm² (10.43% loss)
- Group B: 214.88 ± 97.68 cells/mm² (12.97% loss)

The study concluded Lower laser energy parameters (as in Group A) resulted in less endothelial cell loss, suggesting that using minimal effective energy during Nd:YAG capsulotomy can reduce adverse effects on the corneal endothelium while effectively treating PCO.[11]

Parajuli A et al. (2019) conducted a prospective, descriptive research to assess how YAG laser capsulotomy affects Intraocular pressure, refraction, ACD, BCVA, &macular layer

thickness in pseudophakic eyes having PCO. The researchers assessed these parameters before the procedure, one hour after, and again at follow-up of1-month. Subjects were categorized into two depending upon energy utilized for capsule removal—Group-I received 50 millijoules or less, while Group-II received more than 50 millijoules. Notably, no patients received preventive antiglaucoma medications.

The study included 96 eyes from 83 individuals. The average total energy applied was 26.64 ± 12.92 millijoules in Group-I & 81.96 ± 32.10 millijoules in Group-II. Noteworthy enhancement in acuity at 1 hour &one month subsequent to the procedure was seen in both groups. Spherical equivalent remained largely unchanged across both groups. ACD showed a significant increase at both follow-up points in both groups. Regarding IOP, Group I experienced a temporary rise one hour after the procedure (P=0.023), which returned to baseline levels after a month. In contrast, Group II showed a more significant rise in IOP 1 hour post-procedure (P<0.001), and the levels remained elevated even at one month. Macular thickness also elevates initially in both groups, but while it normalized by one month in Group I, it remained significantly elevated in Group-II. Importantly, no serious complications like cystoid macular edema or dangerously high IOP was seen. The investigation showed that higher energy levels in YAG laser capsulotomy may cause temporary spikes in IOP & macular layer thickness, but often don't require treatment.[41]

Lindholm JM et al. (2019) performed research to assess5-year cumulative cases for Nd:YAG for capsule removal & identify associated risk factors among patients implanted with various types of hydrophobic acrylic IOLs. The study reviewed data from cataract surgeries performed between 2007- 2016 in Finland. It comprises of 10,044 eyes that had undergone cataract operation with in-the-bag placement of either the SN60WF, ZCB00, or ZA9003 IOLs. The researchers used a competing risks approach to estimate the cumulative incidence

of YAG capsulotomy, while potential risk factors were assessed through competing risks regression analysis. These risk factors included age of patient, gender, &the type and dioptric power of the implanted IOL, and the seniority level of the surgeon performing the operation. Over a 5-year period, 13.2% of patients required Nd:YAG capsulotomy. When broken down by IOL type, the incidence was increased for ZCB00 at 18.1%, followed by SN60WF at 11.5%, and lesser for ZA9003 at 9.6%. After adjusting for other variables, implantation with SN60WF & ZA9003 Intraocular lens was linked to 38% & 47% lesser risk of needing Nd:YAG capsulotomy, respectively, when compared to ZCB00 (with sub-hazard ratios of 0.62 and 0.53, both $P < .001$). The study also found that patients under the age of 60, females, and those with intraocular lens of less than 22.5 diopters have higher chances to require Nd:YAG capsulotomy. These findings indicate that, in real-world settings, SN60WF and ZA9003 IOLs linked to a significantly less likely of needing capsulotomy than ZCB00.[42]

Teshigawara T et al. (2020) reported on a rare complication observed over a three-year follow-up period post YAG laser capsulotomy, emphasizing the importance of recognizing such events and considering appropriate treatment approaches. PCO is often a postoperative issue with cataract surgery, often resulting in decreased vision, reduced contrast sensitivity, & glare. Nd:YAG laser capsulotomy is benchmark & successful method to resolve visual disturbances. The rate of PCO necessitating laser treatment differs among studies, typically ranging between 2.2% and 10.0%.YAG laser capsulotomy is generally regarded as safe, but it carries potential risks & complications. Known risk factors are- temporary increases in IOP , anterior uveitis, pitting of IOL, cystoid macular edema, endophthalmitis, &RD. In this case, the authors described an unusual complication in which the laser was inadvertently directed at the cornea due to a misidentification of the PCO as part of the corneal layers during the process. Such rare event underscores need for careful targeting and heightened awareness during laser capsulotomy to prevent similar occurrences.[43]

Das N et al. (2021) performed retrospective research to examine efficiency YAG in capsule removal with improving ophthalmic results. The research took place at ophthalmology department in Karachi, over six-month period from January to June 2020. Using convenient sampling, 50 eyes from patients over the age of 20 who had developed posterior capsule opacification at least six months after cataract surgery were included. These patients exhibited signs such as capsular fibrosis & visual distortion from wrinkling. The mean age of individuals was 59.08 years, having 40% being male. The treated eyes included 22- right & 28- left eyes. Following Nd:YAG capsulotomy, no patients had elevated intraocular pressure (IOP) beyond the first week. 16.84 mmHg of average IOP was on day one, which decreased to 12.48 mmHg by the end of the week. Iritis was observed in 10% of patients on the first day and 8% by the first week. Raised IOP occurred in 20% of patients on the first day, while cystoid macular edema appeared in only 2% of cases, both on the first day and after a week. Despite some post-procedural risks like elevated IOP, iritis, cystoid macular edema, &pitting of IOL, the research concluded that YAG laser capsulotomy effectively enhances optic sharpness in PCO individuals.[44]

Pathak AH et al. (2021) performed a prospective observational investigation for evaluating endothelial architecture of the cornea prior & following YAG for capsule removal among individuals having opacification at the back side of capsule. The study involved 50 eyes from 50 patients and was carried out from October 2020- February 2021. The subjects went through Nd:YAG laser capsulotomy with a follow-up at 1 week &1-month post-procedure. Specular microscopy was used to assess ECD, CV, & HEX of endothelial cells earlier & following the procedure. The results showed BCVA of more than 6/18 after one week of the procedure in 45 patients (90%) &(94%) 47 patients achieved similar or good results after one month from the procedure. Mean ECD has been 2356.76 cells/square millimeter before the laser procedure, that was reduced to 2231.8 cells/square millimeter1 week after & 2199.2 cells/square

millimeter 1 month after the procedure. The reduction in ECD was statistically significant at 1 month. The mean CV increased from 33.74 before the procedure to 35.58 1-week post-procedure and 37.22 one month after, with a significant difference at one month ($p< 0.0001$). Hexagonality decreased from 65.34% at baseline to 62.02% one week after and 60.42% one month after, with a statistically significant difference at 1 month. While YAG laser capsulotomy was secure, efficacious, & conservative method for PCO, the study concluded that this leads structural & functional damage to corneal endothelial cells.[45]

Eleiwa T et al. (2021) examined the differences in CCT, ECC, IOL position, & refractive error one- & three-months following Nd:YAG-PC for PCO in pseudophakic eyes with FECD. The study involved 50 pseudophakic eyes from 50 patients-25 having healthy corneas & 25 having Fuchs' endothelial cell dystrophy grades 1 & 2. Inclusion criteria: individuals without clinically evident corneal edema. Each individual underwent YAG-PC & follow-up was done for 1&3 months. Various parameters, including BCVA, refractive errors, anterior chamber depth, corneal thickness, &endothelial cell count, were evaluated before laser treatment & at follow-up visits. The study found significant betterment of both groups in BCVA. However, healthy subjects, FECD eyes had relevantly hyperopic shift at both follow-up visits. Additionally, there was a significant reverse displacement of IOL in FECD eyes at both follow-up points. In FECD eyes, a notable link was found between hyperopic shift and anterior chamber deepening at first & third months. Both groups showed significant endothelial cell loss, but no significant increase in corneal thickness. The results indicated that, after YAG-PC, FECD eyes experienced a hyperopic shift &retrograde motion of the Intraocular lens compared to healthy controls. Despite the decrease in ECC, there was no significant corneal thickening in either group.[46]

Chen HC et al. (2022) performed retrospective cohort research to examine whether timing of YAG: laser capsulotomy affects the structure & cell density of the corneal endothelium. The research involved 48 individuals having unilateral PCO, went through YAG for capsule removal. All participants had been categorized in two parts of twenty in 1st group&28 in 2nd: initial Nd:YAG category (less than twelve months after phacoemulsification) & latter Nd:YAG category (more than twelve months after phacoemulsification). Corneal endothelial parameters, including ECD, CV, HEX, & CCT, were measured in both groups. Ocular resolution significantly improved after YAG laser capsulotomy, according to the study. However, early treatment (During the first year after cataract surgery) leads to notable decrease in endothelial cell density (ECD) that partially recovered but remained lower than preoperative levels. Early treatment was associated with lower ECD compared to late treatment, suggesting potential risks to corneal health.[47]

Samir AM et al. (2022) performed descriptive longitudinal research to analyze outcome for Nd: YAG for capsule removal at cornea superficially using specular microscope. The research included 60 patients, from 18-65 years, and was carried out. Nd:YAG was tended for capsule removal posteriorly among individuals who previously went through extracapsular cataract extraction. The results showed that 7 patients (11.7%) experienced improvement in sharpness of vision of 0.3 or less, while vision improved by at least one line in all patients. The visual outcomes were not significantly affected by any complications. Notably, no elevation in IOP was seen following the procedure. The primary complaint in many patients was diminished vision 2-3 years post-cataract surgery, which was attributed to PCO. Despite advancements in operative procedures, IOL materials, design, &medications to prevent PCO, YAG laser capsulotomy remains secure method with a lesser complication.[48]

Yetkin AA (2023) conducted a cohort study to investigate the interval between cataract operation& YAG laser capsulotomy & also to evaluate therapeutic outcomes, clinical performance, & adverse effects of capsulotomy in individuals who underwent phacoemulsification and later developed posterior capsule opacification (PCO).. The patients were grouped according to the type of intraocular lens implanted: first category- polymethylmethacrylate lens, second category- hydrophilic acrylic lens, &third category- hydrophobic acrylic lens. The control examinations were carried out before the YAG laser capsulotomy and at the first week, first month, & third month following procedure. The study reported:

- Improved vision clarity in 96.7% of cases.

- 9.1% of patients experienced a temporary IOP spike (>5 mmHg) 3 hours post-procedure, normalizing by 1 week.

- Average energy used: 37.20 mJ; higher in patients with IOP elevation (71.07 mJ).

- Time to Nd:YAG capsulotomy varied by group:

  - Group 1: 6.29 months

  - Group 2: 7.81 months

  - Group 3: 17.7 months.

Nd:YAG laser capsulotomy improves optic sharpness but can cause complications, including:

- Cystoid macular edema (1.9%)

- Intraocular lens damage (3.9%)

- Vitreous hemorrhage (0.6%)

The study suggests using hydrophobic acrylic IOLs to reduce posterior capsule opacification incidence.[49]

Rauf A et al. (2023) investigated the Nd:Yad-Al Garnet among ECC loss & changes at anterior segment elements. The research included 60 individuals with a history of PCO, scheduled for YAG laser posterior capsulotomy. Specular microscopy was used before & after the laser procedure to examine CCT, ECC, & IOP. The results showed that-

Post YAG laser capsulotomy:

- significantly improved optical clarity

- ECC decreased

- Central corneal thickness slightly reduced

- Intraocular pressure remained stable

These changes occurred with both low and high energy levels, indicating that corneal structural changes can occur following the procedure. However, the treatment did not result in any notable change in IOP.[50]

Paranjpe R et al. (2024) assessed outcomes for Nd: YAG for capsule removal for various ocular parameters, including IOP, vision sharpness, ACD, macular thickness, & corneal endothelium in Indian individuals. The study included 72 eyes of 72 individuals with PCO after simple cataract operation also underwent Nd:YAG laser capsulotomy. Exclusion criteria- corneal or retinal pathology, intricate cataract operation, trauma, active uveitis, or non-compliant individuals. The study's key demographics & findings include:

- Mean age: 64 years

- Female majority (51.4%)

- Treated eyes: 51.4% left, 48.6% right

- Baseline BCVA: 62.5% had 6/24-6/12 vision

- Post-procedure BCVA improvements:

  - 1 hour: 63.9% had 6/24-6/12 vision

  - 1 week: 73.6% had >6/12-6/6 vision

- Anterior chamber depth remained normal

- 2 patients developed macular edema post-treatment.

