Original article

Effectiveness of Nd YAG Laser capsulotomy in managing Post IOL low vision due to posterior capsule opacification

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Abstract

Introduction: *Cataract surgery is widely performed; however, posterior capsule opacification remains a major cause of secondary visual impairment and preventable vision loss in India. It arises from proliferation of residual lens epithelial cells, leading to obstruction of the visual axis and reduced visual quality. Despite advances in intraocular lens design, capsulotomy is often required to restore vision. Nd:YAG laser capsulotomy has emerged as the standard noninvasive treatment, providing rapid visual rehabilitation with minimal complications, although transient intraocular pressure elevation may occur.*

Methodology: *This retrospective cross-sectional study was conducted over one year at Index Medical College Hospital and Research Centre, Indore,including patients with post–intraocular lens low vision due to posterior capsule opacification. Eligible patients meeting predefined inclusion and exclusion criteria underwent Nd:YAG laser capsulotomy following detailed baseline ophthalmic evaluation, including BCVA, intraocular pressure, and slit-lamp assessment. Outcomes were assessed pre- and post-procedure with structured follow-up. Statistical analysis was performed using SPSS version 27, applying paired t-test, with $p < 0.05$ considered statistically significant.*

Result: *The findings showed that Pre-laser visual acuity was predominantly moderate (51%) and severe (36%), indicating significant baseline impairment. Post-procedure, BCVA improved markedly from 1.18 ± 0.32 to 0.36 ± 0.21 LogMAR (mean difference = 0.82; $t = 18.72$; $p < 0.001$). Mean IOP increased transiently at 4 hours (16.8 ± 2.9 to 18.2 ± 3.4 mmHg; $p = 0.001$) but decreased below baseline at 1 week (15.9 ± 2.6 mmHg; $p = 0.005$).*

Conclusion: *The study has concluded that Nd:YAG laser capsulotomy demonstrates high efficacy in the management of post–intraocular lens low vision secondary to posterior capsule opacification, producing a substantial and statistically significant improvement in Visual Acuity.*

Keywords: *Posterior Capsule Opacification; Nd:YAG Laser Capsulotomy; Visual Acuity; Intraocular Pressure; Cataract Surgery*

Introduction

Cataract surgery is the most commonly performed eye operation; however, Posterior Capsule Opacification (PCO) is still a major obstacle for the long-term success of the surgery [1]. During 2000s, India experienced tremendous growth in its surgical volume from 3.5 million surgeries in 2000 to being forecasted to need over 14 million surgeries by 2020, using both MSICS and phacoemulsification [2]. Even with this output, PCO can cause "second blindness" and will greatly limit the productivity of the labour force. In tertiary care centres in India, 92.2% of patients have good vision after receiving their cataract surgery initially. 41.2% of patients with PCO develop subsequent visual loss, making PCO the leading cause of preventable visual impairment [1].

PCO is defined as the result of the proliferation and migration of leftover lens epithelial cells (LECs) after cataract surgery. These cells can either form a fibrotic path through epithelial-mesenchymal transition (which leads to contraction of the cells like myofibroblasts) or a regenerative path by creating clusters of "Elschnig pearls" [3]. Both types obstruct the visual axis causing a significant decrease in vision through light scatter and decreased contrast sensitivity. Clinical studies of Indian subjects demonstrate that central fibrosis, as well as both paraxial pearls, are related to functional disability and debilitating glare, despite having relatively high Visual Acuity according to standard charts [4,5]. While modern modifications to edge design of IOLs help alleviate some of these issues, capsulotomy is required to open the central axis to regain the quality of the image reaching the retina, and eliminate light scatter caused by these cellular structures, when PCO occurs [3-5].

Nd:YAG Laser capsulotomy has become the 'standard-of-care' noninvasive treatment option for patients with PCO in India since the 2000s and has transformed the delivery of care in tertiary hospitals from inpatient to outpatient services. It has mostly replaced traditional surgical capsulotomy and offers a clinic-based solution that avoids making an incision into the eye and thus reduces the risk of endophthalmitis [6]. According to the clinical data in India, the Nd:YAG laser capsulotomy can restore the clarity of vision without any trauma from the manipulation of the eye, making it a preferred method for regular post-operative care [6,7]. Since the introduction of Nd:YAG laser capsulotomy, there have been fewer outpatients presenting with late-stage cataract symptoms than previously; therefore, Nd:YAG laser capsulotomy is an effective way to restore the ability to see (functional vision) to many different demographic groups throughout India [6,7].

