

ORIGINAL RESEARCH

Influence of ND:YAG laser capsulotomy on refraction and intraocular pressure and anterior chamber parameters

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ABSTRACT

Background: Nd:YAG laser capsulotomy is a widely accepted safe, effective and quick procedure to treat PCO. However, it comes with its own complications and therefore, it is imperative to assess the anterior and posterior chamber before and after the procedure. **Aims and Objectives:** To assess the changes in refraction, intraocular pressure, anterior chamber depth and angle after Nd:YAG laser capsulotomy. **Materials and methods:** 50 eyes with significant PCO after an uneventful cataract surgery were taken and complete ocular examination was done including slit lamp and fundus examination. Visual acuity assessment by Snellen's chart, IOP measurement by GAT and anterior chamber assessment using anterior segment OCT was carried out in all patients before laser and post-laser at 1 hour, 1 week and 1 month. Capsulotomy was done using VISULAS YAG III Q-switched Nd:YAG laser machine by Zeiss. **Results:** There was a statistically significant improvement in BCVA in all patients. 56% patients had BCVA 6/6, 32% patients had BCVA 6/9 and rest 6% patients had BCVA 6/12 and 6/18. A statistically significant rise in IOP was observed at 1 hour following laser which was >5mmHg. The mean value pre-laser was 12.58, and after 1 hour it was 18.34. Thereafter, there was a sharp decline in IOP and mean value after 1 week was 12.88, and after 1 month was 12.52. Repeated measure ANNOVA showed that the anterior chamber depth increased significantly from pre-laser to 1 hour and from 1 week to 1 month. **Conclusion:** Our study showed that visual acuity improved in all subjects after capsulotomy. A sharp spike in IOP post-laser was observed which declined gradually and attained baseline value in a some time. So, anti-glaucoma medications should be given in glaucomatous, aphakic, and high risk patients. An increase in anterior chamber depth is a significant finding and causes change in refraction.

Keywords: Nd:YAG laser, posterior capsule opacification (PCO), intraocular pressure (IOP), Anterior chamber depth

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INTRODUCTION

Posterior capsule opacification is the most common complication encountered after cataract surgery. PCO is often referred to as 'secondary cataract' or 'after cataract'. In the pathogenesis of PCO, there is opacification of the posterior capsule secondary to cataract removal. The opacification occurs because of migration of epithelial cells of the lens along with their proliferation and differentiation. When it involves the central visual axis, it can cause significant visual symptoms.^[1]

A capsular bag is generated in a modern cataract surgery which comprises the posterior capsule and part of the anterior capsule.^[1] The thin acellular posterior capsule and intraocular lens permit free passage of light through the capsular bag along the visual axis. The lens epithelial cells reside in a stubborn way on the remaining anterior capsule. This group of cells is resilient in nature and recolonise those regions of the anterior capsule that are denuded.

They impinge onto the surface of the intraocular lens and the outer region of the anterior capsule.^[1] The posterior capsule which was previously cell free, gets colonized by these cells which continue to divide and cover its entire surface, ultimately encroaching the visual axis. This gives rise to light scatter due to changes in the matrix and cell organization.^[1]

PCO impairs vision when the central zone of the aperture of the pupil gets involved. Opacification inside the central 3mm area of the posterior capsule has consequences on the visual acuity and contrast sensitivity of the patient.⁽²⁾ There are two methods of treating central PCO obscuring visual axis: surgical intervention like posterior capsule scraping and non-surgical intervention like Nd:YAG laser capsulotomy. It is important to make a capsulotomy of appropriate size and at an appropriate site for restoring vision.

The Nd:YAG(neodymium:yttrium aluminium garnet) laser is a safe technique. It is quick and it is an effective method of treating PCO that is being used

since the last 40 years. However, it comes with its complications. The complications of this procedure are increased IOP, IOL damage, corneal oedema, iris hemorrhage, IOL subluxation, uveitis, corneal endothelial cell loss. Other rare complications are retinal detachment, macular hole, cystoids macular oedema, endophthalmitis. Rarely, patients may require a second laser after development of re-opacification.(3,4)

Since there are a lot of complications associated with YAG capsulotomy, it is imperative that we assess the anterior chamber and posterior chamber well. The most common problem encountered after YAG capsulotomy is that of raised intraocular pressure. It is believed to happen because of reduced aqueous outflow facility. The trabecular meshwork is damaged by capsular debris and by acute inflammatory cells. Deposition of macrophages, lymphocytes, pigment granules, fibrin at the trabecular meshwork site has been found to be associated with increment of IOP following YAG capsulotomy. Glaucomatous eyes which already have reduced outflow facility are at a greater risk.

