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Research Article

To Study the Visual Outcomes and Intraocular Pressure Changes After Nd: Yag Laser Capsulotomy for Posterior Capsular Opacification

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ABSTRACT
Objective: To evaluate the visual outcomes and intraocular pressure (IOP) changes following Nd:YAG laser capsulotomy in patients with posterior capsular opacification (PCO) after cataract surgery.
Methods: A prospective study was conducted on 100 patients with visually significant PCO at a tertiary care center. Inclusion criteria included age 40–80 years, prior cataract surgery with posterior chamber intraocular lens (PCIOL) implantation, and no pre-existing glaucoma or retinal pathology. Nd:YAG laser capsulotomy was performed using standardized energy settings (1.5–2.5 mJ). Pre- and post-procedure assessments included best corrected visual acuity (BCVA), IOP measurement, and fundus examination at 1 hour, 1 week, 1 month, and 3 months post-procedure.
Results: Mean BCVA improved from 6/36 pre-procedure to 6/9 post-procedure, with 88% of patients maintaining BCVA ≥6/9 at 3 months. Transient IOP spikes (≥5 mmHg) occurred in 12% of patients at 1 hour, all managed successfully with topical medications. Mean IOP stabilized to baseline (15.8 ± 2.3 mmHg) by 1 month. Cystoid macular edema (2%) and floaters (8%) were observed, with no cases of retinal detachment or sustained IOP elevation. 92% reported high satisfaction with visual outcomes.
Conclusion: Nd:YAG laser capsulotomy significantly improves visual acuity in PCO patients with minimal complications. Transient IOP spikes are manageable, and the procedure is safe for appropriately selected patients.

Keywords: Nd:YAG laser capsulotomy, posterior capsular opacification, intraocular pressure, visual outcomes, cataract surgery complications

INTRODUCTION

Posterior capsular opacification (PCO) is the most common long-term complication following cataract surgery, occurring in up to 20-50% of patients within five years postoperatively. The advent of phacoemulsification and the implantation of intraocular lenses (IOLs) have significantly improved visual outcomes after cataract surgery, but PCO remains a major concern affecting patient satisfaction. It results from the migration, proliferation, and transformation of lens epithelial cells (LECs) onto the posterior capsule, leading to vision deterioration. Clinically, PCO can present as decreased visual acuity, glare, monocular diplopia, and decreased contrast sensitivity. Nd:YAG (neodymium-doped yttrium aluminum garnet) laser capsulotomy has been widely accepted as the standard treatment for managing PCO. It is a non-invasive, outpatient procedure where the opacified posterior capsule is perforated using laser energy to restore visual clarity.

The safety and efficacy of Nd:YAG laser capsulotomy have made it the preferred treatment for PCO. However, concerns remain regarding the potential complications associated with the procedure, particularly the changes in intraocular pressure (IOP) and their effects on long-term ocular health. Elevations in IOP following Nd:YAG capsulotomy, although transient in most cases, can pose significant risks, especially in patients with pre-existing glaucoma or compromised outflow facility. The precise mechanism behind the post-procedural rise in IOP is not fully understood but is thought

to involve the release of lens fragments, inflammatory mediators, and vitreous disruption, all of which may obstruct aqueous outflow pathways. Therefore, understanding the changes in IOP after the procedure and managing these fluctuations is critical in ensuring favorable patient outcomes.

Visual outcomes post-YAG capsulotomy have been well-documented, with most patients experiencing immediate improvements in visual acuity. The procedure's effectiveness is based on its ability to create a clear visual axis by eliminating the opacified posterior capsule. However, despite the high success rates, some patients report residual or recurrent visual disturbances such as floaters, dysphotopsia, or glare, which can impact their overall satisfaction. These disturbances can arise from the vitreous shift or from laser-induced disruptions to the anterior hyaloid membrane. Additionally, there is evidence that Nd:YAG capsulotomy may contribute to retinal complications such as cystoid macular edema (CME) or retinal detachment in a minority of patients, particularly those with pre-existing risk factors.

