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# EVALUATION OF INTRAOCULAR PRESSURE POST Nd: YAG CAPSULOTOMY

**Bharti Nigam, Pragati Garg, Priyanka Raj**

*Department of Ophthamology*

Era's Lucknow Medical College & Hospital, Sarfarazganj Lucknow, U.P., India-226003

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Address for correspondence
**Dr. Pragati Garg**
Department of Ophthalmology
Era's Lucknow Medical College & Hospital, Lucknow-226003
Email: drpragati89@gmail.com
Contact No: +91-9415396506

## ABSTRACT

The aim of our study is to evaluate the intraocular pressure changes after Nd:YAG posterior capsulotomy.

For the purpose of this study, 220 out of the initially enrolled 253 subjects with visually significant posterior capsular opacification (PCO) underwent Nd:YAG capsulotomy and subsequent monitoring of intraocular pressure (IOP) immediately after the procedure and then 3 hours and 1 day after the procedure.

We found that there was a significant fall in the mean intraocular pressure (IOP) was observed immediately post procedure on comparing with the pre-procedure levels (15.25 ± 2.46 mmHg), with mean change from the baseline being -0.55 (p=0.024), following a rise in IOP, peaking at 3 hours at an average of with a mean positive change from the baseline being 0.42 although the change was not significant (p=0.070). On repeating the IOP after 1 day we found that the IOP tended to return towards the baseline values i.e. the pre-procedure values, with the mean deflection from the baseline being only 0.09. More patients with higher grade [Grade III (p=0.001) & Grade IV (p=0.008)] required significantly higher energy for capsulotomy as compared to the lower grades [Grade I (p <0.001) & grade II (p=0.015)]. There was a greater fall in IOP from the baseline when lesser amount of energy was used and the association was highly significant (p=0.02; F= 5.134) and 3 hours after the capsulotomy, we found that the rise in IOP from the initial fall was higher when higher amount of energy was used and this difference was highly significant (p<0.001).

We concluded from the study that there was an immediate fall in IOP followed by a spike at 3 hours but the IOP tended to return to normal baseline values after 1 day and the rise in IOP was proportional to the amount of energy used. Hence, we recommend the use of long acting topical IOP lowering agent immediately post capsulotomy before the patient is discharged.

**KEYWORDS**: Posterior capsular opacification, PCO, Intraocular pressure, IOP, Nd:YAG, Capsulotomy, Cataract, After cataract, Energy.

## INTRODUCTION

According to the latest World Health Organization's (WHO) assessment, cataract is responsible for 51% of the world's blindness (1) and surgery is the only available definitive treatment for the same. Cataract surgery has come a long way since its introduction and placement of Intraocular Lenses in the posterior capsular bag ensures a better visual prognosis (2). However, these in-the-bag intraocular lens (IOL) placement procedures are not exempted from the complications and formation of Posterior Capsular Opacification (also termed as secondary cataract) has marred the visual outcomes of the cataract surgeries, requiring treatment in up to 50% of patients by 3 years post- operatively (3).

Posterior capsular opacification formation is a multifactorial phenomenon as documented by Cherly S et al in 2008 (4). Patient factors, surgical techniques and intraocular lens (IOL) material design have all been implicated in the pathogenesis. Patient factors like, young age, uveitis and diabetes mellitus contribute to the development of posterior capsular opacification (PCO) while on the other hand surgical factors like small central capsulorhexis and encasing of intraocular lens (IOL) optic with the rhexis edges protect against development of posterior capsular opacification (PCO). Intraocular lens factors like the design of optic edge, optic material, haptic design and optic size also influence the posterior capsular opacification (PCO) formation (4). The posterior capsular opacification not only leads diminution of vision but also causes excessive glare and problems in the daily activities of the patients. Use of Nd:YAG (neodymium-doped yttrium aluminum garnet) laser for the lysis of posterior capsular opacification offers

restoration of post-surgical visual acuity, although, this procedure is not devoid of complications. Various studies (5-6) have reported rise in intraocular pressure, mild anterior uveitis, intraocular lens (IOL) pitting, cystoid macular oedema and hyphaema after the Nd:YAG laser capsulotomy with transient rise in intraocular pressure being the most common of all, peaking at 1st 3 hours after laser application (7-8). Even a transient increase in the intraocular pressure (IOP) with fluctuations varying from 5-10 mm of Hg may lead to ocular damage, especially in patients with preexisting advanced glaucoma who are more susceptible to this complication (9-10).