An improvement in the refractive status of the eye has been observed following YAG capsulotomy. This may be attributed to the posterior displacement of IOL as observed in many studies.

In our study, our aim was to find out how Nd:YAG laser capsulotomy influences refraction and intraocular pressure. Its effect on the anterior segment parameters namely anterior chamber depth has also been studied.

MATERIALS AND METHODOLOGY

It is a prospective observational study conducted in 50 patients attending the Outpatient Department of Ophthalmology at SGT Medical College, Hospital and Research Institute (FMHS), Budhera, Gurugram.

This study has been conducted in 50 clinically diagnosed cases of posterior capsule opacification in pseudophakic patients who underwent Nd:YAG Laser Capsulotomy procedure. It was carried out during the period of 1/1/2021 to 31/6/2022 after being approved by the Ethics Committee. It adhered to the tenets of the Declaration of Helsinki.

Patients who had complications during cataract surgery or the post operative period and patients with corneal opacities, glaucoma, retinopathy, maculopathy and optic neuropathy were excluded from the study.

The complete ophthalmic examination that was done for each patient included biomicroscopic examination and indirect fundus examination. Anterior chamber depth was measured. Intraocular pressure was measured. Visual acuity and refractive change was measured. Written and informed consent was taken from the patients. All the measurements were taken before the procedure and at the first hour, first week and first month after the procedure.

Uncorrected vision was recorded and visual acuity was measured using Snellen's chart and autorefractometer and refraction was carried out.

There was no use of topical or systemic IOP lowering agent before the procedure. IOP was measured using the Goldmann's Applanation Tonometer.

Anterior Chamber Depth and angle was measured with the help of anterior segment OCT (VISANTE OCT by Carl Zeiss Meditec).

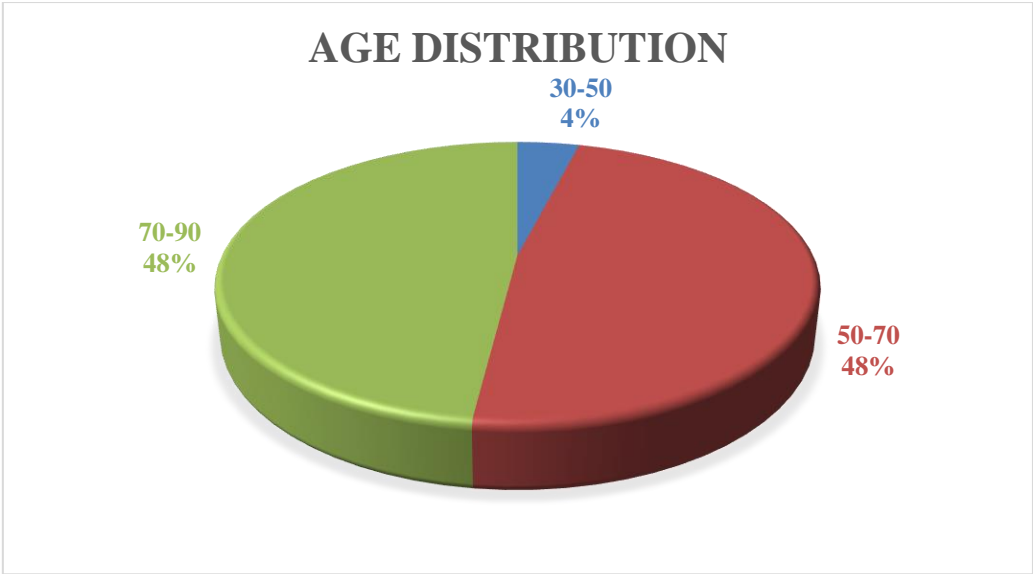
After the procedure, patients were prescribed eye drop timolol(0.5%)(for IOP control) twice a day and eye drop Prednisolone(1%) 4 times/day for 1 week.

RESULTS

Statistical analysis was done using SPSS-software version 28.