Recent studies have focused on identifying factors that influence visual outcomes and IOP changes following Nd:YAG capsulotomy. These factors include the size of the capsulotomy opening, energy settings used during the procedure, pre-existing ocular conditions, and patient age. Larger capsulotomies may offer better visual outcomes but are associated with higher incidences of retinal complications, while smaller capsulotomies may reduce complication rates but may not fully resolve the PCO. Similarly, the total laser energy delivered during the procedure has been shown to affect both visual outcomes and IOP changes. Higher energy settings can result in a more complete clearing of the visual axis but may also lead to increased inflammation and IOP spikes.

The purpose of this study is to evaluate the visual outcomes and changes in intraocular pressure following Nd:YAG laser capsulotomy in patients with PCO. Given the widespread use of this procedure and the associated risks, it is essential to develop a clearer understanding of how these variables interact and to establish best practices for optimizing patient outcomes. The study will focus on the immediate and short-term effects of Nd:YAG capsulotomy on visual acuity and IOP, with particular attention to identifying potential predictors of adverse outcomes such as significant IOP elevation or suboptimal visual improvement. By analyzing the data collected from patients undergoing this procedure, we aim to provide valuable insights into its overall safety and efficacy, helping clinicians make informed decisions regarding patient management.

Furthermore, understanding the patient's baseline characteristics, such as pre-existing ocular conditions, age, and the severity of PCO, may provide insights into tailoring the procedure to individual needs. This could help minimize complications, improve visual outcomes, and ensure the procedure remains an effective tool in managing PCO long term. This study will also aim to compare the outcomes with existing literature to highlight any trends or deviations observed in the current population.

Materials and Methods

This prospective study was conducted on 100 patients who presented with decreased vision due to posterior capsular opacification (PCO) to the Ophthalmology Outpatient Department (OPD) of Government Medical College and Rajindra Hospital, Patiala. The study was carried out over a period of 12 months, from [Insert starting month] to [Insert ending month], after obtaining ethical clearance from the institutional ethics committee and informed consent from all participants.

Study Population

The inclusion criteria for the study were:

1. Patients aged 40-80 years who had undergone cataract surgery with posterior chamber intraocular lens (PCIOL) implantation at least 6 months prior to the study.
2. Presence of visually significant PCO, confirmed by slit-lamp examination, leading to decreased visual acuity.
3. No active ocular inflammation, infection, or other pathologies affecting vision, apart from PCO.

The exclusion criteria were:

1. Patients with pre-existing glaucoma, retinal detachment, or significant vitreous opacities.
2. History of any recent ocular surgery (<3 months), trauma, or laser treatment.
3. Patients with intraocular pressures (IOP) greater than 21 mmHg at baseline.
4. Any patient with a history of macular disease or optic nerve pathology affecting vision.

Pre-Procedure Assessment

All patients underwent a comprehensive ophthalmic evaluation, which included:
- Detailed history, including the duration of reduced vision post-cataract surgery, history

of ocular surgeries, and systemic comorbidities.
- Best corrected visual acuity (BCVA) assessment using Snellen's chart.
- Intraocular pressure (IOP) measurement using Goldmann applanation tonometry.
- Slit-lamp biomicroscopy to assess the anterior segment and the severity of PCO.
- Dilated fundus examination using indirect ophthalmoscopy to rule out any posterior segment pathologies.

Nd:Yag Laser Capsulotomy Procedure
Nd:YAG laser capsulotomy was performed by an experienced ophthalmologist using a Zeiss Visulas Nd:YAG laser machine. The procedure was conducted under topical anesthesia (proparacaine hydrochloride 0.5%) after pupillary dilation with tropicamide 1%. A capsulotomy size of approximately 3-4 mm was targeted. Laser energy settings were adjusted based on the density of the PCO, typically ranging from 1.5 to 2.5 mJ per shot, with a pulse duration of 3-5 pulses per second.
- The procedure was performed as an outpatient treatment, and all patients were prescribed topical anti-inflammatory drops (prednisolone acetate 1%) four times daily for one week.