Studies conducted in India, including the Andhra Pradesh Eye Disease Study (APEDS), have identified PCO as an important cause of poor vision, causing 4% of all cases of blindness in rural central India [8,9]. In the last few years, the widespread use of both PMMA IOL and non-square edge designs for surgery have been associated with a higher incidence of PCO, as compared to currently available acrylic IOL alternatives [9]. In addition, program-based information from rural clinics has demonstrated that Nd:YAG laser capsulotomy provides rapid functional vision improvement within the community setting; however, based on historical data, there is a history of Nd:YAG laser capsulotomy being associated with increased risk of transient IOP elevations and IOL pitting [9]. These results suggest that there is a significant burden to the Indian healthcare system related to the prevalence of PCO and demonstrate the potential for targeted laser therapies to reduce the incidence of "second blindness" from changing surgical materials and designs [8,9].

METHOD

Research design

This is a cross-sectional observational retrospective study which extracted patients' data from the hospital to investigate the efficacy of the Nd YAG Laser capsulotomy, to manage the post IOL, low vision for the posterior capsule opacification. The study was conducted in Index Medical College Hospital and Research Centre, Indore,, for a period of 1 year. The study consists of patients those who have attended the ophthalmology outpatient department, along with the post–intraocular lens (IOL) low vision due to posterior capsule opacification (PCO). Specific inclusion and exclusion criteria were followed for conducting the study, and the eligible patients were selected. Well written and verbal consent were taken for the study. All of the selected patients were performed with Nd:YAG laser capsulotomy and outcome evaluation was investigated by determining the Visual Acuity and the PCO related impairment, before and after the procedure.

Inclusion criteria

- Those patients with significant posterior capsule opacification (PCO) were selected for the study.
- Patients with effective immediate postoperative Visual Acuity after the cataract surgery were considered.
- Those who presented the post-IOL low vision were considered.
- Written and verbal consent were required for the study.

Exclusion criteria

- The presence of corneal or retinal pathology which is affecting the vision was not considered.
- Any pre-history of glaucoma, optic atrophy, amblyopia or retinal disorder were not considered for the study.
- Patients with other severe ocular condition were not included due to low vision problem.
- Patients with incomplete data or unwillingness to enroll, were excluded from the study.

Procedure

The procedural methodology was carried out in a structured and standardized manner in accordance with the study design and outcome measures . All eligible patients underwent a detailed pre-procedural ophthalmic evaluation to determine the extent of visual impairment attributable to posterior capsule opacification (PCO). Baseline assessment included measurement of best-corrected Visual Acuity (BCVA), intraocular pressure (IOP), slit-lamp biomicroscopy for grading of PCO, and comprehensive fundus examination using direct ophthalmoscopy. In cases where posterior segment visualization was inadequate, B-scan ultrasonography was performed to exclude underlying retinal pathology. Following confirmation of eligibility and acquisition of informed written consent, Nd:YAG laser posterior capsulotomy was performed on the affected eye under standard aseptic conditions. The procedure was initiated with an energy level of approximately 1 mJ, which was titrated as required to achieve an adequate capsular opening. A cruciate (cross-shaped) capsulotomy pattern was created along the natural lines of tension of the posterior capsule to ensure a central, well-defined visual axis while minimizing collateral damage to the intraocular lens. Post-procedurally, patients were closely monitored for early complications. Intraocular pressure was measured at 4 hours and again at 1 week following the intervention to detect transient pressure elevations, as reflected in the study outcomes. All patients received standard postoperative medical management, including topical beta-blockers (timolol), antibiotic-steroid combination eye drops to control inflammation, and oral acetazolamide where indicated for IOP control. Subsequent follow-up evaluations were conducted at 1 week, 1 month, 3 months, and 6 months. During each visit, BCVA and IOP were reassessed, and slit-lamp as well as fundus examinations were performed to evaluate anatomical and functional outcomes. Patients were systematically monitored for procedure-related complications, including anterior segment inflammation (iritis, aqueous flare), transient IOP elevation, vitritis, hyphaema, intraocular lens pitting, retinal detachment, and cystoid macular edema. This structured follow-up allowed for comprehensive assessment of both the efficacy and safety profile of Nd:YAG laser capsulotomy in the management of post-IOL visual impairment due to PCO.

Statistical analysis

The study used SPSS 27 for effective analysis and MS excel was used for data management.