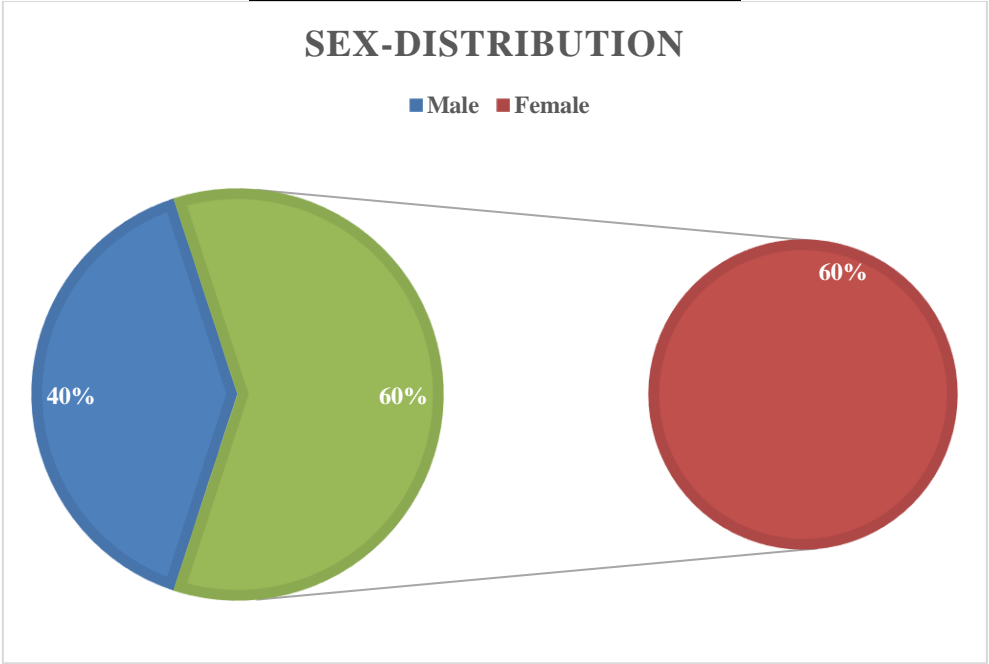
Data comparison was done by specific statistical test to know the statistical significance. Parametric tests were used (Repeated Measure ANOVA) to evaluate the changes in dependent variables from the beginning to the end of the treatment. P-value was set as 0.05 and 0.01 level of significance. The data was distributed into four groups: Group 1 (Pre-Laser), Group 2 (1 hour after Laser), Group 3 (1 week after Laser), Group 4 (1 month after Laser). The following formula was used for statistical test: Post-hoc Analysis for comparison using Bonferroni test.

In the present study, the majority of participants were from 50-70 years (24) and 70-90 years age group (24). The least number of participants (2) were from 30-50 years of age group.

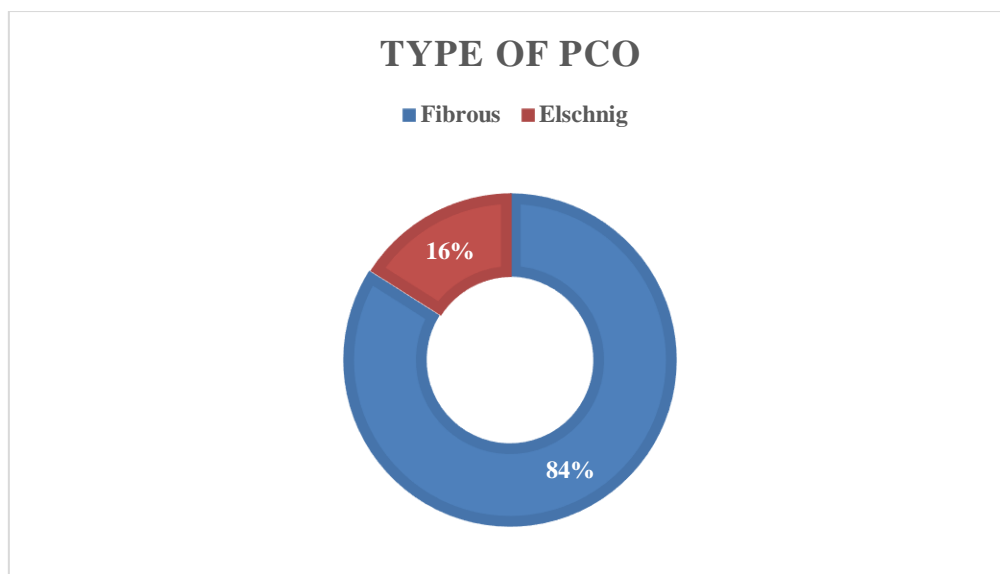


It was found that majority of the participants were female.

Gender	Number(n=50)	Percentage
Male	20	40.00%
Female	30	60.00%



In our study, 84% participants had fibrous PCO and remaining 16% had elschnig type PCO.



In the present study it was found that the mean value (LogMAR) from pre laser (0.62) to one month (0.07) gradually decrease in order. Repeated measure ANOVA test was applied and the result was significant at 1% level of significance. There was a

statistically significant improvement in BCVA in all patients. 56% patients had BCVA 6/6, 32% patients had BCVA 6/9 and rest 6% patients had BCVA 6/12 and 6/18.