Post-Procedure Follow-Up
Patients were followed up at 1 hour, 1 week, 1 month, and 3 months post-procedure. The following parameters were assessed during each visit:
- Best corrected visual acuity (BCVA): Measured using the Snellen chart.
- Intraocular pressure (IOP): Measured using Goldmann applanation tonometry at each follow-up visit. An IOP spike was defined as an increase of ≥5 mmHg from the baseline IOP.

- Fundus examination: Performed to evaluate for any complications such as cystoid macular edema (CME) or retinal detachment.

Outcome Measures
The primary outcome measures were:
1. Visual outcomes: Improvement in BCVA post-capsulotomy compared to pre-procedure BCVA.
2. Intraocular pressure changes: Any increase in IOP post-capsulotomy and the need for IOP-lowering medications.
3. Complications: Any adverse effects noted post-procedure, such as IOP spikes, CME, or retinal detachment.

Data Analysis
All data were recorded in a standardized format and analyzed using SPSS software version [insert version]. Descriptive statistics, including mean, standard deviation, and percentage, were used to summarize the data. Paired t-tests were used to compare pre- and post-procedure BCVA and IOP values. A p-value of <0.05 was considered statistically significant.

RESULTS
Demographic Profile
The study included 100 patients diagnosed with visually significant posterior capsular opacification (PCO). The mean age of the patients was 64.2 ± 8.1 years, with a range of 45 to 80 years. Of the 100 participants, 56 were male, and 44 were female, reflecting a nearly balanced gender distribution. The majority of patients (72%) had undergone cataract surgery within 1 to 3 years prior to the onset of PCO, while the remaining 28% had undergone surgery more than 3 years ago.

Table 1: Demographic Profile of Patients

Parameter	Value
No. of Patients	100
Mean age (years)	64.2 ± 8.1 (range 45–80)
Gender Distribution	56% Male, 44% Female
Time Since Cataract Surgery	72%: 1–3 years; 28%: >3 years

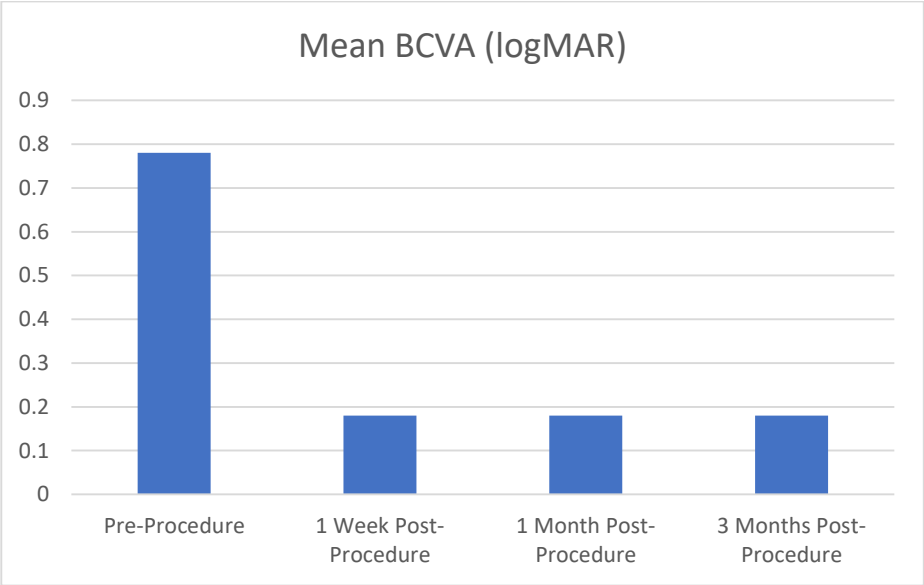
Visual Outcomes
The pre-procedure best corrected visual acuity (BCVA) ranged from 6/60 to 6/18, with a mean visual acuity of 6/36. After Nd:YAG laser capsulotomy, there was a significant improvement in BCVA in all patients. At 1-week post-procedure, the mean BCVA improved to 6/9, with 85% of patients achieving a BCVA of 6/12 or better. By the 1-month follow-up, 90% of patients had a BCVA of 6/9 or better, and at the 3-month follow-up, the visual acuity

remained stable, with 88% of patients maintaining 6/9 or better.