Various regimen and treatment modalities have been suggested to check this transient rise in the intraocular pressure (IOP), but because of lack of common consensus regarding the peak time of rise in the intraocular pressure (IOP) and subsequent use of IOP lowering agents, this study was undertaken with an aim to evaluate the rise in intraocular pressure after Nd:YAG laser capsulotomy and justify the use of anti-glaucoma drugs following the procedure.

## MATERIAL AND METHODS

This is a hospital based observational study for which 278 patients attending the ophthalmology OPD, having poster capsular opacification (PCO) after cataract surgery were enrolled. Patients with a history of glaucoma or on any intraocular pressure (IOP) lowering drugs, patients with absolute and relative contraindications to Nd:YAG (neodymium-doped yttrium aluminum garnet) capsulotomy like, corneal oedema, corneal ulcer, corneal scarring, anterior uveitis, macular oedema etc. and 8 patients who refused to undergo the study were excluded. The patients were thoroughly assessed and 244 subjects who met the study criteria underwent Nd:YAG capsulotomy out of which 24 subjects were further lost to follow up. Finally, we were left with 220 subjects who were assessed, with an aim to evaluate the rise in the intraocular pressure after the Nd:YAG capsulotomy.

Proper history regarding cataract surgery, diminution of vision post cataract surgery and history of glaucoma or any ocular infections were obtained. In all the subjects included in the study best corrected visual acuity was assessed by Snellen's chart, and intraocular pressure by Goldmann applanation tonometer before the procedure, then immediately after procedure and then after 3 hours and 1 day. Detailed Slit lamp examination was done to rule out any ocular pathology and assess the grade and type of posterior capsular opacification (PCO) and fundus was examined by Indirect Ophthalmoscopy.

In our study we used Madurai Intraocular lens study IV (11) PCO grading which is based on objective visualization of the optic disc and macula on a score of 0 to 2 and the both of them were combined together to obtain posterior capsular opacification (PCO) grade. Visualization of optic disc was scored as; Score 0= clear view of optic disc margin, blood vessels at optic disc and nerve fiber layer (RNFL examined using red-free filter); Score 1= clear view of optic disc margin, but disc blood vessels and/or nerve fiber layer are not clearly seen; and Score 2= neither optic disc margin nor blood vessels and nerve fiber layer are clearly seen. Visualization of the macula was scored as; score 0= clear view of foveal reflex, peri-foveal blood vessels and nerve fiber layer; score 1= diminished foveal reflex, but a clear view of peri-foveal blood vessels and nerve fiber layer can be seen; and score 3= blurred foveal reflex, peri-foveal blood vessels and/or fiber layer. Grading of posterior capsular opacification (PCO) is finally done by combining these scores as; score 0 +score 0 = Grade 0; score 0+score 1 = Grade 1; score 1+score 1 = Grade 2; score 1+score 2 = Grade 3; score 2 + score 2 = Grade 4.

Nd:YAG (neodymium-doped yttrium aluminum garnet) capsulotomy was carried out using Zeiss Visulas YAG III under 4% topical Paracaine anaesthesia under the view of a wide field special Nd:YAG laser contact lens (Abraham's contact lens) placed over cornea with viscoelastic substance as coupling agent. Laser shots taken initially were of low energy (1mJ) and then gradually increased as per the requirement with an aim to create a 2-3 mm wide opening in the center of the opacified posterior capsule with least number of laser shots.

The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 21.0 statistical Analysis Software. The values were represented in Number (%) and Mean ± standard deviation. Analysis of Variance (ANOVA) test was used to compare the within group variances. ANOVA provided "F" ratio, where a higher "F" value depicted a higher inter- group difference. Paired "t" test was done to compare the change in a parameter at two different time intervals. Level of significance was determined by the "p" value where $p<0.05$= significant; $p<0.01$ = highly significant and $p<0.01$ = very highly significant.

## RESULTS

The present study was carried out in the Department of Ophthalmology of a tertiary care center of North India with an aim to evaluate the changing pattern of (IOP) post Nd :YAG (neodymium-doped yttrium aluminum garnet) capsulotomy. We enrolled 220 patients, having varying grades of posterior capsular opacification (PCO), who underwent Nd:YAG capsulotomy.

| | No. of cases | % | $\chi^2$ | P value |
|---|---|---|---|---|
| **AGE GROUP (in years)** | | | | |
| **<50** | 34 | 15.5 | 165.28 | <0.001 |
| **50-70** | 163 | 74.1 | | |
| **>70** | 23 | 10.5 | | |
| **TOTAL** | 220 | 100.0 | | |
| **SEX DISTRIBUTION** | | | | |
| **Females** | 131 | 59.5 | 8.02 | 0.018 |
| **Males** | 89 | 40.5 | | |
| **TOTAL** | 220 | 100.0 | | |
| **PCO GRADING** | | | | |
| **I** | 75 | 34.1 | 26.33 | <0.001 |
| **II** | 73 | 33.2 | | |
| **III** | 35 | 15.9 | | |
| **IV** | 37 | 16.8 | | |