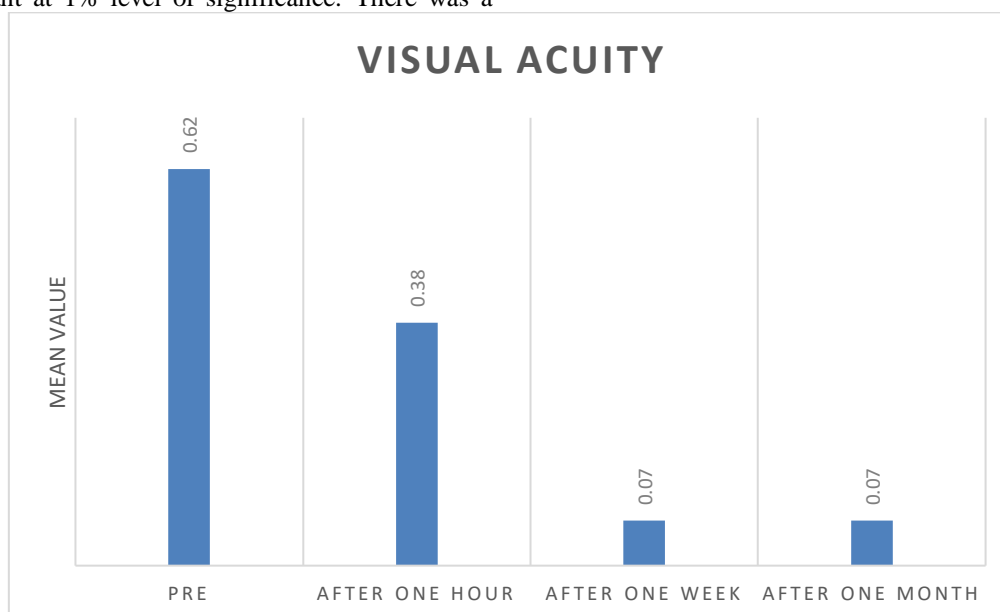


Figure 1

Post hoc analysis of Visual acuity for pairwise comparison using Bonferroni test.(Table 1)

(I) factor1	(J) factor1	Mean Difference (I-J)	p-value
Pre Laser	After one hour	0.237	<0.0001**
After one hour	After One Week	0.308	<0.0001**
After One Week	After One Month	0.002	1.000 ^{NS}
Pre Laser	After One Month	0.547	<0.0001**

Post hoc test was applied for pairwise comparison, from pre laser to after one hour and one hour to after one week the results were significant. The result was insignificant after one week to one month. The mean difference from pre to after one month was calculated as 0.547 and the result was significant at 0.01 level of significance.

The IOP recorded 1 hour post laser showed a spike from pre-laser levels but gradually came down to baseline values at 1 week. According to table 2 and figure 2, it shows the comparison of intraocular pressure from pre laser to one month. The mean value in pre laser was found to be 12.58 with 2.71 variation, at one hour it was 18.34 with 2.61 SD. At one week

and one month the average value was calculated as 12.88 and 12.52 respectively. Repeated measure ANOVA test was applied with F-value 244.77 and the result was significant at 1% level of significance.