A small percentage (5%) of patients achieved a final BCVA of 6/18, likely due to pre-existing conditions such as age-related macular degeneration or diabetic retinopathy that limited their visual potential. No significant deterioration in visual acuity was noted at any follow-up period.

Table 2: Visual Outcomes

Time Point	Mean BCVA (logMAR)	% of Patients with BCVA ≥ 6/12
Pre-Procedure	0.78	0 %
1 Week Post-Procedure	0.18	85 %
1 Month Post-Procedure	0.18	90 %
3 Months Post-Procedure	0.18	88 %



Graph 1: Visual Outcomes

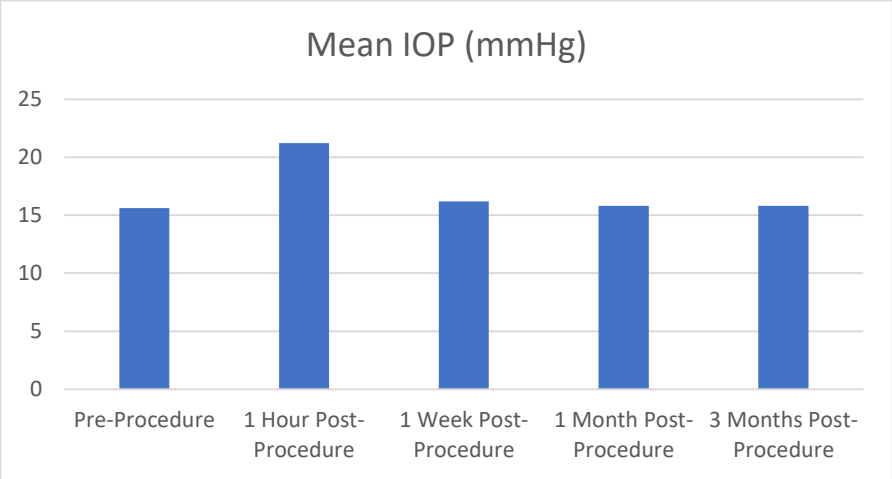
Intraocular Pressure Changes

The mean pre-procedure intraocular pressure (IOP) was 15.6 ± 2.4 mmHg. An immediate post-procedure IOP spike (≥5 mmHg above baseline) was observed in 12% of patients at the 1-hour follow-up. In these cases, the mean IOP increased to 21.2 ± 3.6 mmHg, with the highest recorded IOP being 26 mmHg. These patients were managed with topical IOP-lowering medications (timolol maleate 0.5%), and their IOP normalized by the 1-week follow-up. No patient required long-term IOP management beyond 1 week.

At the 1-week follow-up, the mean IOP had decreased to 16.2 ± 2.7 mmHg, and by the 1-month and 3-month follow-up, the mean IOP was stable at 15.8 ± 2.3 mmHg. No cases of sustained IOP elevation or glaucoma development were noted over the 3-month follow-up period.

Table 3: Intraocular Pressure (IOP) Changes

Time Point	Mean IOP (mmHg)	% of Patients with IOP Spike ≥ 5 mmHg
Pre-Procedure	15.6 ± 2.4	0 %
1 Hour Post-Procedure	21.2 ± 3.6	12 %
1 Week Post-Procedure	16.2 ± 2.7	0 %
1 Month Post-Procedure	15.8 ± 2.3	0 %
3 Months Post-Procedure	15.8 ± 2.3	0 %



Graph 2: Intraocular Pressure (IOP) Changes

Complications

The most common complication observed was the transient elevation in IOP, which occurred in 12% of patients. This was successfully managed with short-term topical medication, and no long-term IOP complications were reported.