The average Intraocular pressure at baseline, 1-hour, &1-week were 13.5, 13.86-, & 13.69-mmHg. A considerable elevation in Intraocular pressure was noted 1-hour post-procedure, followed by a decline to baseline levels by 1-week. A significant decrease in ECC was found at 1-hour post-procedure, and this decline persisted at one week. Although ocular refraction remained largely unaffected in the short term, anterior chamber reactions were observed in nearly all patients but subsided within a week. The study concluded that while Nd:YAG capsulotomy led to improved visual acuity and an initial rise in IOP, it also contributes to a reduction in endothelial cell count & occurrence of macular edema in some cases.[51]

MATERIALS & METHODS

MATERIALS AND METHODS

SOURCE OF DATA:

It was a prospective research which took place in OPD of Ophthalmology at Sri Devraj Urs Medical College , Tamaka , Kolar , Karnataka June 2023 to August 2024 . it took place as per the rules and regulations given by IEC. Consent had been priorly taken from the subjects.

SAMPLE SIZE : 40 patients .

STUDY DESIGN: Hospital based Observational prospective study

INCLUSION CRITERA:

1. individuals from age thirty five till sixty five years are included in the study.

2. subjects who have significant PCO

EXCLUSION CRITERIA:

1. Corneal pathologies like :

• endothelial dystrophy

• corneal scar or trauma

2. Pseudo exfoliation syndrome

3. Active uveitis

4. Injury-induced cataract

METHOD OF COLLECTION OF DATA:

All consecutive patients visiting Ophthalmology Out patient department of either sex and 35-65 years of age to undergo ND: YAG for capsule removal procedure for PCO are considered for this research.

1) Each patient will be checked by history and seeing clinically both eyes before and after the procedure by various methods as follows-

2) Visual acuity by Snellens chart for distant vision.

3) Near vision by Jaeger chart.

4) Slit lamp biomicroscopy to check front region.

5) Fundus examination by + 90D lens assisted slit lamp biomicroscopy and direct ophthalmoscopy.

6) Intra ocular Pressure (IOP) by Goldmann applanation tonometry.

7) Assessment of endothelial cell morphology by Tomey's Non-contact Specular Microscopy EM-4000 for Endothelial cell density (ECD), Polymegathism and Pleomorphism.

• After the detailed history and clinical examination, each patient will be evaluated for corneal endothelial findings, prior to and following ND: YAG for capsule removal.

• Follow up for these patients will be Day 1, 1 week after the procedure and 1 month post procedure.

• Corneal endothelial findings of groups will be documented.

• The study subjects was evaluated for corneal endothelial findings by Tomey's Non-contact Specular Microscopy and following parameters will be measured.

1. Endothelial cell density

2. % of Hexagonality

3. Pleomorphism

SAMPLE SIZE ESTIMATION:

Assessed using Mean ECD among pre-op & 1month after completion of study done by Amit Hemant pathak et al[45] as pre-op ECD was 2356.76 ± 213 and 1month it was 2199.2 ± 209.5. by utilizing ninety five percent of confidence limit & eighty percent of power sample size for 36 is checked through mentioned formula & using software of Med calc. 10% nonresponse sample with 36 +3.6 ≈ 40 subjects will be considered.

where:

n = sample size

o = standard deviation of the within - pair difference

difference = clinically meaningful difference

p = corresponds to power (.84 = 80% power)

Za12 = corresponds to two - tailed significance level (1.96 for a = .05)

STATISTICAL METHODS USED FOR THIS STUDY

Microsoft excel using SPSS 22 version software is utilized for evaluating in frequency & proportions format. Chi-square had been considered as test of significance. Continuous matter will be shown as average & as SD. Paired t test used to assess variation among data. P value <0.05 is chosen significant.

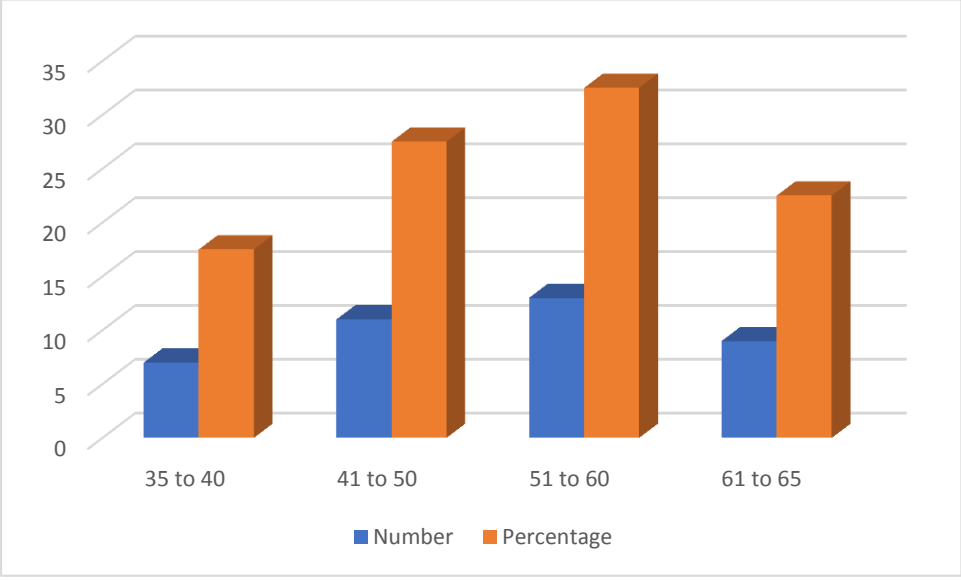
RESULTS

RESULTS

Table 2 : Age-wise distribution among patients

Age group (years)	Number	Percentage
35 to 40	7	17.5
41 to 50	11	27.5
51 to 60	13	32.5
61 to 65	9	22.5
Total	40	100
Mean	51.8	

Graph 1: Age-wise distribution among patients

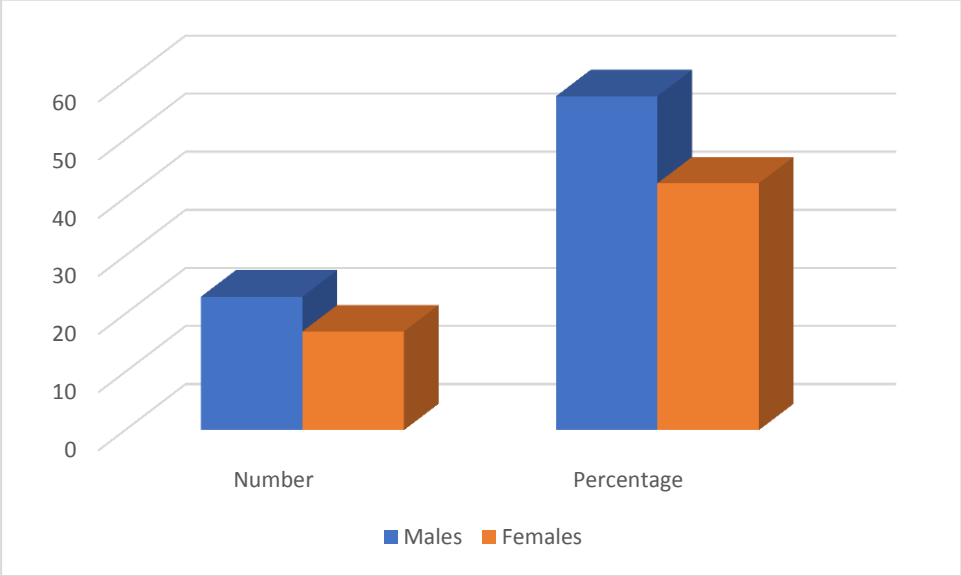


The majority of patients fell within two age groups: 51-60 years (32.5%) and forty one to fifty years (27.5%). Average age had been 51.58 yrs, indicating that middle-aged individuals were predominantly affected.

Table 3: Gender-wise distrbution of patients

Gender	Number	Percentage
Males	23	57.5
Females	17	42.5
Total	40	100

Graph 2: Gender-wise distribution of patients

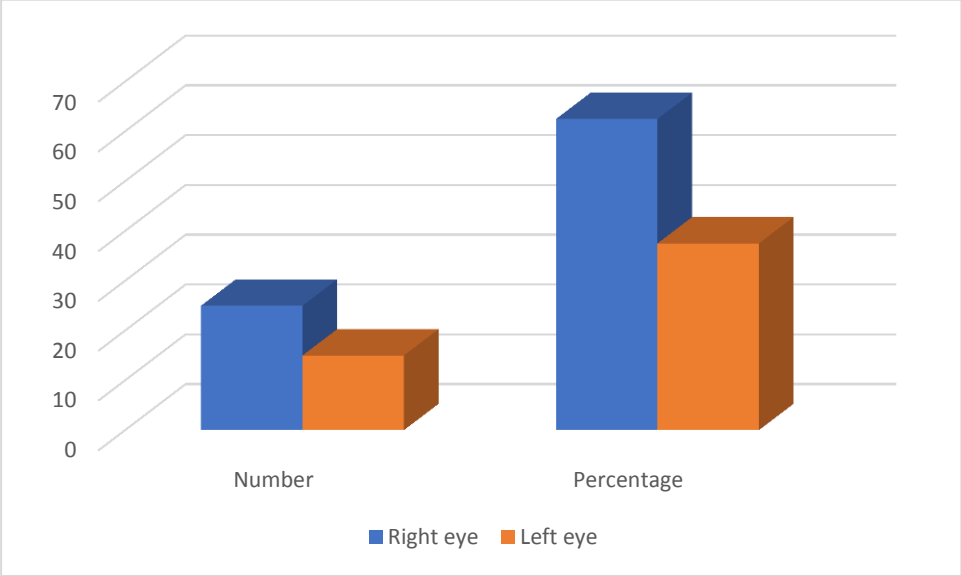


- 57.5% of the patients were males.

Table 4: Patient distribution by eye involvement

Side involved	Number	Percentage
Right eye	25	62.5
Left eye	15	37.5
Total	40	100

Graph 3: Patient distribution by eye involvement

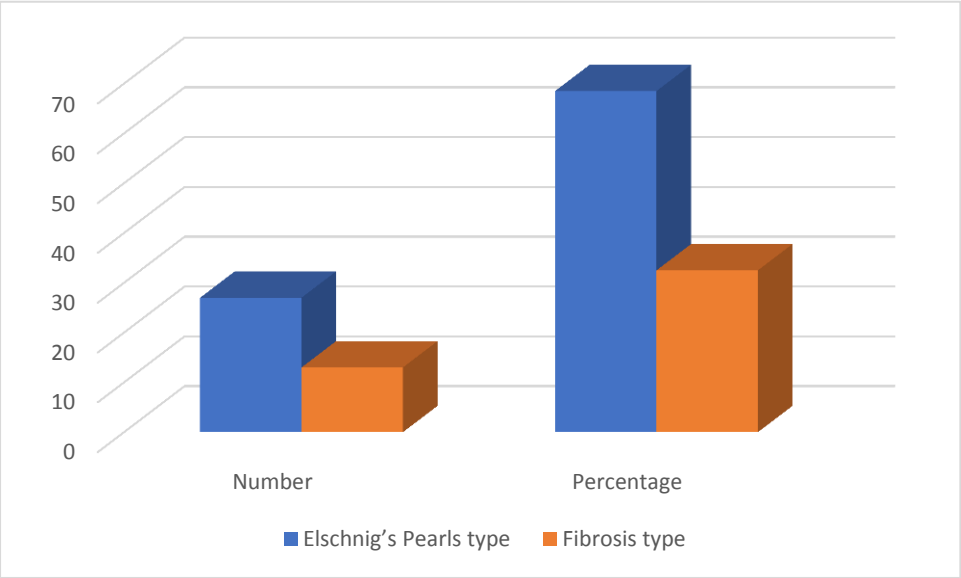


Right eye involvement occurred in 62.5% of patients

Table 5 : PCO-wise distribution of patients

PCO	Number	Percentage
Elschnig's Pearls (including Soemmering's type)	27	68.5
Fibrosis type	13	32.5
Total	40	100

Graph 4: PCO-wise distribution of patients

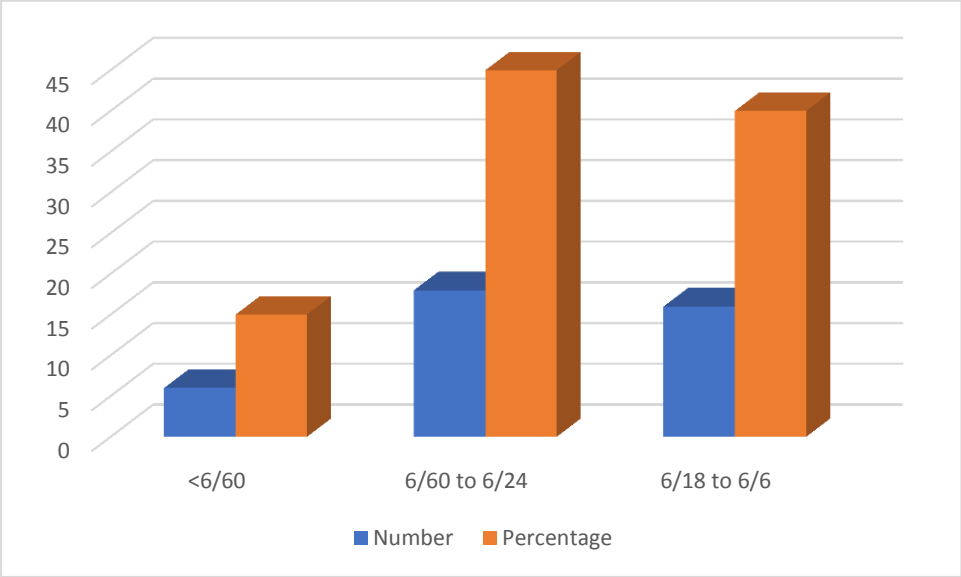


Elschnig's Pearls type and Fibrosis type among 68.5 % & 32.5 % subjects respectively.