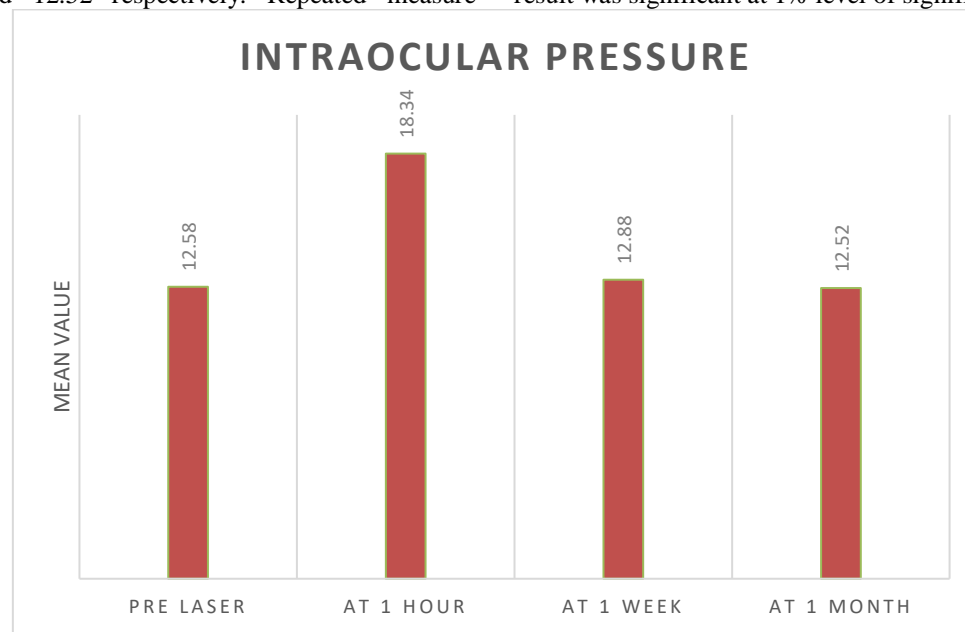


Table.2. Comparison of intraocular pressure during different time intervals

Intraocular Pressure	Mean	Std. Deviation	F-value	p-value
Pre Laser	12.58	2.71	244.77	<0.0001**
At 1 hour	18.34	2.61		
At 1 Week	12.88	2.43		
At 1 month	12.52	2.38		

Post hoc analysis of Intraocular Pressure for pairwise comparison using Bonferroni test.(Table 2)

(I) factor1	(J) factor1	Mean Difference (I-J)	p-value
Pre Laser	At 1 hour	-5.76	<0.0001**
At 1 hour	At 1 Week	5.46	<0.0001**
At 1 Week	At 1 month	0.36	0.972 ^{NS}
Pre Laser	At 1 month	0.06	1.000 ^{NS}

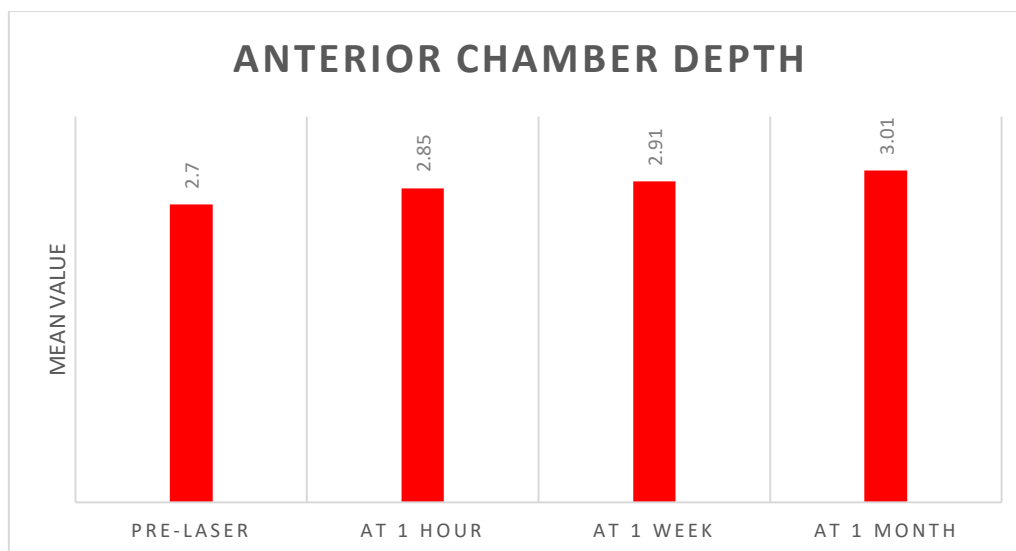
Post hoc test was applied for pairwise comparison, the mean difference shows the result was significant at pre laser to one hour and one hour to one week. The difference was found at week to one month was 0.36 and pre laser to one month was 0.06. The p-value remains insignificant for both the duration at 1% level of significance.

In this present study, table 3 and figure 3.1 represent the comparison of anterior chamber depth from pre

laser treatment to one month exposure. The mean value at pre laser was found to be 2.70 with 0.36 variation. At one hour it was going to 2.85 with 0.39 SD, at one week and at one month, the average value was calculated as 2.91 and 3.01 respectively. Repeated measures ANOVA test was applied and the result was significant at 0.01 level of significance.

Table.3. Comparison of anterior chamber depth during different time intervals

Anterior Chamber Depth	Mean	Std. Deviation	F-value	p-value
Pre-Laser	2.70	0.36	40.59	<0.0001**
At 1 hour	2.85	0.39		
At 1 Week	2.91	0.38		
At 1 Month	3.01	0.42		



Post hoc analysis of Anterior Chamber Depth for pairwise comparison using Bonferroni test.