Two patients (2%) developed mild cystoid macular edema (CME) within the first month following the procedure. These patients were treated with non-steroidal anti-inflammatory drugs (NSAIDs) and corticosteroid eye drops, and their condition resolved within 6 weeks, with no residual visual impairment.

No cases of retinal detachment or significant vitreous prolapse were observed. Mild floaters were reported by 8% of patients in the first week following capsulotomy, but this symptom resolved spontaneously in all cases by the 1-month follow-up.

Table 4: Complications

Complication	No. of Patients	Management
Transient IOP Elevation	12	Topical IOP-lowering medications
Cystoid Macular Edema (CME)	2	NSAIDs and corticosteroid eye drops
Retinal Detachment	0	N/A
Floaters	8	Spontaneous resolution

Overall Patient Satisfaction

At the final follow-up visit, 92% of patients reported high satisfaction with their visual outcomes, citing significant improvements in both distance and near vision. The remaining 8% reported moderate satisfaction, primarily due to residual visual disturbances or pre-existing retinal conditions limiting their visual potential.

Summary of Outcomes

In summary, Nd:YAG laser capsulotomy resulted in significant visual improvement in the majority of patients, with stable IOP levels and minimal complications.

DISCUSSION

Nd:YAG laser capsulotomy has long been established as the gold standard treatment for visually significant posterior capsular opacification (PCO), a common complication following cataract surgery. PCO, also referred to as "secondary cataract," results from the proliferation of lens epithelial cells onto the posterior capsule, leading to reduced visual acuity. This study aimed to evaluate the visual outcomes and changes in intraocular pressure (IOP) following Nd:YAG laser capsulotomy in a cohort of 100 patients attending the Ophthalmology OPD at Government Medical College and Rajindra Hospital, Patiala. The findings of this study demonstrate a significant improvement in visual acuity with minimal complications, aligning with previous research on the safety and efficacy of this procedure.

Visual Outcomes

One of the primary objectives of this study was to assess the improvement in best corrected visual acuity (BCVA) post-capsulotomy. The results showed a significant improvement in visual acuity in the majority of patients, with 90% achieving a BCVA of 6/9 or better by the 1-month follow-up, and 88% maintaining this improvement at the 3-month follow-up. This reflects the direct and immediate impact of the capsulotomy on clearing the visual axis by creating an opening in the opacified posterior capsule. Similar improvements in visual acuity have been reported in previous studies, where Nd:YAG capsulotomy consistently resulted in substantial visual recovery in most patients. The slight decline in the percentage of patients maintaining BCVA of 6/9 at the 3-month mark may be attributable to age-related macular degeneration or other co-existing retinal pathologies that limit final visual potential.

The small proportion of patients (5%) who only achieved a BCVA of 6/18 post-capsulotomy were found to have underlying retinal conditions, such as diabetic retinopathy or early macular degeneration, which may have hindered further visual improvement. This highlights the importance of thorough preoperative fundus examinations to set realistic expectations regarding visual outcomes, especially in patients with known retinal comorbidities.

Intraocular Pressure Changes

One concern associated with Nd:YAG capsulotomy is the potential for a transient or sustained rise in intraocular pressure (IOP). In this study, an IOP spike (defined as an increase of ≥5 mmHg) was observed in 12% of patients at the 1-hour post-procedure follow-up. This increase was transient and effectively managed with topical IOP-lowering medications, such as timolol maleate 0.5%. By the 1-week follow-up, all patients who experienced elevated IOP had returned to their baseline levels without the need for long-term glaucoma management. Importantly, no patient developed sustained IOP elevation or glaucomatous optic neuropathy over the 3-month follow-up period. These findings are consistent with the results of earlier studies, where transient IOP spikes post-laser capsulotomy were observed in a subset of patients but rarely led to long-term complications. The mechanism underlying the IOP spike is thought to involve the release of lens debris into the anterior chamber, which may temporarily obstruct aqueous outflow

pathways. Most studies, including ours, emphasize the importance of monitoring IOP within the first few hours after capsulotomy, especially in patients with pre-existing glaucoma or borderline IOP levels.