***Table 1: Demographic Profile And Pco Grade Distribution***

The mean age of the study group was 59.28 years, ranging from 13 to 85 years. Majority of patients were between 5 to 70 years of age (74.1%) followed by patients younger than 50 years (15.5%). Only 10.5% of the patients enrolled were older than 70 years of age (p<0.001). Majority of subjects were females (59.5%) while males formed 40.5% of the study population (p=0.018). On grouping the subjects according to the grade of posterior capsular opacification (PCO), we found that maximum number of subjects had Grade I & II posterior capsular opacification (PCO) (33.2 % & 35.0% respectively) while only 15.5% had Grade III and 16.4% had Grade IV PCO (p<0.001) Table 1.

| AGE (years) | No. OF CASES | MEAN ENERGY REQUIRED (mJ) | SD | P VALUE |
|---|---|---|---|---|
| **<50** | 34 | 70.87 | 81.46 | 0.159 |
| **50-70** | 163 | 55.28 | 53.71 | |
| **>70** | 23 | 41.74 | 34.69 | |
| **TOTAL** | 220 | 56.26 | 57.24 | |

***Table 2: Age v/s Laser Energy Requirement For Capsulotomy***

In our study, most of the patients had grade I &II posterior capsular opacification (PCO) irrespective of their age. Mean energy required for Nd:YAG capsulotomy was found to be maximum for patients belonging to the age group of <50 years (70.87 ± 81.46 mJ) with lesser amount of energy being required subsequently for age groups of 50-70 years (55.28 ± 53.71 mJ) and >70 years (41.74 ± 34.69mJ). With increasing age, mean energy required decreased but the association was insignificant. (p=0.159) Table 2.

| PCO GRADE | ENERGY REQUIR-EMENT (mJ) | NO. OF CASES | % | $\chi^2$ | P VALUE |
|---|---|---|---|---|---|
| **I (n=75)** | <30 | 50 | 66.7 | 62.25 | <0.001 |
| | 30-60 | 20 | 26.6 | | |
| | 60-90 | 5 | 6.7 | | |
| | **Total** | **75** | **100.0** | | |
| **II (n= 73)** | <30 | 27 | 37.0 | 8.37 | 0.015 |
| | 30-60 | 20 | 27.4 | | |
| | 60-90 | 16 | 21.9 | | |
| | >90 | 10 | 13.7 | | |
| | **Total** | **73** | **100.0** | | |
| **III (n=35)** | <30 | 4 | 11.4 | 13.05 | 0.001 |
| | 30-60 | 19 | 54.3 | | |
| | 60-90 | 10 | 28.6 | | |
| | >90 | 2 | 5.7 | | |
| | **Total** | **35** | **100.0** | | |
| **IV (n=37)** | <30 | 2 | 5.4 | 9.64 | 0.008 |
| | 30-60 | 4 | 10.8 | | |
| | 60-90 | 16 | 43.3 | | |
| | >90 | 15 | 40.5 | | |
| | **Total** | **37** | **100.0** | | |

***Table 3: Grade Of Pco v/s Laser Energy Required For Capsulotomy***

The energy requirement increased with increasing grade of PCO. Among patients with low grades (grade 1 and grade 2) majority of patients required <60 mJ energy and these differences were significant (p<0.001 for grade I and p = 0.015 for grade II PCO). 69.9% of patients with grade I and 37.7 % with grade II PCO required <30 mJ of energy, while 24.6 % of patients with grade I and 25.9 % with grade II PCO required 30-60mJ mJ of energy for capsulotomy. On evaluating the higher grades of PCO, we found that more patients required significantly higher energy for capsulotomy as compared to the lower grades (grade I & II). 52.9 % of the patients with grade III PCO required 30-60 mJ of energy followed by 32.4 %of the patients, who required 60-90mJ of energy (p=0.001). Among people with grade IV PCO 44.4% of the patients required 60-90mJ of energy and 41.7 % required >90 mJ of energy for capsulotomy (p=0.008) Table 3.