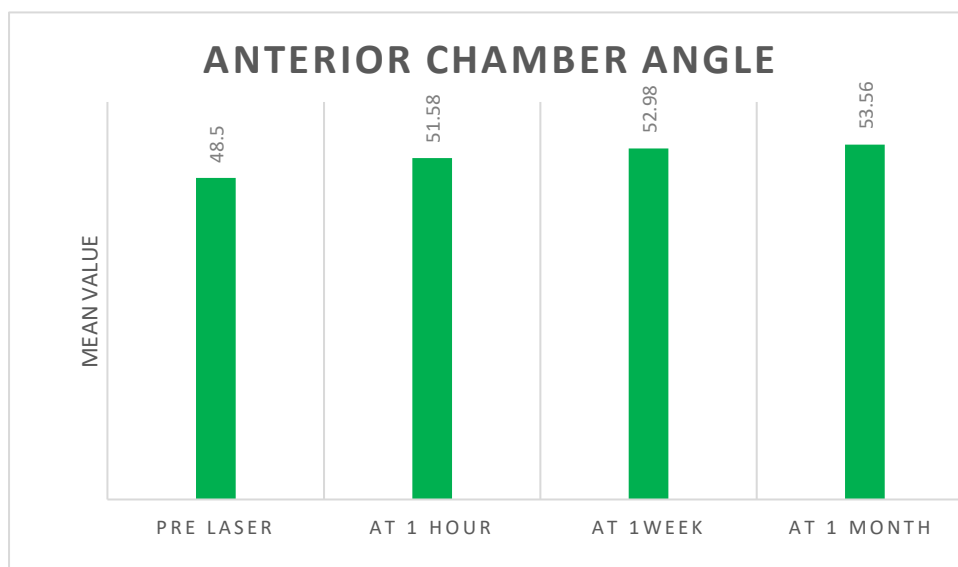
(I) factor	(J) factor	Mean Difference (I-J)	p-value
Pre Laser	At 1 hour	-0.146	<0.0001**
At 1 hour	At 1 Week	-0.063	0.089 ^{NS}
At 1 Week	At 1 month	0.101	0.001**
Pre Laser	At 1 month	0.310	<0.0001**

Post hoc analysis was done through Bonferroni test, it was found that at pre laser to one hour the mean difference was -0.146 and the result was significant but at one hour to one week the result was insignificant i.e., there were a very little changed in that duration. However, after one week to one month, the result was statistically significant at 1% level of significance.

According to table 4 and diagram 4.1, it shows the comparison of anterior chamber angle with different time duration. The mean value at 48.50 with 6.06 standard deviation. At one hour the average value goes to 51.58 and then at one week it goes to 52.98 and at one month the value comes at 53.56 with 6.05 deviation from mean. Repeated measure ANOVA was applied and the result was significant at 0.01 level of significance.

Table 4: Comparison of anterior chamber angle during different time intervals.

Anterior Chamber Angle	Mean	Std. Deviation	F-value	p-value
Pre Laser	48.50	6.06	387.422	<0.0001**
At 1 Hour	51.58	6.36		
At 1week	52.98	6.21		
At 1 month	53.56	6.05		



Post hoc analysis of Anterior Chamber Angle for pairwise comparison using Bonferroni test

(I) factor1	(J) factor1	Mean Difference (I-J)	p-value
Pre Laser	At 1 hour	-3.08	<0.0001**
At 1 hour	At 1 Week	-1.4	<0.0001**
At 1 Week	At 1 month	-0.58	0.001**
Pre Laser	At 1 month	-5.06	<0.0001**

Bonferroni test was applied for post hoc analysis between the groups. The mean difference from pre laser to one hour, one hour to one week, one week to

one month and pre laser to one month, all were having the significant result from starting to the end at 1% level of significance.

DISCUSSION

In the study conducted by us, our motive was to study how Nd:YAG laser capsulotomy affects intraocular pressure, visual acuity and anterior chamber depth. The observations made in our study are discussed below.

1. INCREASED INTRAOCULAR PRESSURE

In our study, GAT was done for all patients pre-laser and at 1 hour, 1 week and 1 month following Nd:YAG laser capsulotomy. IOP lowering agents like eye drop timolol were not administered in these patients before performing capsulotomy. At 1 hour following capsulotomy, a spike in IOP was observed which was significant statistically.

These finding supports the use of IOP lowering agents like eye drop timolol which are given post Nd:YAG laser capsulotomy to all patients.

In our study also, eye drop timolol maleate 0.5% twice a day was prescribed to all patients after capsulotomy for 1 week.

At 1 week, the IOP came down from the spike that was initially seen. The decline in IOP from 1 hour to 1 week was found to be statistically significant in our study.

In the follow up visit at 1 month, the IOP values stabilized and were comparable to the pre-laser GAT values.

It has been observed that the rise in IOP after Nd:YAG laser capsulotomy may be only transient and no persistent elevation of IOP was found.