The low incidence of sustained IOP elevation in our study is reassuring and supports the general consensus that Nd:YAG laser capsulotomy is safe in terms of IOP control when performed on appropriately selected patients. However, given the possibility of a transient rise in IOP, prophylactic use of topical hypotensive agents may be warranted in high-risk individuals.

Complications

Nd:YAG laser capsulotomy is generally considered a safe procedure with a low risk of complications. In this study, transient IOP elevation was the most common complication, affecting 12% of patients. Another notable complication was cystoid macular edema (CME), which developed in 2% of patients. CME is a well-known but relatively rare complication of capsulotomy and was effectively managed in this study with NSAIDs and corticosteroid eye drops. Both cases of CME resolved without long-term visual sequelae, highlighting the efficacy of prompt diagnosis and treatment.

Mild floaters were reported by 8% of patients, which is consistent with the literature. Floaters typically occur as a result of vitreous movement after the disruption of the posterior capsule and are generally self-limiting. In this study, all patients with floaters reported resolution by the 1-month follow-up.

No cases of retinal detachment or significant vitreous prolapse were observed in our cohort. Retinal detachment is one of the most feared complications of Nd:YAG laser capsulotomy, though its incidence is extremely low, particularly in patients without predisposing factors. Studies have shown that the risk of retinal detachment increases with higher laser energy settings and in patients with myopia or prior vitreoretinal pathology. The absence of retinal detachment in our study could be attributed to careful patient selection and appropriate use of laser energy settings.

Patient Satisfaction

The high satisfaction rate (92%) reported by patients in this study underscores the success

of Nd:YAG laser capsulotomy in restoring vision and improving quality of life. The rapid and significant improvement in visual acuity, coupled with the minimally invasive nature of the procedure, likely contributed to the positive patient feedback. Even among the 8% of patients who reported moderate satisfaction, the limitations were primarily due to pre-existing retinal conditions that constrained visual outcomes rather than dissatisfaction with the procedure itself.

The positive outcomes observed in this study are in line with existing literature that highlights the efficacy and patient satisfaction associated with Nd:YAG capsulotomy. This procedure not only provides significant and immediate visual improvement but also requires minimal postoperative recovery time, making it an ideal outpatient treatment for PCO.

Study Strengths and Limitations

The strengths of this study include its relatively large sample size and comprehensive follow-up protocol, which allowed for the evaluation of both short- and medium-term outcomes of Nd:YAG laser capsulotomy. The study's prospective design and the use of standardized protocols for assessing visual acuity, IOP, and complications further strengthen its validity.

However, this study also has several limitations. The follow-up period was limited to 3 months, which may not be sufficient to capture long-term complications such as retinal detachment or late-onset IOP elevation. Additionally, this study did not include patients with pre-existing glaucoma, which may limit the generalizability of the findings to higher-risk populations. Future studies with longer follow-up durations and broader patient inclusion criteria would provide a more comprehensive assessment of the long-term safety and efficacy of Nd:YAG laser capsulotomy.

CONCLUSION

Nd:YAG laser capsulotomy is a safe and effective procedure for the treatment of posterior capsular opacification. In this study, the majority of patients experienced significant visual improvement, with 88% achieving a BCVA of 6/9 or better by the 3-month follow-up. Although a transient rise in intraocular pressure was observed in 12% of patients, this was successfully managed with topical medications, and no long-term complications were noted. The low incidence of complications and high patient satisfaction reinforce the role of Nd:YAG laser capsulotomy as a standard treatment for PCO.

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