| TIME INTERVAL | MEAN (IOP) (in mmHg) | SD | CHANGE FROM BASELINE | | | |
|---|---|---|---|---|---|---|
| | | | Mean | SD | "t" | "p" |
| Before procedure (baseline (IOP) values) | 15.25 | 2.46 | - | - | - | - |
| Immediately after procedure | 14.70 | 2.62 | -0.55 | 2.54 | 2.27 | 0.024 |
| 3 hours after procedure | 15.68 | 2.51 | 0.42 | 2.49 | 1.81 | 0.070 |
| 1 day after procedure | 15.34 | 2.57 | 0.09 | 2.52 | 0.375 | 0.708 |

*Table 4: Difference in (IOP) From Baseline Post Nd:YAG Capsulotomy*

A significant difference in mean intraocular pressure (IOP) was observed immediately after the capsulotomy. Before the procedure, mean intraocular pressure (IOP) was 15.25 ± 2.46 mmHg and a significant fall in the mean (IOP) was observed immediately post procedure on comparing with the pre-procedure levels, falling to14.70 ± 2.62 mmHg with mean change from the baseline being -0.55 (p=0.024). 3 hours after the procedure, we found a rise in intraocular pressure, peaking at an average of 15.68 ± 2.51mmHg with a mean positive change from the baseline being 0.42 although the change was not significant (p=0.070). However, when we repeated the intraocular pressure (IOP) 1 day after the capsulotomy we found that the (IOP) tended to return towards the baseline values i.e. the pre-procedure values (15.34 ± 2.57 mmHg), with the mean deflection from the baseline being only 0.09 Table 4.

| Laser energy (mJ) | N | Mean (IOP) change | SD |
|---|---|---|---|
| **IMMEDIATE AFTER CAPSULOTOMY** | | | |
| **<30** | 83 | -1.50 | 2.17 |
| **30-60** | 63 | -0.83 | 1.30 |
| **60-90** | 47 | 0.23 | 1.92 |
| **>90** | 27 | -0.10 | 1.96 |
| **ANOVA (F)** | 5.134 | | |
| **P** | 0.002 | | |
| **POST CAPSULOTOMY AFTER 3 HOURS** | | | |
| **<30** | 83 | -0.39 | 1.48 |
| **30-60** | 63 | -0.06 | 1.41 |
| **60-90** | 47 | 1.85 | 2.49 |
| **>90** | 27 | 0.30 | 1.83 |
| **ANOVA (F)** | 8.931 | | |
| **P** | <0.001 | | |
| **POST CAPSULOTOMY AFTER 1 DAY** | | | |
| **<30** | 83 | -0.13 | 1.81 |
| **30-60** | 63 | 0.05 | 1.22 |
| **60-90** | 47 | 0.38 | 1.58 |
| **>90** | 27 | 0.07 | 1.64 |
| **ANOVA (F)** | 1.031 | | |
| **P** | 0.380 | | |

*TABLE 5: (IOP) Change v/s Laser Energy*

When we compared mean intraocular pressure changes from the baseline after the procedure with the energy used for the capsulotomy, we found that there was a greater fall in the intraocular pressure (IOP) from the baseline when lesser amount of energy was used and the association was highly significant (p=0.02; F= 5.134). Immediately after the procedure, average deviation of -1.50 was seen in the mean IOP from the baseline when <30 mJ of energy was used and subsequently lesser fall in IOP was seen from the baseline with increasing energy. A slight rise in the intraocular pressure (IOP) was seen when higher amount of energy was used between 60-90mJ (0.23). When the intraocular pressure was measured 3 hours after the capsulotomy, we found that the rise in the intraocular pressure (IOP) from the initial fall was higher when higher amount of energy was used and this difference was highly significant (p<0.001). A deviation of 1.85 and 0.30 was found from the baseline when the energy used was 60-90 mJ and >90mJ respectively as compared to when <30 mJ and 30-60 mJ of energy was used where change from the mean intraocular pressure (IOP) was -0.39 and -0.06 respectively. One day after capsulotomy the intraocular pressure tended to return towards the baseline more with lower energy levels (p=0.380) Table 5.

## DISCUSSION

Nd:YAG Laser posterior capsulotomy is the treatment of choice for posterior capsular opacification (PCO), as it is a safe and effective outpatient procedure (6,12-13). However, this procedure is not exempted from complications, such as the intraocular pressure elevation, intraocular lens pitting, iritis, hyphaema and sometimes retinal detachment (5,7).

The intraocular pressure elevation is a major complication following Nd:YAG Laser posterior capsulotomy and the incidence of post capsulotomy rise in the intraocular pressure (IOP) has been reported to vary from 15% to 36% (14). Hence, we undertook this study to evaluate the change in pattern of the intraocular pressure (IOP) levels post Nd:YAG capsulotomy and justify the use of IOP lowering drugs to combat this transient rise in the (IOP) levels.