This rise in IOP is more pronounced in eyes where the pre-laser IOP was already above normal and hence caution must be exercised in these patients. It is safer to give eye drop timolol maleate 0.5% pre-laser in these patients.

S.Kapoor et al(2020) found an immediate rise in IOP in 42% patients which declined to 2% incidence in 1 month.(5) In other studies as well, similar results were observed.

A statistically significant ($p<0.001$) rise in IOP was observed at 1 hour by Hassan HT in their study in 2020 in both pseudophakic and aphakic eyes. An average of 8.35 mm Hg rise in IOP from baseline was observed.(6)

Janye Ge et al (2000) concluded that patients with glaucoma are more likely to experience a significant rise in IOP.(7)

Hu et al measured IOP 30 minutes after and weeks after surgery and found that the rise in IOP hours or

days after procedure was not significant. However, they administered a drop of timolol or betaxolol. (4)

Waseem et al suggested that the use of high-energy settings during YAG laser capsulotomy may cause elevation of IOP.(8)

2. IMPROVEMENT IN VISUAL ACUITY

There was excellent improvement in vision in our study. Out of 50 patients taken in the study, 28 patients got 6/6 vision at the end of 1 month. 11 out of these 28 patients got 6/6 vision without glasses. In 16 patients, the vision improved to 6/9. In 3 patients, the vision improved to 6/12 and in the other 3 patients, 6/18 visual acuity was recorded.

The improvement in vision was statistically significant from pre-laser to after 1 hour and from 1 hour to 1 week. Improvement in visual acuity from pre-laser to 1 month post-laser was also statistically significant. Because of the significant improvement in visual acuity and a significant change in refraction, the need for a new spectacle was observed.

In our study, Nd:YAG laser cleared the central pupillary area effectively in every case as shown in Table 1. A statistically significant increase in BCVA was observed post Nd:YAG capsulotomy. This is in conjunction to the findings noted by Gardener KM (9), Wasserman (10) and Mohan Lal Gupta (11). They reported improvement in visual acuity in 90% cases after capsulotomy out of the 100 cases studied that was significant.

Ramachandra and Kuriakose made note of improvement in vision and change in refraction that was significant after Nd:YAG capsulotomy. Hence the need for a new prescription of glasses was suggested.(12)

Some studies found no significant change in SE values.(4) A hyperopic shift following YAG laser capsulotomy was observed by Karahan et al. The posterior movement of the IOL due to YAG capsulotomy could be responsible for the hyperopic shift observed.(13)

3. INCREASE IN ANTERIOR CHAMBER DEPTH

It has been observed that there is an increase in the depth of anterior chamber after Nd:YAG laser capsulotomy due to posterior displacement of IOL. In our study, a statistically significant increase in the depth of anterior chamber was observed from pre-laser to after 1 hour and from 1 week to 1 month. The anterior chamber depth increased on all three visits.

This may be attributed to movement of IOL towards vitreous.

Findl et al reported an average 25µm posterior displacement of IOL post YAG capsulotomy which caused an increase in ACD. (14)

Eliacik et al reported 60µm posterior movement of IOL. The ACD increased by 0.06±0.04 mm in the study conducted by them.(15)

M.Bazaz et al found forward displacement of IOL one month after capsulotomy which led a decrease in ACD and myopia.(16) Zaidi et al (17) also had similar findings.

However, some studies have also reported no change in ACD.(10,4)

Olsen et al indicated that 0.1mm change in ACD might cause a 0.1 D difference in IOL calculation and led to a conclusion that the change in ACD may cause a change in refraction.(18)

4. INCREASE IN ANTERIOR CHAMBER ANGLE

Our study shows a significant increase in Anterior Chamber Angle after Nd:YAG laser Capsulotomy in all visits.

Eliacik et al conducted a study with AS-OCT to assess anterior segment parameters and reported a 2.8%-2.9% increase in Anterior chamber angle.(15)

Oztas et al used a Pentacam and found a statistically significant increase in Anterior chamber Angle 1 week post capsulotomy. They found no significant increase 1 month after the procedure.(19)

CONCLUSION

Nd:YAG Laser capsulotomy is a non-invasive technique with good safety profile. It is a fast and convenient outpatient procedure for restoring vision after development of PCO.

It provides excellent improvement in BCVA with most of the patients with most patients showing improvement upto 6/9 and more. It has been found to be associated with elevation in IOP . The IOP elevation is transient and becomes steady in a week's time. Because of the transient nature of IOP rise, antiglaucoma medicines given routinely need not be necessarily given in all the patients undergoing Nd:YAG laser capsulotomy. In patients who are known glaucomatous, high myopic or aphakic, caution must be exercised.