Table 6 : Pre-treatment BCVA

Pretreatment	Number	Percentage
<6/60	6	15
6/60 to 6/24	18	45
6/18 to 6/6	16	40
Total	40	100

Graph 5: Pre-treatment BCVA

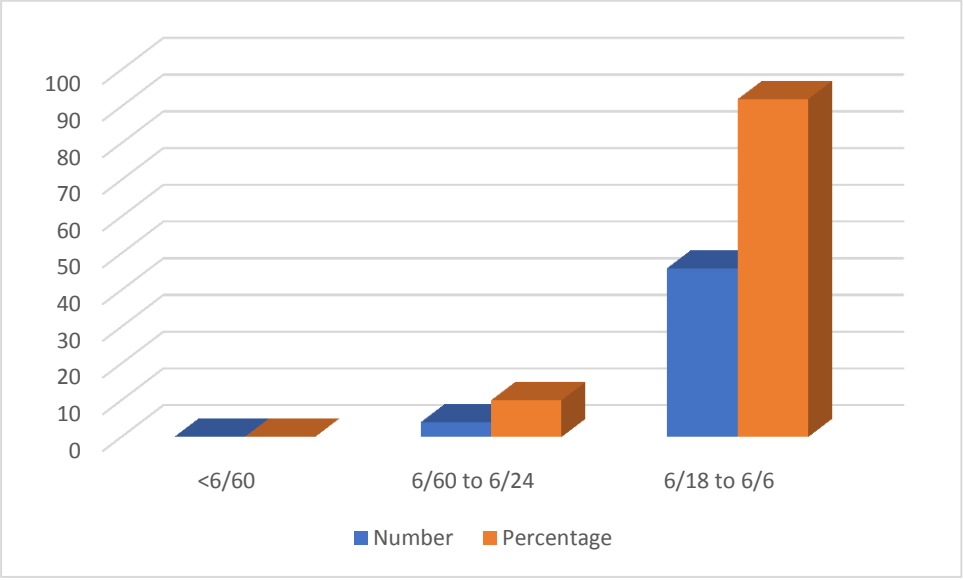


Initially, 15% of patients had BCVA <6/60, 45% had 6/60 to 6/24, and 40% had 6/18 to 6/6.

Table 7: Post-treatment 1 week BCVA

Post-treatment	Number	Percentage
<6/60	0	0
6/60 to 6/24	4	10
6/18 to 6/6	46	92
Total	40	100

Graph 6: Post-treatment 1 week BCVA

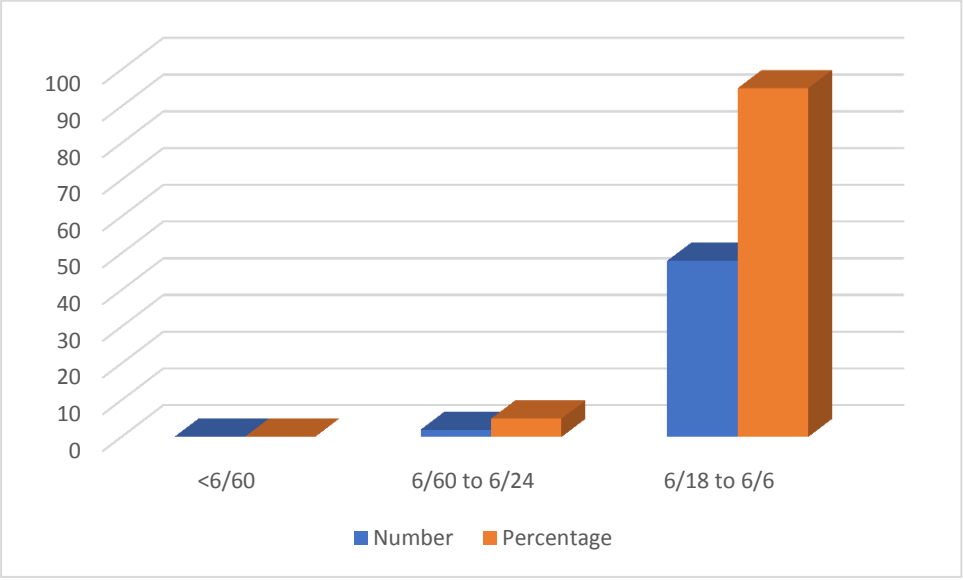


Post-treatment after 1 week: 8% had 6/60 to 6/24 and 92% had 6/18 to 6/6, - After 1 month: 5% had 6/60 to 6/24 and 95% had 6/18 to 6/6.

Table 8: Post-treatment 1 month BCVA

Post-treatment	Number	Percentage
<6/60	0	0
6/60 to 6/24	2	5
6/18 to 6/6	48	95
Total	40	100

Graph 7: Post-treatment 1 month BCVA

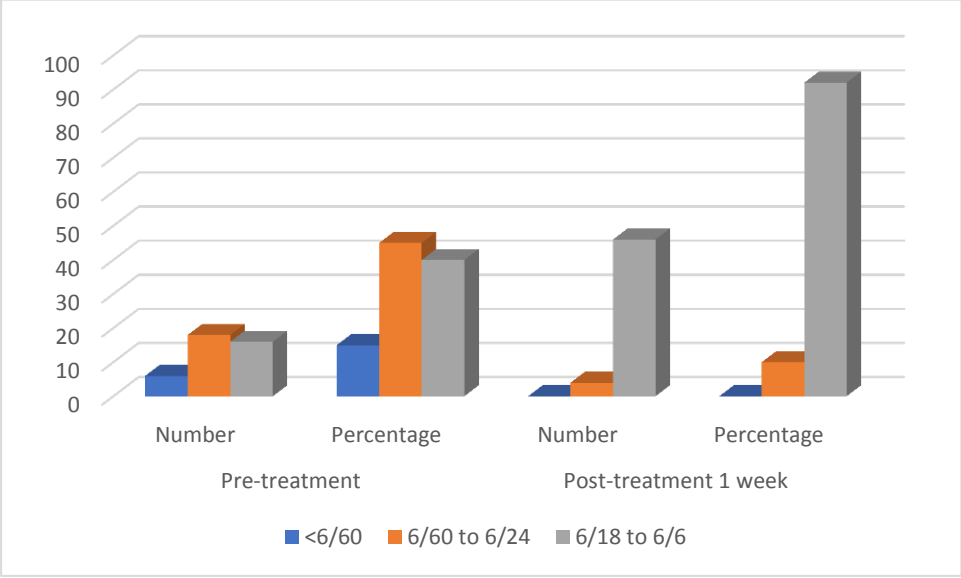


After 1 month: 5% cases had 6/60 to 6/24 and 95% cases had 6/18 to 6/6.

Table 9: Comparison of pre & post-treatment 1 week

Variable	Pre-treatment		Post-treatment 1 week	
	Number	Percentage	Number	Percentage
<6/60	6	15	0	0
6/60 to 6/24	18	45	4	10
6/18 to 6/6	16	40	46	92
Total	40	100	40	100
p-value	0.0001 (Significant)			

Graph 8: Comparison of pre & post-treatment 1 week

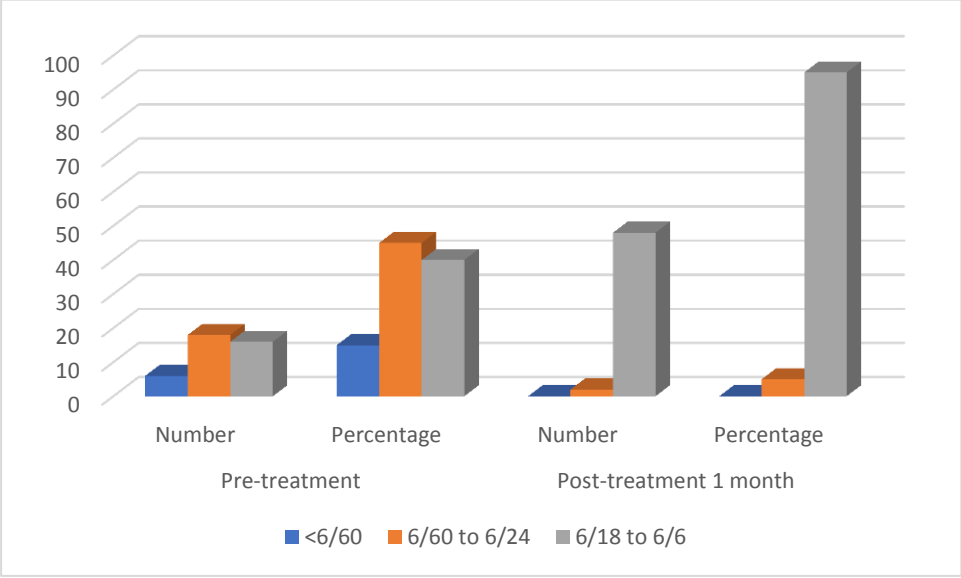


Significant improvement was seen while comparing BCVA at post-treatment 1 week in comparison to pre-treatment.

Table 10: Comparison of pre & post-treatment 1 month

Variable	Pre-treatment		Post-treatment 1 month	
	Number	Percentage	Number	Percentage
<6/60	6	15	0	0
6/60 to 6/24	18	45	2	5
6/18 to 6/6	16	40	48	95
Total	40	100	40	100
p-value	0.0000 (Significant)			

Graph 9: Comparison of pre & post-treatment 1 month

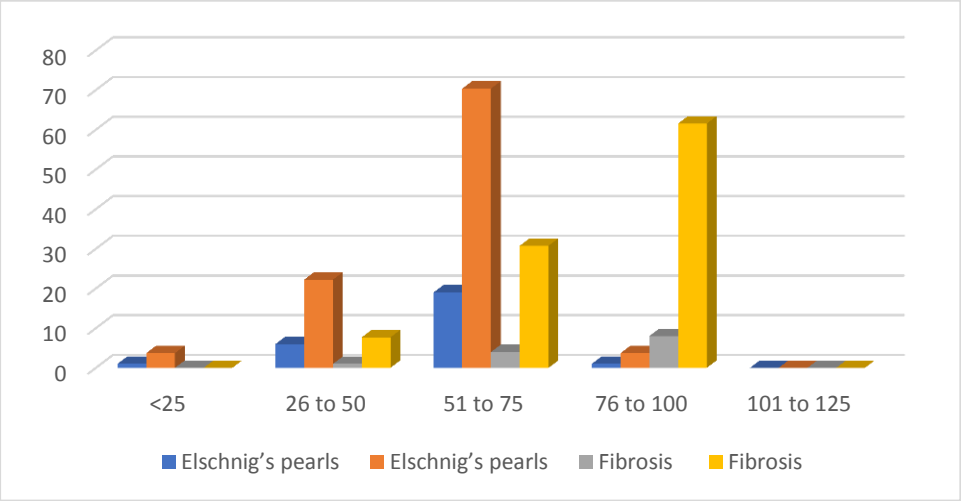


Significant improvement was seen while comparing BCVA at post-treatment 1 month in comparison to pre-treatment.