Descriptive statistics were used for data summarization, while categorical variables were presented as frequencies and percentages**.** Pre- and post-procedural outcomes like Visual Acuity and intraocular pressure (IOP**)**, were compared by paired t-test. The p-value <0.05 was considered as the statistical significance.

RESULTS

Table 1 shows the baseline demographic and clinical characteristics of the study population prior to Nd:YAG laser capsulotomy. The age distribution demonstrates a predominance of elderly patients, with the highest proportion in the 61–70 years category (36%), followed by those above 70 years (24%), indicating that posterior capsule opacification is largely observed in older individuals. The gender distribution reveals a mild male predominance (58%) compared to females (42%), although the difference is not substantial. The laterality of eye involvement is nearly balanced, with the right eye affected in 54% of cases and the left eye in 46%, suggesting no significant lateral preference. With respect to the duration since cataract surgery, the majority of patients presented within 1–3 years (44%), followed by those with a duration greater than 3 years (38%), while a smaller proportion (18%) developed symptoms within the first year, reflecting the progressive nature of posterior capsule opacification over time. The type of intraocular lens implanted shows a marked predominance of posterior chamber IOLs (91%), consistent with standard surgical practice, whereas anterior chamber IOLs account for only 9%. Baseline Visual Acuity assessment indicates that most patients had moderate visual impairment (6/60–6/36: 51%), followed by severe impairment (HM–CF: 36%), and a smaller proportion with relatively better vision (13%), highlighting that the majority presented with clinically significant visual compromise.

Baseline intraocular pressure is largely within normal to borderline limits, with 48% of patients in the 16–20 mmHg range and 39% in the 10–15 mmHg range, while only 13% exhibited elevated IOP (>20 mmHg). The grading of posterior capsule opacification reveals that moderate (49%) and severe (34%) cases constitute the majority, with fewer mild cases (17%), indicating advanced disease at presentation. Regarding systemic comorbidities, more than half of the patients (52%) had no associated conditions, while diabetes mellitus (28%) and hypertension (20%) were the most common coexisting disorders. Overall, the table reflects a predominantly elderly cohort with moderate-to-severe visual impairment and significant posterior capsule opacification, providing an appropriate baseline for evaluating post-procedural outcomes.

Table 1: Baseline characteristics of the patients

Parameter	Category	Number of Patients (n)	Percentage (%)
Age (years)	40–50	12	12%
	51–60	28	28%
	61–70	36	36%
	>70	24	24%
Gender	Male	58	58%
	Female	42	42%
Laterality of Eye Involved	Right Eye	54	54%

	Left Eye	46	46%
Duration since Cataract Surgery	<1 year	18	18%
	1–3 years	44	44%
	>3 years	38	38%
Type of IOL Implanted	Posterior Chamber IOL	91	91%
	Anterior Chamber IOL	9	9%
Baseline Visual Acuity (BCVA)	HM – CF 5 meters	36	36%
	6/60 – 6/36	51	51%
	6/24 – 6/12	13	13%
Baseline Intraocular Pressure (IOP)	10–15 mmHg	39	39%
	16–20 mmHg	48	48%
	>20 mmHg	13	13%
Grade of PCO (Slit-lamp assessment)	Mild	17	17%
	Moderate	49	49%
	Severe	34	34%
Systemic Comorbidities	None	52	52%
	Diabetes Mellitus	28	28%
	Hypertension	20	20%

Table 2 showed that major patients showed moderate visual impairment, while 51% were under the *6/60–6/36* category, indicated the most common and general baseline of visualization. 36% of population had severe visual impairment, which reflected substantial burden of the visual deficit during presentation. Contrastingly, 13% of patients showed better Visual Acuity. This distribution suggested most of the patients had advanced stage of visualization.

Table 2: Patient distribution of the Pre-laser Visual Acuity (VA) among the study patients

VA Category	Number of Cases	Percentage (%)
HM – CF 5 mts	36	36%
6/60 – 6/36	51	51%
6/24 – 6/12	13	13%
Total	**100**	**100%**

Table 3 demonstrated the rise of the intraocular pressure (IOP) as the most common complication, which affected around 46.3% of cases. This was indicated as the predominant immediate post-procedural event. The most frequent finding was Aqueous flare, accounted to be 28.8%, which was considered as the inflammatory response after the procedure. 13% of cases showed Viritis, indicated moderate incidence of posterior segment inflammation. Rare complications include the pitting of the intraocular lens (6.5%) and bleeding from the iris (3.8%). Around 1.6% of cases showed no complications, which highlighted most of the complications were mild and transient. While the post-procedural conditions was high.