Careful follow up is important. The spike in IOP that occurs in some cases can be prevented by the use of eye drop Timolol maleate 0.5%. Nd:YAG laser capsulotomy is a significant procedure as it may cause changes in the position of IOL. This may lead to increased Anterior Chamber depth and change in refraction. Hence, it is important to consider the changes that can develop after the procedure.

REFERENCES

1. Wormstone IM, Wang L, Liu CS. Posterior capsule opacification. *Exp Eye Res* 2008; 88: 257– 69.

2. Bron, A.J.Tripathi, R.C.Tripathi, B.J., Wolff, E.(1997). Wolff's anatomy of the eye and orbit. London: Chapman & Hill Medical.
3. Hu CY, Woung LC, Wang MC. Change in the area of laser posterior capsulotomy: 3month follow-up. *J Cataract Refract Surg* 2001; 27: 538– 42.
4. Hu CY, Woung LC, Wang MC, Jian JH. Influence of laser posterior capsulotomy on anterior chamber depth, refraction, and intraocular pressure. *J Cataract Refract Surg* 2000; 26: 1183– 9.
5. Shilpi Kapoor et al. International Journal of Medical Reviews and Case Reports. (2021) 5(1):146-149
6. Hassan HT. Changes in intraocular pressure after Nd-yag laser posterior capsulotomy. *Int J Clin Exp Ophthalmol.* 2020; 4: 021-030.
7. Jayne et al., Long-term Effect of Nd:YAG Laser Posterior Capsulotomy on Intraocular Pressure; *Archives of Ophthalmology.* 2000; 118(10):1334-7
8. Waseem M, Khan HA. Association of raised intraocular pressure and its correlation to the energy used with raised versus normal intraocular pressure following Nd: YAG laser posterior capsulotomy in pseudophakes. *J Coll Physicians Surg Pak* 2010; 20(8): 524–7.
9. Gardener KM, Straatsma BR and Pettit TH. Neodymium: YAG laser posterior capsulotomy: the first 100 cases at UCLA. *Ophthalmic Surg*1985;16(1):24-28.
10. Wasserman EL, Axt JC and Sheets JH. Neodymium: YAG Laser Posterior Capsulotomy. *J Am Intraocul Implant Soc* 1985; 11(3):245-248.
11. Gupta ML. Visual benefits of ND: YAG laser capsulotomy study in South Eastern Rajasthan. *Int J Biol Med Res* 2012; 3(4): 2507-2514.
12. Ramachandra S, Kuriakose F. Study of early refractive changes following Nd: YAG capsulotomy for posterior capsule opacification in pseudophakia. *Indian J Clin Exp Ophthalmol.* 2016;2(3):221–226. doi:10.5958/2395-1451.2016.00048.2
13. Eyyup Karahan, Ibrahim Tuncer, and Mehmet Ozgur Zengin. The effect of Nd:YAG laser posterior capsulotomy size on refraction, intraocular pressure, and macular thickness. *Hindawi publishing corporation journal of ophthalmology* 2014.
14. Findl O, Drexler W, Menapace R, et al. Changes in intraocular lens position after neodymium: YAG capsulotomy. *Ophthalmic Surg Lasers.* 1995 Nov-Dec;26(6):529–34. PMID: 8746574.
15. Mustafa Eliacik, Huseyin Bayramlar, Sevil Karaman Erdur. Anterior segment Optical Coherence Tomography measurement after Neodymium-Yttrium-Aluminium-Garnet laser capsulotomy. *American Journal of Ophthalmology* 2004;158:994-98.
16. Mahmoud Reza Panahi Bazaz, Gholamreza Khataminia, Mohammad Taayeed, et al. Changes of anterior chamber depth and volume before and after Nd: YAG Laser posterior capsulotomy. *Medical Science*, 2020, 24(104), 2366-2372.
17. Zaidi, Meena & Askari, Saiyid. (2004). Effect of Nd:YAG Laser Posterior Capsulotomy on Anterior Chamber Depth, Intraocular Pressure, and Refractive Status. *Asian J Ophthalmol.* 5.
18. Olsen T, Corydon L, Gimbel H. Intraocular lens power calculation with an improved anterior chamber depth prediction algorithm. *J Cataract Refract Surg* 1995; 21(3): 313–9.

19. Zafer Oztas, Melis Palamar, Filiz Afrashi, Ayse Yagci. opacification. Clinical Experimental Optometry
The effects of Nd:YAG laser capsulotomy on anterior 2015;98(2):168-71
segment parameters in patients with posterior capsular