Table 11 : Energy levels required in different types of PCO

Cumulative laser energy mJ	Elschnig's pearls		Endothelial cell loss / energy	Fibrosis	
	Number	Percentage	Average	Number	Percentage
<25	1	3.70	1895	0	0
26 to 50	6	22.23	2085	1	7.69
51 to 75	19	70.37	2280	4	30.77
76 to 100	1	3.70	2441	8	61.54
101 to 125	0	0	2567	0	0
Total	27	100		13	100
p-value			0.0000 (Significant)		

Graph 10: Energy levels required in different types of PCO

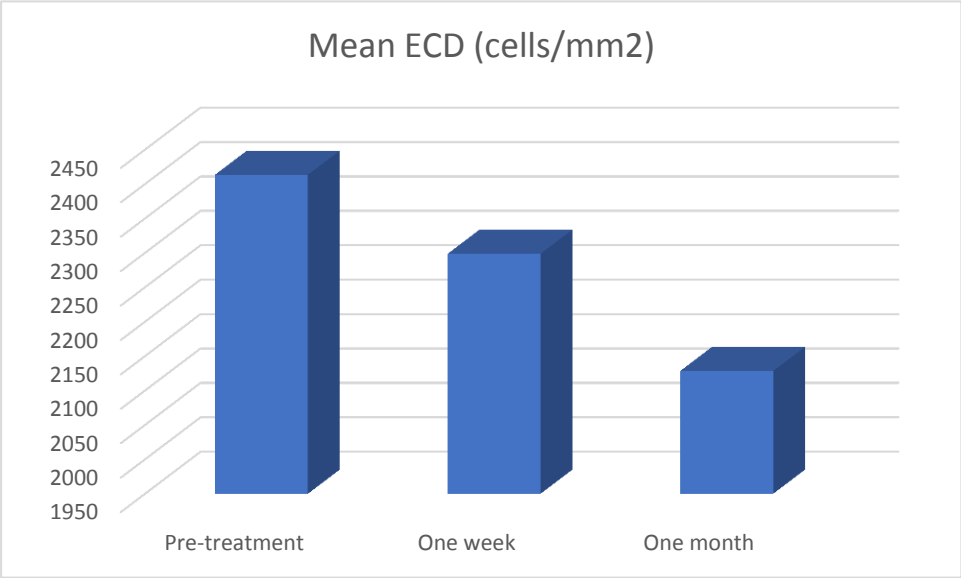


For Elschnig's pearls type PCO, 70.37 percent & 22.23 percent for the eyes required cumulative laser energy of 51 to 75 and 26 to 50 respectively. For fibrosis type of PCO, 30.77 percent and 61.54 percent of the eyes required cumulative laser energy of 51 to 75 and 26 to 50 respectively. Significantly higher cumulative laser energy was needed for eyes with Fibrosis type of PCO in comparison to eyes with Elschnig's pearls type PCO .

Table 12 : Comparison of ECD

Time period	Mean-ECD (cells/mm^2)	SD	p-value
Pre-treatment	2413.3	206.2	0.001 (Significant)
One week	2298.5	213.4	
One month	2128.3	222.9	

Graph 11: Comparison of ECD

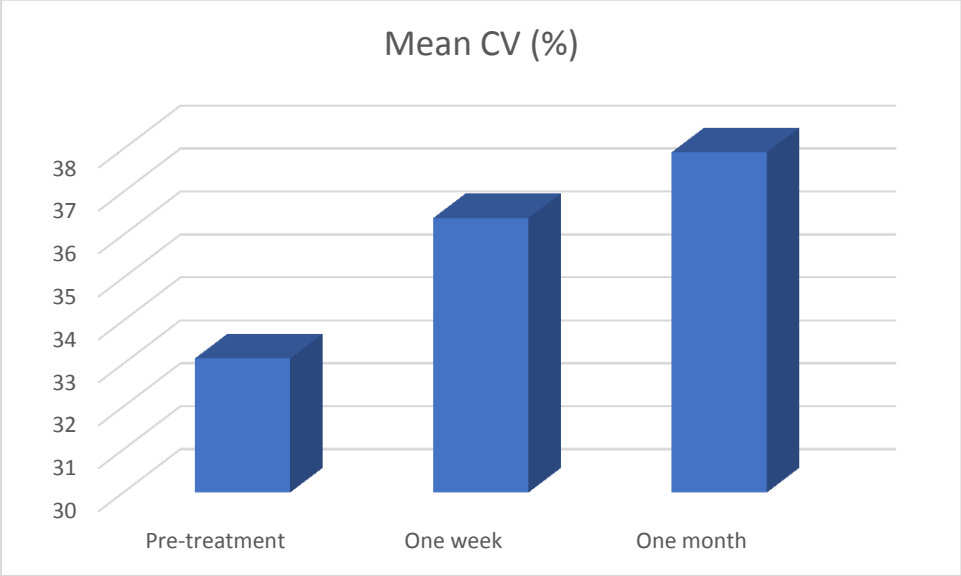


Mean ECD pre-treatment was 2413.3 cells/mm^2. It showed a subsequent significant reduction to 2298.5 cells/mm^2 at one week follow-up and that lowered till 2231.8 cells for every mm^2 & 2199.2 cells for every mm^2 in 1 week & 2128.3cells/mm^{2}at one month follow-up, respectively

Table 13 : Comparison of CV

Time period	Mean CV (%)	SD	p-value
Pre-treatment	33.12	2.3	0.000 (Significant)
One week	36.39	1.5	
One month	37.92	1.9	

Graph 12: Comparison of CV

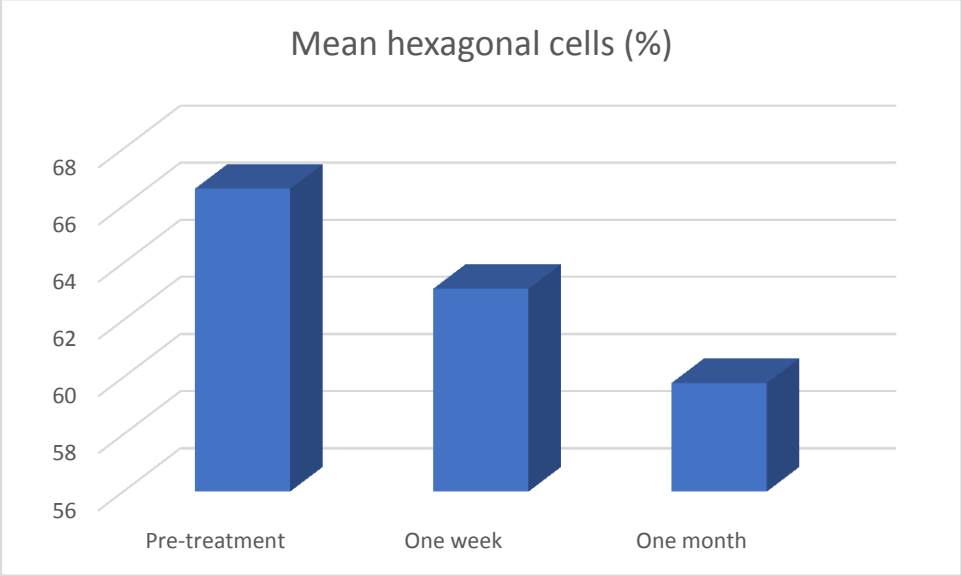


Mean CV at pre-treatment was 33.12 percent. It showed significant enhancement at one week follow-up (36.39 percent) and one month follow-up (37.92 percent).

Table 14 : Comparison of mean hexagonal cells (%)

Time period	Mean hexagonal cells (%)	SD	p-value
Pre-treatment	66.6	2.10	0.000 (Significant)
One week	63.1	1.69	
One month	59.8	1.98	

Graph 13: Comparison of mean hexagonal cells (%)

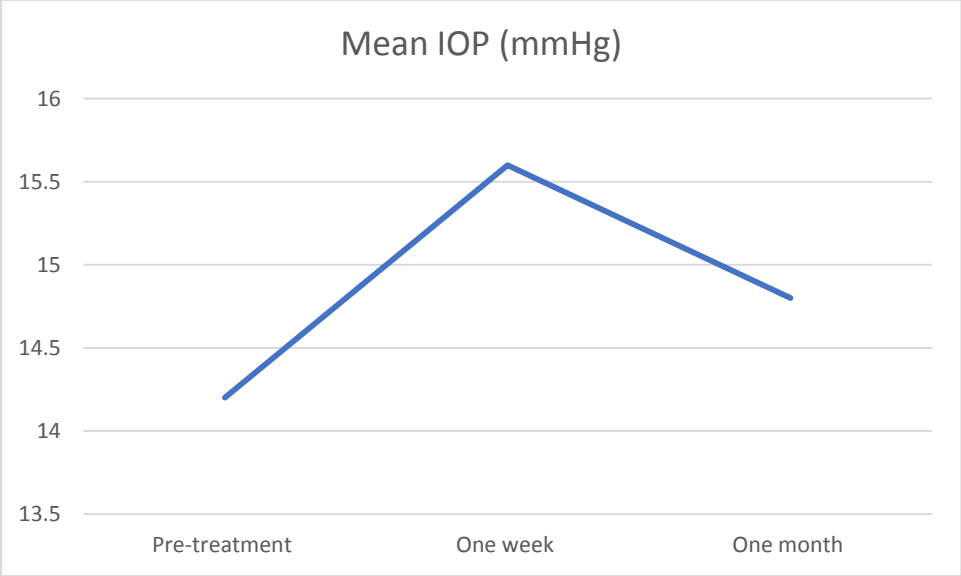


Mean hexagonal cells pre-treatment was 66.6 percent which showed significant reduction at one-week post-treatment (63.3 percent) and at one-month post-treatment (59.8 percent).

Table 15 : Comparison of IOP (mmHg)

Time period	Mean IOP (mmHg)	SD	p-value
Pre-treatment	14.2	0.38	0.000 (Significant)
One week	15.6	0.45	
One month	14.8	0.44	

Graph 14: Comparison of IOP (mmHg)

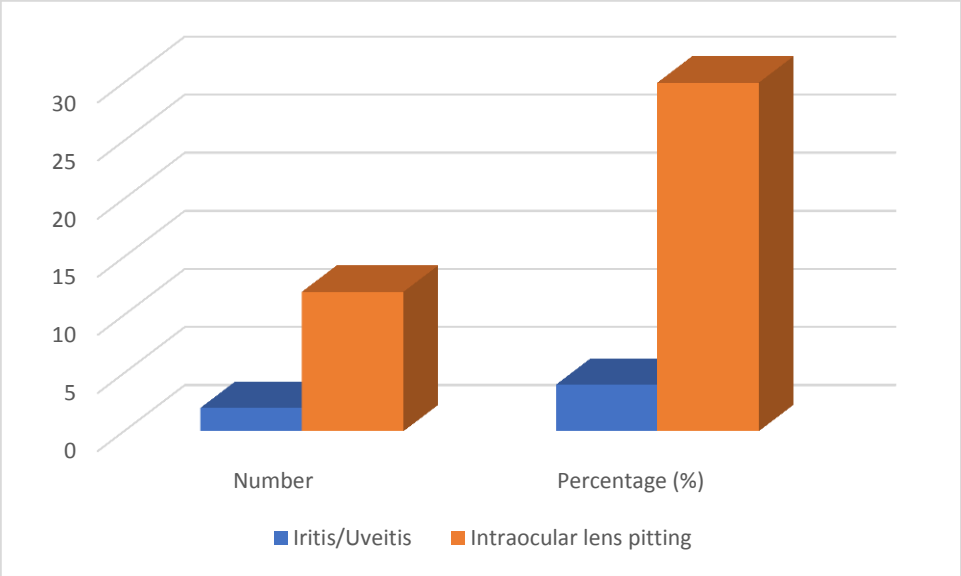


Mean IOP at pre-treatment, 1 week & 1 month was 14.2 mmHg, 15.6 mmHg and 14.8 mmHg correspondingly. Significant outcomes were obtained while comparing mean IOP at one week while returned to normal range at one month follow-up.

Table 16 : Complications

Complications	Number	Percentage (%)
Iritis/Uveitis	2	4
Intraocular lens pitting	12	30

Graph 15: Complications



Iritis/Uveitis and Intraocular lens pitting had been observed among 4% & 30% subjects.