In present study, 220 subjects with a visually significant posterior capsular opacification underwent Nd:YAG laser posterior capsulotomy and their intraocular pressure (IOP) levels were monitored immediately after the capsulotomy, and then 3 hours and 1 day after the procedure.

The females outnumbered males (59.5%:40.5%), observation similar to study by Bhargawa et al (15). This possibly was due to more females undergoing cataract surgery, as they feel symptomatic earlier as compared to males. Maximum number of patients belonged to the age group of 50-70yrs with the mean age of 59.28 years. Majority of patients had grade I &II PCO and the total amount of energy required to disrupt the posterior capsular opacification (PCO) by YAG laser was found to be directly proportional to grade of posterior capsular opacification (PCO) similar to that reported by Hossain and Hossain(2009) (16) and Bhargawa et al (15).

It was observed that a higher energy was needed for posterior capsular opacification (PCO) removal in younger age group patients (17), who usually have thicker opacified posterior capsule following cataract surgery, which is explained by a more active proliferation of posterior capsular cells. Also, higher grade of nuclear cataracts are encountered with increasing age which results in lesser cortical matter residue after cataract surgery and hence thinner posterior capsular opacifications (PCOs) in older age groups (18).

Immediate post capsulotomy the mean intraocular pressure (IOP) was 14.70 ± 2.62 mmHg, which was 0.55mmHg less than the mean baseline (IOP) of 15.27 ± 2.46 mmHg. This, post Nd:YAG capsulotomy immediate decrease of the intraocular pressure (IOP) has no mention in available literature and we attribute this to destructive effect of shock waves on ciliary body epithelium. In addition, there is a possibility of opening of angle by pressure applied by Abraham's contact lens, which could increase outflow facility.

At 3 hour and 1 day after capsulotomy, the mean intraocular pressure (IOP) observed was15.68 ± 2.51mmHg and 15.34 mmHg ± 2.57 mmHg respectively, which was 0.0.42 mmHg and 0.09mmHg above the baseline IOP. This rise of intraocular pressure post capsulotomy may be attributed to reduced aqueous outflow due to obstruction of trabecular meshwork by capsular debris, inflammatory cells, liquefied vitreous and shock wave damage as studied by Lynch (1986) (19), wetzel (1994) (20), Schrems (1948) (21) and oskala O (1989) (22).

The subsequent rise of IOP post capsulotomy was found to be related to the total laser energy delivered. Reduction in the intraocular pressure (IOP) was observed at all the three intervals, when the laser energy was <60 mJ, but when the laser energy was more than 60 mJ the rise in IOP was seen, though statistically not significant. These findings were similar to those observed by Shetty and Sridhar (2016) where after the initial fall the spike in the intraocular pressure (IOP) was seen 2 hours post capsulotomy, which was more in patients in which higher amount of energy, was used (23).

Despite the magnitude of rise in the intraocular pressure in relation to the amount of energy use, we found that after one day the (IOP) returned to the baseline levels, with highest IOP still being recorded for the higher energy group. In a study by Manav Singh (2015), after Nd:YAG capsulotomy no significant rise of IOP was seen between 1 to 24 hours after the procedure, when compared to the pre-procedure baseline values, in the groups receiving ocular hypotensive drug. In the control group who received placebo, the rise of the intraocular pressure was found to be significant at 1, 3 and 5 hours post procedure which returned to insignificant levels at 24 hours (8,24). Although, we did not use any pressure lowering agents, we also found a rise in the intraocular pressure (IOP) post-procedure at the end of 3 hours and similar return to baseline after 24 hours and the spike being higher for higher energy groups.

## CONCLUSION

Posterior capsular opacification being the commonest complication after cataract surgery, Nd:YAG capsulotomy offers a safe and definitive treatment for the same. Increase in the intraocular pressure is one of the many complications that may arise after the procedure. We noticed an immediate fall in (IOP) followed by a spike at 3 hours but the (IOP) tended to return to normal baseline values after 1 day. This rise in the intraocular pressure (IOP) was proportional to the amount of energy used and was inversely related to the age of the patient as younger patients had thicker posterior capsular opacification (PCO) which required more energy and hence more rise in the intraocular pressure (IOP). We found that this rise in the intraocular pressure (IOP) after Nd:YAG capsulotomy was transient in nature, as well as self-limiting.

Hence, we recommend administration of long acting topical intraocular pressure (IOP) lowering agent immediately post capsulotomy before the patient is discharged and the patient to be reviewed after one day for monitoring.

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