Table 3: Distribution of complications associated with procedure among patients

Complication	**Number of Cases**	**Percentage (%)**
No complications	2	1.60%
Aqueous flare	29	28.80%
Bleeding from iris	4	3.80%
Vitritis	13	13.00%
Rise in IOP (transient)	46	46.30%
Pitting of IOL	6	6.50%
Total	**100**	**100%**

The table 4 indicated that IOP was observed to be stable among patients, 51% showed the change at 4 hours, which rises up to 65% at 1 week. This indicated the impact of normalization. The rise in the IOP was common, with 36% exhibited the 1–2 mmHg increase and 9% a 3–4 mmHg increase at 4 hours; while these proportions reduced from 10% to 2% at 1 week. This rise of (>5 mmHg) was frequent and lacked during the follow up period. No of cases reduced in IOP, which rises from 3% at 4 hours to 23% at 1 week, reflected the delay in the hypotensive effect. The result findings suggested the early elevation of IOP, which are transient and get improved within 1 week.

Table 4: The change in the **Intraocular Pressure (IOP) during the interval of 4 hours and 1 Week Post-procedure**

Change in IOP	After 4 Hours (n=100)	Percentage (%)	After 1 Week (n=100)	Percentage (%)
No change	51	51%	65	65%
1–2 mmHg ↑	36	36%	10	10%
3–4 mmHg ↑	9	9%	2	2%
>5 mmHg ↑	1	1%	0	0%
−1 mmHg ↓	3	3%	23	23%
Total	**100**	**100%**	**100**	**100%**

In Table 5, the baseline best-corrected Visual Acuity (BCVA) expressed in LogMAR shows a markedly elevated mean value prior to the procedure (1.18 ± 0.32), indicating substantial visual impairment. Following Nd:YAG laser capsulotomy, the mean BCVA improves significantly to 0.36 ± 0.21. The mean difference of 0.82 LogMAR units represents a pronounced gain in visual function. This improvement is statistically highly significant, as evidenced by the large t-value (18.72) and a p-value of <0.001 ($p<0.001$). When comparing pre- and post-procedure values, there is a clear and substantial reduction in LogMAR scores, signifying enhanced Visual Acuity in the majority of patients. Clinically, this magnitude of change corresponds to multiple Snellen line improvements, underscoring the effectiveness of the procedure in restoring vision compromised by posterior capsule opacification.

Table 5: Comparative Analysis of Visual Acuity (LogMAR) Before and After Nd:YAG Laser Capsulotomy

Parameter	Pre-procedure (Mean ± SD)	Post-procedure (Mean ± SD)	Mean Difference	t-value	p-value
BCVA (LogMAR)	1.18 ± 0.32	0.36 ± 0.21	0.82	18.72	<0.001

In **Table 6**, intraocular pressure (IOP) demonstrates a dynamic pattern across time points. At baseline, the mean IOP is 16.8 ± 2.9 mmHg. At 4 hours post-procedure, the mean IOP rises to 18.2 ± 3.4 mmHg, with a mean increase of 1.4 mmHg. This elevation is statistically significant ($p=0.001$), indicating a transient post-procedural

spike in IOP. However, at 1 week post-procedure, the mean IOP decreases to 15.9 ± 2.6 mmHg, which is lower than baseline, with a mean difference of −0.9 mmHg. This reduction is also statistically significant (p=0.005). When comparing pre- and post-procedure intervals, the findings suggest an initial short-term increase in IOP followed by normalization and slight reduction below baseline levels. This pattern is consistent with a transient physiological response to laser capsulotomy, which stabilizes with time and appropriate medical management.