DISCUSSION

DISCUSSION

Cataract surgery is a common ophthalmic procedure that often yields excellent visual outcomes due to advancements in techniques, instruments, and intraocular lens (IOL) technology. However, posterior capsule opacification (PCO) remains a potential late complication. Studies show PCO rates of around twelve percent within one year, around twenty percent by three years, and around twenty-eight percent after five years post-surgery. PCO can cause significant visual disturbances, including decreased acuity, contrast sensitivity, glare, and monocular diplopia. Proper IOL design and placement, such as full contact with the anterior capsule, may help reduce PCO incidence.[5, 23, 55, 56]

PCO is linked to various factors, including diabetes, inflammation, and certain eye conditions. Individuals with diabetes are at higher risk compared to those without diabetes. Research suggests that the type of lens material used in cataract surgery can impact PCO risk, with some materials being more effective at reducing this risk. When PCO significantly impairs vision, a procedure such as laser capsulotomy or surgical intervention may be necessary to restore clarity. Risk factors for Posterior Capsule Opacification (PCO) include diabetes, uveitis, elevated myopia, retinitis pigmentosa, cataracts due to accidents, & abnormality for myotonia, with diabetics being more susceptible. Hydrophobic acrylic lenses have a lower incidence of PCO compared to PMMA and hydrophilic acrylic lenses. When PCO significantly impairs vision, treatment options comprise Nd:YAG laser capsule removal or surgical capsule removal to restore clarity. [23, 55, 56]

Nd:YAG for capsule removal has been highly effective in PCO, and success rate over 95%. This utilises Nd-doped Yad Aluminum Garnet crystal and operates at 1064 nm, disrupting tissue through ionization. While generally safe, potential problems comprises increased IOP, fluid accumulation at cystoid macular, endothelial cell injury, retinal tears, & intraocular lens

damage. Despite these risks, Nd: YAG for capsule removal remains preferred option in case of PCO.[44]

Corneal endothelium has a significant part for sustaining corneal transparency by regulating stromal hydration through an active pumping mechanism, ensuring proper corneal function. Hence; it was conducted for assessing the efficacy of ND:YAG capsulotomy at corneal endothelium at tertiary hospital.

AGE

The majority of patients fell within two age groups: 51-60 years (32.5%) and forty one to fifty yrs (27.5%). Average age had been 51.8 yrs, indicating that middle-aged individuals were predominantly affected. In a comparable investigation carried out by Pathak AH et al, the patient demographic ranged from thirty five to eighty five yrs, with a significant proportion exceeding sixty yrs. This age bracket likely corresponds to the period when individuals with age-related cataracts seek ophthalmological intervention, leading to an increase in cataract surgeries as age progresses.[45] Similarly, Das et al reported a mean age of 59.08 years.[44] Our findings align with those of other studies, which noted mean ages sixty and 58.6 yrs, correspondingly (Prajna NV et al and Jain S et al).[52, 53] Additionally, Samir et al documented average age to be 57.48 yrs.[48]

GENDER

57.5% were males in current research. Similarly, Pathak AH et al, in another similar study reported 23 females (46%) and 27 males (54%). The analysis revealed no notable gender preference among patients who developed posterior capsule opacification (PCO). Cataracts are the main factor responsible for blindness globally & affect both sex. Problems such as PCO manifest with similar ratios regardless of sex.[45] Finding aligns research conducted by

Aslam TM et al., Dharmaraju B et al., & Spalton DJ.[54- 56] Furthermore, a related study by Das et al. indicated that 40% are male & 60% are female.[44] Additionally, Samir et al. found that 35 % male, with remainder being female.[48]

SIDE INVOLVED

Right eye involvement occurred in 62.5 %. Similar investigation performed by Pathak AH et al, the laterality distribution of eyes was right eye in 56 percent & 44 percent in left eyes.[45] Das et al, in another similarly showed right and left eye involvement occurred in 44 % and 56 % subjects correspondingly.[44]

TYPE OF PCO

Elschnig's Pearls type and Fibrosis type 68.5 %and 32.5 % subjects correspondingly. Similarly, Pathak AH et al reported that from total of fifty eyes, thirty four eyes had Elschnig's Pearls type of PCO and sixteen eyes had fibrosis type of PCO.[45]

BCVA

Initially, 15% of patients had BCVA <6/60, 45% had 6/60 to 6/24, and 40% had 6/18 to 6/6. Post-treatment, significant improvements were observed:- After 1 week: 8% had 6/60 to 6/24 and 92% had 6/18 to 6/6, After 1 month: 5% had 6/60 to 6/24 and 95% had 6/18 to 6/6.Comparisons between pre-treatment and post-treatment outcomes at both 1 week and 1 month showed statistically significant improvements in BCVA. Our findings align with those of previous researchers who reported comparable results. Research performed by Pathak AH et al., it was noted that prior to laser treatment, 48% subjects with visual acuity between 6/60 and 6/24, 38% with visual acuity between 6/18 & 6/6, & 14% with visual acuity bad than 6/60. After undergoing Nd:YAG treatment, ninety percent subjects (45 individuals) achieved BCVA of 6/18 or better within seven days and 94% the same level of BCVA after thirty days.

The results were noteworthy, indicating that Nd:YAG capsulotomy effectively enhances BCVA in patients with posterior capsule opacification (PCO) when appropriate refractive correction is applied.[45] Additionally, Dharmaraju B et al. reported a 95% improvement in BCVA among 100 patients that experienced Nd:YAG laser capsulotomy.[55] Furthermore, Das et al. noted that pre-laser VA ranged from 1/60-6/36, with 18% of patients achieving a post-laser VA of 6/12, 8% achieving 6/18, and 4% achieving 6/24 after Nd:YAG laser capsule removal.[44]

Earlier Gardner et al. showed an initial anatomical success rate of 97% among hundred Nd:YAG laser capsule removal. Visual acuity among ninety subjects, remained unaffected for 5, and declined for 5 others. Decline for visual acuity for these 5 subjects had been attributed with the progression of preexisting retinal conditions rather than the capsulotomy itself. Their findings indicated that careful patient assessment and meticulous surgical technique are essential for minimizing complications and achieving optimal outcomes.[57] Similarly, Wasserman EL et al. conducted research involving three hundred sixty seven Nd:YAG laser capsule removal, where 87.5% of patients experienced visual perception improved from 20/30.[58] Additionally, Samir et al. demonstrated a noteworthy enhancement for visual acuity postoperatively, with mean values rising from 0.17 before surgery to 0.61 afterward.[48]

Oztas et al demonstrated that best-corrected visual acuity (BCVA) improved by the one-month follow-up. Here, Nd:YAG laser proved to be efficient for pupillary opening in sixty eyes affected with Posterior Capsular Opacification. Additionally, Hossain et al stated visual outcomes among 500 patients before and after capsulotomy, revealing that 80% of participants experienced an enhancement in visual acuity of ≥6/12.[59, 60]

ENERGY LEVELS REQUIRED IN DIFFERENT TYPES OF PCO :

For Elschnig's pearls type of PCO, 70.37 percent & 22.23 percent for the eyes required cumulative laser energy of 51 to 75 and 26 to 50 respectively. For fibrosis type of PCO, 30.77 percent and 61.54 percent of the eyes required cumulative laser energy of 51 to 75 and 26 to 50 respectively. Significantly higher cumulative laser energy was needed for eyes with Fibrosis type of PCO in comparison to eyes with Elschnig's pearls type PCO. In a comparable investigation carried out by Pathak AH et al., the total cumulative energy necessary for an effective capsulotomy varied between 25 and 110 mJ. The average energy needed for Elschnig Pearls type PCO was fifty four milli Joules, whereas a greater energy requirement of 86 mJ was observed for the fibrous type of PCO. The findings suggest that a higher percentage of patients requiring <50 millijoule of cumulative energy was noted among those with Elschnig Pearls PCO compared to those with Fibrosis PCO. Conversely, a lower percentage of patients needing >75 millijoule of cumulative energy was found in the Elschnig Pearls PCO group relative to the Fibrosis PCO group. These results are statistically significant.[45]

The energy necessary to disrupt the posterior capsule is contingent upon the specific type of posterior capsule opacification (PCO). The fibrotic variant of PCO, being denser, necessitates a greater amount of energy for capsulotomy creation. Pathak AH et al. indicated that the fibrotic type of PCO required an average energy of 86 mJ, which is considerably higher than the 50 millijoule average energy needed for the Elschnig's Pearls type of PCO.[45] In a prior investigation conducted by Rajappa N et al., the average energy required for the fibrotic type of PCO was found to be 63.43 mJ, while for the Elschnig's Pearls type, it was 51.22 millijoule.[34] Additionally, Agarwal G et al. reported that significantly greater average energy was necessary for the fibrotic type of PCO compared to the Elschnig's Pearls type.[11]

COMPARISON OF ECD :

Mean ECD pre-treatment was 2413.3 cells/mm^2. It showed a subsequent significant reduction to 2298.5 cells/mm^2 at one week follow-up and which further reduced to 2231.8 cells/mm^2 & 2199.2 cells/mm^2at 1 week & 2128.3cells/mm^2at 1 month follow-up, correspondingly. Out results were in concordance with the results obtained by previous authors who also reported similar findings. In the research performed by Pathak AH et al., the mean endothelial cell density (ECD) prior to laser treatment was recorded at 2356.76 cells/square millimeter, which subsequently declined to 2231.8 cells/ square millimeter & 2199.2 cells/ square millimeter at 1 week and one month follow-ups, respectively. The findings demonstrated a statistically significant decrease in ECD from the prelaser measurement to the one-month follow-up. This notable reduction in ECD & hexagonality from the pre-laser state to 1 month can be linked to diminished activity of the Na/K-ATPase pump in the endothelial cells, leading to a reduction in cell count & alterations in cell structure over time.[45] A comparable investigation by Rajappa N et al. noted a mean ECD of 2298.7 cells/mm^2 prior to laser intervention, which decreased to 2178.1 cells/mm^2 at 1 week & 2121.3 cells/mm^2 at 12 weeks post-Nd:YAG Laser Capsulotomy. The significant variation in ECD observed prior & following laser treatment aligns with the results of our study.[34] Additionally, Wasserman EL et al. reported findings from a research involving 367 Nd:YAG laser posterior capsulotomies, indicating an average corneal endothelial cell loss of 7%, equating to 115 cells/square millimeter.[58]

In a related investigation conducted by Allan et al., the central corneal endothelial cell counts were assessed. The average endothelial cell density (ECD) prior to laser treatment was recorded at 1,840 cells/square millimeter, while the post-laser count was noted at 1,798 cells/mm^2.[61] Additionally, a separate study by Qasim KF and Hasanain AR reported a mean ECD of 2,047 cells/mm^2 before Nd:YAG Laser Capsulotomy, which reduced to 1,938

cells/square millimeter after one week and further to 1,916 cells/mm² after one month. The change in mean ECD from the pre-laser measurement to one week post-treatment was not statistically significant; however, the difference observed from pre-laser to one month post-treatment was significant.[40] These results align with those of the current study. Kanchanaranya N & Sonthirathi S examined 41 patients with posterior capsule opacification (PCO) and found that the mean ECD prior to laser intervention was 2,213 cells/mm², which subsequently decreased to 2,177 cells/square millimeter at one month and increased to 2,237 cells/mm² at three months post-laser. There exists considerable variability in the absolute number of endothelial cells lost following Nd:YAG laser capsulotomy, which may be attributed to various factors including the precision of the technician's endothelial cell measurements, the distance between the target tissue & the endothelium, variations in laser energy delivery, and the time elapsed from cataract operation to Nd:YAG laser capsulotomy.[12] Therefore, further research is warranted to elucidate the significance of these factors.

COMPARISON OF CV :

Mean CV at pre-treatment was 33.12 percent. It showed significant enhancement at one week follow-up (36.39 percent) and one month follow-up (37.92 percent). Our results were in concordance with Pathak AH et al who also reported same results. In their research, the average coefficient of variation (CV) prior to the laser treatment was recorded at 33.74%. Following the procedure, the CV rose to 35.58% after one week and further increased to 37.22% at the one-month follow-up. This indicates a consistent rise in CV from the pre-laser measurement to the one-month assessment, which was found to be statistically significant. The coefficient of variation serves as an indicator of the variability in the sizes of endothelial cells, commonly referred to as polymegathism. By evaluating the size variation among

endothelial cells, we can ascertain the extent of cell loss occurring. Another study indicated a mean baseline CV of 33.7, which increased to 34.3 at one week and 34.5 at the 12-week mark (Rajappa N et al).[34, 45]

COMPARISON OF MEAN HEXAGONAL CELLS (%) :

Mean hexagonal cells pre-treatment was 66.6 percent which showed significant reduction at one-week post-treatment (63.3 percent) and at one-month post-treatment (59.8 percent) (p-value < 0.05). In alignment with our research, Pathak AH et al. demonstrated that the average hexagonality at baseline was 65.34%, which subsequently declined to 62.02% after one week and further to 60.42% at the one-month follow-up. Pleomorphism signifies a notable alteration in the typical hexagonal configuration of the endothelium, leading to a reduction in the stability of the endothelial mosaic. Consequently, hexagonality serves as the primary cell shape within a healthy corneal endothelium.[45] Similarly, Rajappa N et al. reported a pre-laser mean hexagonality of 72.22%, which decreased to 71.42% at one week, a change that was statistically significant and aligns with our findings.[34]

IOP :

Mean IOP at pre-treatment, one week and one month was 14.2 mmHg, 15.6 mmHg and 14.8 mmHg respectively. Significant results were obtained while comparing mean IOP at one week while returned to normal range at one month. Similar to our study, Sırakaya et al also observed a statistically significant increment in the IOP levels on postop day 1 and postop 1 week. On month follow-up, there was no significant difference in terms of IOP change.

COMPLICATIONS :

Iritis/Uveitis and Intraocular lens pitting was seen in 4% & 6% of the patients respectively. In a same investigation performed by Das et al, Iritis/Uveitis and Intraocular lens pitting was seen in 10% & 30% of the patients correspondingly on day 1 post-treatment.[44]

Research indicates that complications arising from Nd:YAG laser posterior capsulotomy, such as corneal damage, iritis, and lens pitting, occurred in 20% of cases, while CME was observed in 2% of instances. Additional complications included RD & endophthalmitis (Khanzada MA et al, Waseem et al). It is important to note that these complications may not be directly linked to the YAG laser procedure itself, but could result from factors such as surgical techniques and individual patient responses.[63, 64]

In the research conducted by Rajappa N et al., the authors assessed the alterations in corneal endothelial cells prior to and following Nd:YAG laser posterior capsulotomy in adult patients suffering from posterior capsular opacification (PCO). Their findings revealed a substantial enhancement in visual acuity post-laser capsulotomy; however, a notable decrease in endothelial cell density (ECD) was also observed. While Nd:YAG laser capsulotomy is recognized for its non-invasive nature and efficacy in treating PCO, it poses a risk of potential damage to the corneal endothelium due to laser exposure.[34]

The loss of endothelial cells resulting from Nd:YAG laser capsulotomy is directly related to the amount of energy applied during the procedure. This study emphasizes the importance of assessing the corneal endothelium through Specular Microscopy for every patient undergoing Nd:YAG capsulotomy. Furthermore, optimizing energy usage can significantly reduce endothelial cell loss, thereby mitigating corneal endothelial damage.

CONCLUSION

CONCLUSION

- Cataract surgery is a highly effective procedure for restoring vision. However, posterior capsular opacification (PCO) remains a potential late complication that can impact post-operative vision. PCO can develop months or years after surgery, causing vision problems. Treatment typically involves Nd:YAG laser capsulotomy, a safe and efficient procedure that creates an opening in the cloudy posterior capsule, restoring vision.
- The Nd:YAG laser capsulotomy is a non-invasive method for the treatment of PCO. However, it is not devoid of complications and can cause damage to the corneal endothelial cells. There is a significant decrease in corneal ECD, change in hexagonality of cells, following Nd:YAG laser capsulotomy along with transient alteration in IOP.
- Hence, in order to reduce the damage to corneal endothelial cells, it is necessary to minimize the laser energy delivered in the eye as much as possible along with ensuring that the posterior capsule is accurately focused and the eye is stabilized by using a contact lens during the procedure.
- However; further studies are recommended for better exploration of results.

SUMMARY

SUMMARY

The present study was conducted for assessing the effect of ND:YAG laser capsulotomy on corneal endothelium at tertiary hospital.

- 32.5% of the patients belonged to the age group of 51 to 60 years while 27.5% of the patients belonged to the age group of 41 to 50 years. Mean age of the patients was 51.8 years.
- 57.5% of the patients were males.
- Right eye involvement occurred in 62.5% of the patients.
- Elschnig's Pearls type and Fibrosis type was seen in 68.5 percent and 32.5 percent of the patients respectively.
- Pre-treatment BCVA was <6/60, 6/60 to 6/24 and 6/18 to 6/6 in 15%, 45% & 40% of the patients respectively. After one-week post-treatment, BCVA was 6/60 to 6/24 and 6/18 to 6/6 in 8 percent and 92 percent of the patients respectively. After one-month post-treatment, BCVA was 6/60 to 6/24 and 6/18 to 6/6 in 5% & 95% of the patients correspondingly. While comparing between pre & post-treatment 1-week, significant improvement in BCVA was seen. Also, while comparing between pre-treatment and post-treatment 1-month, significant improvement in BCVA was seen.
- For Elschnig's pearls type of PCO, 70.37 percent and 22.23 percent of the eyes required cumulative laser energy of 51 to 75 & 26 to 50 respectively. For fibrosis type of PCO, 30.77 percent and 61.54 percent of the eyes required cumulative laser energy of 51 to 75 and 26 to 50 respectively. Significantly higher cumulative laser energy was needed for eyes with Fibrosis type of PCO in comparison to eyes with Elschnig's pearls type PCO.
- Mean ECD pre-treatment was 2413.3 cells/mm^2. It showed a subsequent significant reduction to 2298.5 cells/mm3 at one week follow-up and which further decreased to 2231.8 cells/mm^2 and 2199.2 cells/mm^2 at one week and 2128.3 cells/mm^2 at one month follow-up, respectively.

- Mean CV at pre-treatment was 33.12 percent. It showed significant enhancement at one week follow-up (36.39 percent) and one month follow-up (37.92 percent).
- Mean hexagonal cells pre-treatment was 66.6 percent which showed significant reduction at one-week post-treatment (63.3 percent) and at one-month post-treatment (59.8 percent) (p-value < 0.05).
- Mean IOP at pre-treatment, one week and one month was 14.2 mmHg, 15.6 mmHg and 14.8 mmHg respectively. Significant results were obtained while comparing mean IOP at one week while returned to normal range at one month follow-up.
- Iritis/Uveitis and Intraocular lens pitting was seen in 4% & 6 % of the patients correspondingly.

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ANNEXURE

ANNEXURE- I

CASE PROFORMA

CASE PROFORMA	
Name:	Case No:
Age:	Date:
Sex:	OP No:
Occupation:	DOE:
Address:	

Chief complaints:

H/O presenting illness:

Past history:

DM / HTN / BA / Epilepsy

Family history:

Personal history:

Appetite – Sleep – Bowel –

Diet – Habits – Bladder –

GPE:

Pallor / Edema /Icterus / Cyanosis / Clubbing / Lymphadenopathy

Vital signs:

a. Pulse – c) RR –

b. BP – d) Temp –

Systemic examination:

a. CVS – c. RS –

b. PA – d. CNS –

OCULAR EXAMINATION		
TESTS	**RE**	**LE**
HEAD POSTURE OCULAR POSTURE FACIAL SYMMETRY		
EXTRAOCULAR MOVEMENTS Ductions Versions		
VISUAL ACUITY: Distant Near		
ANTERIOR SEGMENT		
FUNDUS Distant direct ophthalmoscopy Direct ophthalmoscopy Indirect ophthalmoscopy		

SPECULAR MICROSCOPY: 1. ECD 2. HEXAGONALITY(%) 3. POLYMEGATHISM		
IOP by GOLDMANN APPLANATION TONOMETRY		

ANNEXURE- II

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH,

TAMAKA, KOLAR - 563101

PATIENT INFORMATION SHEET

This information is to help you understand the purpose of the study "**EFFECT OF NEODYMIUM : YTTRIUM ALUMINIUM GARNET (ND:YAG) LASER CAPSULOTOMY ON CORNEAL ENDOTHELIUM AT TERTIARY HOSPITAL , KOLAR** ". You are invited to take part voluntarily in this research study, it is important that you read and understand the purpose, procedure, benefits and discomforts of the study.

After cataract surgery , many of the cases develop Posterior capsular opacification (PCO) , which is the most common complication . This PCO causes significant degree of diminision of vision or decrease in visual acuity in patients after certain months or years leading them with same complaints to Out patient department.

Nd:YAG laser capsulotomy is by far the most successful and commonly employed procedure for resolving this post-op complication of cataract . Laser capsulotomy uses a quick-pulsed Nd:YAG laser to apply a series of focal ablations in the posterior capsule and create a small circular opening in the visual axis . Thus , giving the patient a better vision .

YAG laser capsulotomy is generally a very safe procedure. However, there are some risks and side-effects which includes an increase in floaters, raised intraocular pressure, inflammation, haloes/glare, lens damage, retinal tear/detachment ,corneal endothelial destruction .

Hence , this study is to assess the degree of damage to corneal endothelial cell count and morphology after the ND:YAG laser procedure , by observing the patients through specular microscopy for corneal endothelial cell density and morphology .

If you are willing to take part in this study, you need to give clinical information and following procedures will be carried out:

1. Visual acuity by Snellens chart for distant vision .
2. Near vision – jaeger chart.
3. Slit lamp biomicroscopy.
4. Fundus examination by 90D slit lamp biomicroscopy and indirect ophthalmoscopy, including optic disc evaluation.
5. ECD, Hexagonality(%),Polymegathism by Tomey's Non contact Specular Microscopy.
6. Intra ocular Pressure (IOP) by Goldmann applanation tonometry

You will not be charged for any of the tests. All the expenditures in the study will be borne by the principle investigator . All the tests are routine tests and absolutely no risks are associated with various investigations.

If during the procedure, any unexpected event occurs like redness of eyes, itching, blurring due to any drops , Doctor will take care of it.

If you participate in the study, the generated data might be helpful for further treatment protocol or to avoid complications. The collected data will be used for presentation in medical conferences and personal identity of the patient will not be revealed. Your original records may be reviewed by your doctor or ethics review board.

You may refuse to take part in the study or you may stop your participation in the study at any time, without a penalty to which you were otherwise entitled before taking part in this study.

Extra monetary benefits or money will not be paid for taking part in the study.

For further information/ clarification please contact

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ಶ್ರೀ ದೇವರಾಜ್ ಯುಆರ್ಎಸ್ ಅಕಾಡೆಮಿ ಆಫ್ ಹೈಯರ್ ಎಜುಕೇಶನ್ ಅಂಡ್ ರಿಸರ್ಚ್, ತಮಕಾ,

ಕೋಲಾರ್ - 563101

ರೋಗಿಯ ಮಾಹಿತಿ ಪತ್ರ

ಈ ಮಾಹಿತಿಯು "ಕೋಲಾರದ ತೃತೀಯ ಆಸ್ಪತ್ರೆಯಲ್ಲಿ ಕಾರ್ನಿಯಲ್ ಎಂಡೋಥೆಲಿಯಂ ಮೇಲೆ ನಿಯೋಡಿಮಿಯಂ ಪರಿಣಾಮ: YTTRIUM ಅಲ್ಯೂಮಿನಿಯಂ ಗಾರ್ನೆಟ್ (ND:YAG) ಲೇಸರ್ ಕ್ಯಾಪ್ಸುಲೋಟಮಿ" ಅಧ್ಯಯನದ ಉದ್ದೇಶವನ್ನು ಅರ್ಥಮಾಡಿಕೊಳ್ಳಲು ನಿಮಗೆ ಸಹಾಯ ಮಾಡುತ್ತದೆ. ಈ ಸಂಶೋಧನಾ ಅಧ್ಯಯನದಲ್ಲಿ ಸ್ವಯಂಪ್ರೇರಣೆಯಿಂದ ಪಾಲ್ಗೊಳ್ಳಲು ನಿಮ್ಮನ್ನು ಆಹ್ವಾನಿಸಲಾಗಿದೆ, ಅಧ್ಯಯನದ ಉದ್ದೇಶ, ಕಾರ್ಯವಿಧಾನ, ಪ್ರಯೋಜನಗಳು ಮತ್ತು ಅನಾನುಕೂಲತೆಗಳನ್ನು ನೀವು ಓದುವುದು ಮತ್ತು ಅರ್ಥಮಾಡಿಕೊಳ್ಳುವುದು ಬಹಳ ಮುಖ್ಯ. ಕಣ್ಣಿನ ಪೊರೆ ಶಸ್ತ್ರಚಿಕಿತ್ಸೆಯ ನಂತರ, ಅನೇಕ ಪ್ರಕರಣಗಳು ಹಿಂಭಾಗದ ಕ್ಯಾಪ್ಸುಲರ್ ಒಪಾಸಿಫಿಕೇಷನ್ (ಪಿಸಿಒ) ಅನ್ನು ಅಭಿವೃದ್ಧಿಪಡಿಸುತ್ತವೆ, ಇದು ಅತ್ಯಂತ ಸಾಮಾನ್ಯ ತೊಡಕಾಗಿದೆ. ಈ ಪಿಸಿಒ ಕೆಲವು ತಿಂಗಳುಗಳು ಅಥವಾ ವರ್ಷಗಳ ನಂತರ ರೋಗಿಗಳಲ್ಲಿ ದೃಷ್ಟಿಯ ಕ್ಷೀಣತೆ ಅಥವಾ ದೃಷ್ಟಿ ತೀಕ್ಷ್ಣತೆಯ ಇಳಿಕೆಗೆ ಕಾರಣವಾಗುತ್ತದೆ, ಇದು ಹೊರ ರೋಗಿಗಳ ವಿಭಾಗಕ್ಕೆ ಅದೇ ದೂರುಗಳನ್ನು ನೀಡುತ್ತದೆ.