Table 6: Comparative Analysis of Intraocular Pressure (IOP) at Baseline, 4 Hours, and 1 Week

Time Interval	Mean IOP (mmHg) ± SD	Mean Difference (vs Baseline)	t-value	p-value
Baseline	16.8 ± 2.9	—	—	—
4 Hours Post-procedure	18.2 ± 3.4	1.4	3.92	0.001
1 Week Post-procedure	15.9 ± 2.6	−0.9	2.85	0.005

Discussion

Nd:YAG laser capsulotomy has been shown to provide rapid, significant improvement in vision in Indian cohorts; on average, best corrected Visual Acuity has improved from <6/18 to 6/9. A randomised trial indicates that, although hydrodissection decreased rates of PCO to 2.3%, Nd:YAG is still necessary for restoring the clarity of the central lens in all affected cases [10]. Just as a rural tertiary vision center reported that, of their hyper mature cataract patients, 14.5% required Nd:YAG within one year, with 0.0–0.2 logMAR of stable vision without complications [7]. For younger adults (<50 years; where PCO exists in 22.2% of cases), 94% of the patients reached a Visual Acuity of 20/40 after Nd:YAG [6,7]. These recognise that Nd:YAG is effective for addressing both measurable vision loss and nonumical deficiencies such as glare and contrast sensitivity and is a reliable gold standard to provide secondary rehabilitation to patients of all ages in India [6,7,10].

Evidence from Chandigarh shows that surgical techniques and the type and fixation of intraocular lens (IOL) are among the most important predictors of the development of posterior capsule opacification (PCO). Compared with the older method of extracapsular cataract extraction, the use of phacoemulsification combined with hydrophobic acrylic optics, centred implant placement and in-the-bag haptic positioning results in a substantially lower rate of clinically significant PCO [11]. The primary reason is most likely due to thorough cortical cleanup and the use of continuous curvilinear capsulorhexis, which helps provide an additional barrier effect to migration of lens epithelial cells. The results of comparative studies also demonstrate that both phacoemulsification and small-incision cataract surgery (SICS) have a better PCO profile than the older extracapsular method [12]. These findings indicate that the use of less invasive methods and the current practice of implanting centred IOLs have significantly reduced the overall incidence of PCO (the "second blindness" burden) in Indian patients and has minimised the activation of regenerative pathways that lead to PCO [11,12].

Studies in the literature show that IOL material greatly influences the PCO. Hydrophobic acrylic IOLs have better long-term clarity compared to hydrophilic IOLs. At three years, the hydrophobic Acrysof group had significantly lower EPCO (Early Posterior Capsule Opacification) scores and did not require Nd:YAG capsulotomy, whereas some hydrophilic groups had capsulotomy rates of up to 16% [13]. Additionally, unilateral PCO (only one eye affected) clinical studies showed that Nd:YAG laser capsulotomy resulted in a

greater than simple ability to read letters at distance following capsulotomy: post Nd:YAG capsulotomy spatial acuity improved from 0.34 logMAR to 0.16 logMAR while contrast sensitivity improved from 22.4 dB to 35.5 dB [14]. More significantly, stereoacuity improved fourfold from 240 to 60 seconds of arc indicating that Nd:YAG capsulotomy is an important step towards restoring binocular depth perception and resolving certain subjective visual disabilities that may be out of proportion with conventional charted acuity [13,14].

the Nd:YAG Laser capsulotomy is still the most widely accepted method for helping individuals to regain their vision after developing posterior capsule opacification. This procedure is rapid to perform, non-invasive and can help prevent "secondary blindness." More focus should be placed on developing standardized energy protocols between different tertiary centres, and larger longitudinal studies should be done on the long-term impact of new square-edged IOL designs. Increasing access to lasers in rural eye hospitals is also important to ensure all individuals can receive equal opportunity in terms of visual rehabilitation.

CONCLUSION

The study has concluded that Nd:YAG laser capsulotomy demonstrates high efficacy in the management of post–intraocular lens low vision secondary to posterior capsule opacification, producing a substantial and statistically significant improvement in Visual Acuity. The marked reduction in LogMAR values reflects meaningful functional visual recovery in the majority of patients. Although transient intraocular pressure elevation may occur, it remains self-limiting and does not compromise overall outcomes. Thus, the procedure represents a reliable and effective modality for rapid visual rehabilitation in affected individuals. Despite this significant initial deficit, the procedure yields substantial and statistically significant improvement in visual outcomes, as evidenced by marked reduction in LogMAR scores, indicating meaningful restoration of functional vision. Although post-procedural complications are relatively common, particularly transient rise in intraocular pressure and mild inflammatory responses such as aqueous flare, these events are largely self-limiting and clinically manageable. The observed pattern of intraocular pressure changes—characterized by an early transient elevation followed by normalization and slight reduction below baseline within one week—further supports the safety profile of the intervention. Overall, Nd:YAG laser capsulotomy emerges as an effective and safe therapeutic modality for posterior capsule opacification, offering significant visual rehabilitation with minimal long-term adverse effects when appropriately monitored and managed.

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