ವೈಎಜಿ ಲೇಸರ್ ಕ್ಯಾಪ್ಸುಲೋಟಮಿ ಕಣ್ಣಿನ ಪೊರೆಯ ಈ ಶಸ್ತ್ರಚಿಕಿತ್ಸೆಯ ನಂತರದ ತೊಡಕನ್ನು ಪರಿಹರಿಸಲು ಅತ್ಯಂತ ಯಶಸ್ವಿ ಮತ್ತು ಸಾಮಾನ್ಯವಾಗಿ ಬಳಸಲಾಗುವ ಕಾರ್ಯವಿಧಾನವಾಗಿದೆ. ಲೇಸರ್ ಕ್ಯಾಪ್ಸುಲೋಟಮಿ ಹಿಂಭಾಗದ ಕ್ಯಾಪ್ಸ್ಯೂಲ್ನಲ್ಲಿ ಫೋಕಲ್ ಅಬ್ಲೇಶನ್ಗಳ ಸರಣಿಯನ್ನು ಅನ್ವಯಿಸಲು ಮತ್ತು ದೃಶ್ಯ ಅಕ್ಷದಲ್ಲಿ ಸಣ್ಣ ವೃತ್ತಾಕಾರದ ತೆರೆಯುವಿಕೆಯನ್ನು ರಚಿಸಲು ತ್ವರಿತ-ನಾಡಿಮಿಡಿತ ಎನ್ಡಿ: ವೈಎಜಿ ಲೇಸರ್ ಅನ್ನು ಬಳಸುತ್ತದೆ. ಹೀಗಾಗಿ, ರೋಗಿಗೆ ಉತ್ತಮ ದೃಷ್ಟಿಯನ್ನು ನೀಡುತ್ತದೆ. ವೈಎಜಿ ಲೇಸರ್ ಕ್ಯಾಪ್ಸುಲೋಟಮಿ ಸಾಮಾನ್ಯವಾಗಿ ಬಹಳ ಸುರಕ್ಷಿತ ಕಾರ್ಯವಿಧಾನವಾಗಿದೆ. ಆದಾಗ್ಯೂ, ಫ್ಲೋಟರ್ ಗಳ ಹೆಚ್ಚಳ, ಹೆಚ್ಚಿದ ಕಣ್ಣಿನೊಳಗಿನ ಒತ್ತಡ, ಉರಿಯೂತ, ಹ್ಯಾಲೋಸ್ / ಗ್ಲೇರ್, ಲೆನ್ಸ್ ಹಾನಿ, ರೆಟಿನಾ ಕಣ್ಣೀರು / ನಿರ್ಲಿಪ್ತತೆ, ಕಾರ್ನಿಯಲ್ ಎಂಡೋಥೆಲಿಯಲ್ ನಾಶ ಸೇರಿದಂತೆ ಕೆಲವು ಅಪಾಯಗಳು ಮತ್ತು ಅಡ್ಡಪರಿಣಾಮಗಳು ಇವೆ. ಆದ್ದರಿಂದ, ಈ ಅಧ್ಯಯನವು ಕಾರ್ನಿಯಲ್ ಎಂಡೋಥೆಲಿಯಲ್ ಕೋಶ ಸಾಂದ್ರತೆ ಮತ್ತು ರೂಪವಿಜ್ಞಾನಕ್ಕಾಗಿ ಸ್ಪೆಕ್ಯುಲರ್ ಮೈಕ್ರೋಸ್ಕೋಪಿ ಮೂಲಕ ರೋಗಿಗಳನ್ನು ಗಮನಿಸುವ ಮೂಲಕ ಎನ್ಡಿ: ವೈಎಜಿ ಲೇಸರ್ ಕಾರ್ಯವಿಧಾನದ ನಂತರ ಕಾರ್ನಿಯಲ್ ಎಂಡೋಥೆಲಿಯಲ್ ಕೋಶ ಎಣಿಕೆ ಮತ್ತು ರೂಪವಿಜ್ಞಾನಕ್ಕೆ ಹಾನಿಯ ಪ್ರಮಾಣವನ್ನು ನಿರ್ಣಯಿಸುತ್ತದೆ.

ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಪಾಲ್ಗೊಳ್ಳಲು ನೀವು ಸಿದ್ಧರಿದ್ದರೆ, ನೀವು ವೈದ್ಯಕೀಯ ಮಾಹಿತಿಯನ್ನು ನೀಡಬೇಕಾಗುತ್ತದೆ ಮತ್ತು ಈ ಕೆಳಗಿನ ಕಾರ್ಯವಿಧಾನಗಳನ್ನು ಕೈಗೊಳ್ಳಲಾಗುವುದು:

1.ದೂರದ ದೃಷ್ಟಿಗಾಗಿ ಸ್ನೆಲೆನ್ಸ್ ಚಾರ್ಟ್ ನಿಂದ ದೃಶ್ಯ ತೀಕ್ಷ್ಣತೆ.

2.ಹತ್ತಿರದ ದೃಷ್ಟಿ - ಜೇಗರ್ ಚಾರ್ಟ್.

3.ಸ್ಲಿಟ್ ಲ್ಯಾಂಪ್ ಬಯೋಮೈಕ್ರೊಸ್ಕೋಪಿ.

4.ಆಪ್ಟಿಕ್ ಡಿಸ್ಕ್ ಮೌಲ್ಯಮಾಪನ ಸೇರಿದಂತೆ 90 ಡಿ ಸ್ಲಿಟ್ ಲ್ಯಾಂಪ್ ಬಯೋಮೈಕ್ರೊಸ್ಕೋಪಿ ಮತ್ತು ಪರೋಕ್ಷ ನೇತ್ರಶಾಸ್ತ್ರದ ಮೂಲಕ ಫಂಡಸ್ ಪರೀಕ್ಷೆ.

5.ECD, Hexagonality(%), Specular Microscopy ಮೂಲಕ ಪಾಲಿಮೆಗಥಿಸಂ.

6. ಗೋಲ್ಡ್ಮನ್ ಅಪ್ಲನೇಷನ್ ಟೋನೊಮೆಟ್ರಿಯಿಂದ ಇಂಟ್ರಾ ಒಕ್ಯುಲರ್ ಪ್ರೆಶರ್ (ಐಒಪಿ)

ಯಾವುದೇ ಪರೀಕ್ಷೆಗಳಿಗೆ ನಿಮಗೆ ಶುಲ್ಕ ವಿಧಿಸಲಾಗುವುದಿಲ್ಲ. ಅಧ್ಯಯನದಲ್ಲಿನ ಎಲ್ಲಾ ವೆಚ್ಚಗಳನ್ನು ಪ್ರಧಾನ ಪರಿಶೋಧಕರು ಭರಿಸುತ್ತಾರೆ. ಎಲ್ಲಾ ಪರೀಕ್ಷೆಗಳು ವಾಡಿಕೆಯ ಪರೀಕ್ಷೆಗಳಾಗಿವೆ ಮತ್ತು ವಿವಿಧ ತನಿಖೆಗಳೊಂದಿಗೆ ಯಾವುದೇ ಅಪಾಯಗಳಿಲ್ಲ. ಕಾರ್ಯವಿಧಾನದ ಸಮಯದಲ್ಲಿ, ಕಣ್ಣುಗಳು ಕೆಂಪಾಗುವುದು, ತುರಿಕೆ, ಯಾವುದೇ ಹನಿಗಳಿಂದಾಗಿ ಮಸುಕಾಗುವಿಕೆಯಂತಹ ಯಾವುದೇ ಅನಿರೀಕ್ಷಿತ ಘಟನೆ ಸಂಭವಿಸಿದರೆ, ವೈದ್ಯರು ಅದನ್ನು ನೋಡಿಕೊಳ್ಳುತ್ತಾರೆ. ನೀವು ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಿದರೆ, ಉತ್ಪತ್ತಿಯಾದ ಡೇಟಾವು ಹೆಚ್ಚಿನ ಚಿಕಿತ್ಸಾ ಪ್ರೋಟೋಕಾಲ್ ಗೆ ಅಥವಾ ತೊಡಕುಗಳನ್ನು ತಪ್ಪಿಸಲು ಸಹಾಯಕವಾಗಬಹುದು. ಸಂಗ್ರಹಿಸಿದ ಡೇಟಾವನ್ನು ವೈದ್ಯಕೀಯ ಸಮ್ಮೇಳನಗಳಲ್ಲಿ ಪ್ರಸ್ತುತಪಡಿಸಲು ಬಳಸಲಾಗುತ್ತದೆ ಮತ್ತು ರೋಗಿಯ ವೈಯಕ್ತಿಕ ಗುರುತನ್ನು ಬಹಿರಂಗಪಡಿಸಲಾಗುವುದಿಲ್ಲ. ನಿಮ್ಮ ಮೂಲ ದಾಖಲೆಗಳನ್ನು ನಿಮ್ಮ ವೈದ್ಯರು ಅಥವಾ ನೈತಿಕ ಪರಿಶೀಲನಾ ಮಂಡಳಿಯು ಪರಿಶೀಲಿಸಬಹುದು. ನೀವು ಅಧ್ಯಯನದಲ್ಲಿ ಪಾಲ್ಗೊಳ್ಳಲು ನಿರಾಕರಿಸಬಹುದು ಅಥವಾ ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸುವ ಮೊದಲು ನೀವು ಅರ್ಹರಾಗಿದ್ದ ದಂಡವಿಲ್ಲದೆ ಯಾವುದೇ ಸಮಯದಲ್ಲಿ ಅಧ್ಯಯನದಲ್ಲಿ ನಿಮ್ಮ ಭಾಗವಹಿಸುವಿಕೆಯನ್ನು ನಿಲ್ಲಿಸಬಹುದು. ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸುವುದಕ್ಕಾಗಿ ಹೆಚ್ಚುವರಿ ವಿತ್ತೀಯ ಪ್ರಯೋಜನಗಳು ಅಥವಾ ಹಣವನ್ನು ಪಾವತಿಸಲಾಗುವುದಿಲ್ಲ. ಹೆಚ್ಚಿನ ಮಾಹಿತಿ/ ಸ್ಪಷ್ಟೀಕರಣಕ್ಕಾಗಿ ದಯವಿಟ್ಟು ಸಂಪರ್ಕಿಸಿ :

ಡಾ. ಸಂಜನಾ ಕೆ.ಪಿ.

ಪೋಸ್ಟ್ ಗ್ರಾಜುಯೇಟ್

ಎಸ್ ಡಿ ಯು ಎಂ ಸಿ

ಟಮಕ, ಕೋಲಾರ

ಸಂಪರ್ಕ ಸಂಖ್ಯೆ: 8660627486

ಡಾ.ಉಷಾ ಬಿ.ಆರ್.

ಪ್ರೊಫೆಸರ್, ನೇತ್ರಶಾಸ್ತ್ರ ವಿಭಾಗ,

ಶ್ರೀ ದೇವರಾಜ ಅರಸು ಅಕಾಡೆಮಿ ಆಫ್ ಹೈಯರ್ ಎಜುಕೇಶನ್ ಅಂಡ್ ರಿಸರ್ಚ್, ತಮಕ, ಕೋಲಾರ - 563101.

ANNEXURE- III

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

INFORMED CONSENT FORM

Case no:

IP no:

TITLE: EFFECT OF ND:YAG LASER CAPSULOTOMY ON CORNEAL ENDOTHELIUM AT A TERTIARY HOSPITAL KOLAR

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

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

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

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

Participation in this study does not involve any extra cost to me.

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

ಶ್ರೀ ದೇವರಾಜ್ ಯುಆರ್ಎಸ್ ಅಕಾಡೆಮಿ ಆಫ್ ಹೈಯರ್ ಎಜುಕೇಶನ್ ಅಂಡ್ ರಿಸರ್ಚ್, ತಮಕಾ, ಕೋಲಾರ್ - 563101.

ತಿಳಿವಳಿಕೆಯ ಸಮ್ಮತಿ ನಮೂನೆ

ಪ್ರಕರಣ ಸಂಖ್ಯೆ: ಐಪಿ ಸಂಖ್ಯೆ:

ಶೀರ್ಷಿಕೆ: ಕೋಲಾರದ ತೃತೀಯ ಆಸ್ಪತ್ರೆಯಲ್ಲಿ ಕಾರ್ನಿಯಲ್ ಎಂಡೋಥೆಲಿಯಂ ಮೇಲೆ ಎನ್ಡಿ: ಯಾಗ್ ಲೇಸರ್ ಕ್ಯಾಪ್ಸುಲೋಟೋಮಿಯ ಪರಿಣಾಮ

ನಾನು, ಅಂಗೀಕರಿಸಿದ, ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಪಾಲ್ಗೊಳ್ಳಲು ಮತ್ತು ಈ ಸಮ್ಮತಿಯ ರೂಪದಲ್ಲಿ ವಿವರಿಸಿರುವಂತೆ ವೈಯಕ್ತಿಕ ಮಾಹಿತಿಯ ಸಂಗ್ರಹ ಮತ್ತು ಬಹಿರಂಗಪಡಿಸುವಿಕೆಯನ್ನು ಅನುಮೋದಿಸಲು ಒಪ್ಪುತ್ತೇನೆ.

ಈ ಅಧ್ಯಯನದ ಉದ್ದೇಶ, ತಂತ್ರದ ಅಪಾಯಗಳು ಮತ್ತು ಪ್ರಯೋಜನಗಳನ್ನು ಮತ್ತು ಅಧ್ಯಯನದ ಸಮಯದಲ್ಲಿ ಸಂಗ್ರಹಿಸಲ್ಪಟ್ಟಿರುವ ಮತ್ತು ಬಹಿರಂಗಪಡಿಸುವ ಮಾಹಿತಿಯ ಗೌಪ್ಯತೆ ನಾನು ಅರ್ಥಮಾಡಿಕೊಂಡಿದ್ದೇನೆ. ಸಂಗ್ರಹಿಸಿದ ಮಾಹಿತಿಯನ್ನು ಸಂಶೋಧನೆಗೆ ಮಾತ್ರ ಬಳಸಲಾಗುತ್ತದೆ.

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

ಈ ಅಧ್ಯಯನದಿಂದ ಭಾಗವಹಿಸುವಿಕೆಯನ್ನು ಯಾವುದೇ ಸಮಯದಲ್ಲಿ ನಾನು ಹಿಂಪಡೆಯಲು ಮುಕ್ತವಾಗಿರುತ್ತೇನೆ ಮತ್ತು ಇದು ಭವಿಷ್ಯದ ಕಾಳಜಿಯನ್ನು ಬದಲಿಸುವುದಿಲ್ಲ ಎಂದು ನಾನು ಅರ್ಥಮಾಡಿಕೊಂಡಿದ್ದೇನೆ.

ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸುವಿಕೆ ನನಗೆ ಯಾವುದೇ ಹೆಚ್ಚುವರಿ ವೆಚ್ಚ ಒಳಗೊಳ್ಳುವುದಿಲ್ಲ.

ಹೆಸರು	ಸಹಿ/ಹೆಬ್ಬೆಟ್ಟಿನ ಗುರುತು	ದಿನಾಂಕ	ಸಮಯ
ರೋಗಿಯ ಹೆಸರು			
ಸಾಕ್ಷಿಗಳ ಹೆಸರು			
ಪ್ರಾಥಮಿಕ ಸಂಶೋಧಕರು/ ವೈದ್ಯರು			

ANNEXURE- IV

PHOTOGRAPHS

PHOTOGRAPH 1 – SLIT LAMP EXAMINATION

PHOTOGRAPH 2 – Nd:YAG LASER CAPSULOTOMY

PHOTOGRAPH 3: SPECULAR MICROSCOPY EXAMINATION

PHOTOGRAPH 4: IOP BY GAT

MASTER CHART

ANNEXURE-V

KEY TO MASTER CHART

RE - Right Eye

LE – Left Eye

BCVA -Best corrected visual acuity

ECD – endothelial cell density

CV – co-efficient of variance

IOP – Intraocular pressure

HEX- hexagonality of cells %

PrT – Pre-treatment

PT – Post treatment

MASTERCHART

S No	Age	Gender	Eye	PCO	BCVA-PrT	BCVA-PT-1 WK	BCVA-PT -1 month	LASER Energy	ECD PrT	ECD PT 1wk	ECD PT 1month	CV PrT	CV PT 1 week	CV PT 1 month	Hex Prt	Hex PT 1 week	Hex PT 1 month	IOP PrT	IOP PT-1week	IOP PT-1 month	Complications
1	43	Male	Right	Fibrosis	6/60 to 6/24	6/18 to 6/6	6/18 to 6/6	51 to 75	2532	2415	2247	35	38	39	68	65	61	14.5	15.8	15.1	Absent
2	38	Male	Left	Fibrosis	<6/60	6/18 to 6/6	6/18 to 6/6	51 to 75	2412	2295	2127	34	37	38	67	64	60	14.1	15.4	14.5	Absent
3	45	Female	Right	Fibrosis	6/60 to 6/24	6/18 to 6/6	6/18 to 6/6	76 to 100	2352	2235	2067	33	36	37	69	62	62	14.6	15.9	15.6	Absent
4	48	Male	Left	Elschnig's	6/60 to 6/24	6/18 to 6/6	6/18 to 6/6	51 to 75	2541	2424	2256	35	38	39	68	65	61	14.5	15.8	15.2	Intraocular lens pitting
5	56	Male	Right	Fibrosis	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	76 to 100	2541	2424	2256	34	37	38	67	64	60	14.3	15.9	14.5	Absent
6	37	Female	Left	Fibrosis	<6/60	6/18 to 6/6	6/18 to 6/6	76 to 100	2418	2301	2133	35	38	39	65	62	58	13.9	15.8	14.5	Iritis/Uveitis
7	56	Male	Right	Elschnig's	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	26 to 50	2332	2215	2047	35	38	39	64	61	57	14.2	15.5	14.8	Absent
8	58	Male	Left	Fibrosis	<6/60	6/18 to 6/6	6/18 to 6/6	51 to 75	2512	2395	2227	34	37	38	62	59	55	13.9	15.2	14.5	Absent
9	39	Female	Right	Elschnig's	6/60 to 6/24	6/60 to 6/24	6/60 to 6/24	51 to 75	2415	2298	2130	36	39	40	68	65	61	14.5	15.8	15.1	Absent
10	62	Male	Right	Fibrosis	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	51 to 75	2564	2447	2279	34	37	38	67	64	60	14.9	16.2	15.5	Absent
11	40	Female	Left	Elschnig's	<6/60	6/18 to 6/6	6/18 to 6/6	<25	2358	2241	2073	34	37	38	65	62	58	14.2	15.5	14.8	Absent
12	39	Male	Right	Elschnig's	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	51 to 75	2316	2199	2031	35	38	39	64	61	57	13.8	15.1	14.4	Intraocular lens pitting
13	56	Male	Left	Elschnig's	6/60 to 6/24	6/18 to 6/6	6/18 to 6/6	51 to 75	2415	2298	2130	34	37	38	69	65	62	13.9	15.2	14.5	Absent
14	38	Female	Right	Elschnig's	6/60 to 6/24	6/60 to 6/24	6/18 to 6/6	51 to 75	2368	2251	2083	36	39	40	68	64	61	14.1	15.4	14.7	Absent
15	55	Male	Left	Elschnig's	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	26 to 50	2369	2252	2084	32	35	38	69	64	62	13.8	15.1	14.4	Iritis/Uveitis
16	46	Female	Right	Elschnig's	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	51 to 75	2536	2419	2251	31	38	39	70	64	63	13.9	15.2	14.5	Absent
17	64	Male	Right	Elschnig's	<6/60	6/18 to 6/6	6/18 to 6/6	26 to 50	2542	2425	2257	30	38	34	65	62	58	14.2	15.5	14.8	Absent
18	62	Female	Left	Elschnig's	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	51 to 75	2515	2398	2230	35	38	39	68	65	61	14.4	15.7	15.6	Absent
19	37	Male	Right	Fibrosis	6/60 to 6/24	6/60 to 6/24	6/18 to 6/6	26 to 50	2395	2278	2110	34	37	38	67	64	60	13.8	15.1	14.4	Absent
20	64	Female	Right	Fibrosis	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	76 to 100	2335	2218	2050	32	35	40	69	66	62	13.7	15.3	14.3	Absent
21	42	Male	Left	Elschnig's	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	26 to 50	2526	2315	2241	32	35	39	69	66	62	14.6	15.9	15.2	Intraocular lens pitting
22	55	Female	Right	Elschnig's	6/60 to 6/24	6/60 to 6/24	6/60 to 6/24	51 to 75	2524	2407	2139	32	36	38	68	65	60	14.2	15.5	14.8	Absent
23	56	Male	Left	Elschnig's	<6/60	6/18 to 6/6	6/18 to 6/6	51 to 75	2399	2282	2114	32	36	38	70	64	60	13.9	15.2	14.5	Absent
24	62	Female	Right	Elschnig's	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	51 to 75	2315	2196	2030	33	35	37	69	63	63	14.1	15.4	14.7	Absent
25	45	Male	Left	Elschnig's	6/60 to 6/24	6/18 to 6/6	6/18 to 6/6	51 to 75	2326	2223	2041	32	36	38	68	62	62	14.1	15.4	14.7	Absent
26	64	Female	Left	Elschnig's	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	26 to 50	2348	2231	2063	32	36	38	68	66	62	13.5	14.8	14.1	Absent
27	51	Male	Right	Elschnig's	6/60 to 6/24	6/18 to 6/6	6/18 to 6/6	51 to 75	2313	2196	2028	31	35	37	67	63	61	13.7	15.9	14.3	Absent
28	49	Female	Right	Fibrosis	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	76 to 100	2341	2224	2056	32	35	38	64	61	58	14.5	15.8	15.1	Absent
29	64	Male	Right	Elschnig's	6/60 to 6/24	6/18 to 6/6	6/18 to 6/6	51 to 75	2299	2182	2014	33	35	38	62	60	56	14.1	15.4	14.4	Absent
30	55	Female	Right	Fibrosis	6/60 to 6/24	6/18 to 6/6	6/18 to 6/6	76 to 100	2398	2281	2013	32	34	36	64	61	58	14.1	15.4	14.2	Absent
31	48	Male	Right	Elschnig's	6/60 to 6/24	6/18 to 6/6	6/18 to 6/6	51 to 75	2351	2374	2066	32	34	36	67	63	60	14.8	16.1	15.1	Absent
32	62	Male	Left	Elschnig's	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	51 to 75	2352	2405	2067	35	36	39	67	63	60	14.7	16.8	15.1	Absent
33	56	Female	Right	Fibrosis	6/60 to 6/24	6/18 to 6/6	6/18 to 6/6	76 to 100	2519	2351	2234	34	37	38	66	63	59	14.8	16.5	15.3	Absent
34	43	Male	Right	Elschnig's	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	26 to 50	2412	2302	2127	32	36	39	65	62	58	14.6	15.9	15.2	Absent
35	64	Female	Left	Elschnig's	6/60 to 6/24	6/18 to 6/6	6/18 to 6/6	51 to 75	2368	2261	2183	32	35	39	64	62	57	14.2	16.2	15.5	Absent
36	54	Male	Right	Fibrosis	6/60 to 6/24	6/18 to 6/6	6/18 to 6/6	76 to 100	2316	2208	2131	34	38	39	67	64	60	14.5	15.8	15.1	Absent
37	57	Male	Right	Elschnig's	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	76 to 100	2318	2201	2033	31	34	35	65	62	60	13.6	14.9	14.2	Absent
38	48	Female	Left	Elschnig's	6/60 to 6/24	6/18 to 6/6	6/18 to 6/6	51 to 75	2411	2294	2126	32	35	36	65	62	61	14.8	16.1	15.2	Absent
39	59	Female	Right	Elschnig's	6/18 to 6/6	6/18 to 6/6	6/18 to 6/6	51 to 75	2516	2284	2231	32	35	35	65	62	58	13.5	14.8	14.1	Absent
40	46	Male	Right	Elschnig's	6/60 to 6/24	6/18 to 6/6	6/18 to 6/6	51 to 75		-117	-285	32	35	36	65	62	58	14.5	15.8	15.5	Absent

THANK YOU