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Research Article

Effect of Nd:Yag Laser Posterior Capsulotomy on Intraocular Pressure, Refraction, Anterior Chamber Depth, Macular Thickness, and Spherical Equivalent in Patients with Posterior Capsular Opacification: a Prospective Interventional Study

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ABSTRACT
Background: Posterior capsular opacification is the most common late complication of cataract surgery and a major cause of visual deterioration after successful cataract extraction. Nd:YAG laser posterior capsulotomy is the standard treatment for visually significant posterior capsular opacification; however, it may influence intraocular pressure, refraction, anterior chamber depth, and macular thickness. This study evaluated the effect of Nd:YAG laser posterior capsulotomy on these ocular parameters.
Methods : A prospective interventional study was conducted in the Department of Ophthalmology, Jawaharlal Nehru Medical College, Ajmer, Rajasthan, from June 2024 to May 2025. One hundred patients with visually significant posterior capsular opacification underwent Nd:YAG laser posterior capsulotomy. Best corrected visual acuity, spherical equivalent, influence intraocular pressure, anterior chamber depth, and macular thickness were assessed before treatment and at 1 hour, 1 week, and 1 month post-procedure. Statistical analysis was performed using paired t-tests, with $p<0.05$ considered significant.
Results: The mean age of participants was 67.37 ± 16.05 years, and 62% were female. Visual acuity improved significantly after capsulotomy, with all patients achieving best corrected visual acuity of 6/6 at one month. Mean spherical equivalent changed from −0.27 ± 0.279 D to −0.195 ± 0.272 D at one week ($p=0.040$) and remained stable thereafter. Mean influence intraocular pressure increased significantly from 14.6 ± 2.01 mmHg to 17.0 ± 1.95 mmHg at 1 hour ($p<0.001$), followed by gradual reduction. Anterior chamber depth and macular thickness showed transient postoperative increases and approached baseline values during follow-up.
Conclusion: Nd:YAG laser posterior capsulotomy is a safe and effective treatment for posterior capsular opacification, providing excellent visual rehabilitation with only transient changes in influence intraocular pressure, refractive status, anterior chamber depth, and macular thickness.

Keywords: Posterior Capsular Opacification, Nd:YAG Laser Capsulotomy, Intraocular Pressure, Anterior Chamber Depth, Macular Thickness, Spherical Equivalent.

INTRODUCTION

Posterior capsular opacification, commonly referred to as secondary cataract, is the most frequent long-term complication following cataract surgery. It results from the proliferation, migration and transformation of residual lens epithelial cells onto the posterior capsule, leading to progressive opacification of the visual axis and deterioration of visual quality (1,2). Despite major advances in cataract surgical techniques and intraocular lens technology, posterior capsular opacification continues to represent a significant cause of visual impairment among pseudophakic patients worldwide.

The incidence of posterior capsular opacification varies according to patient age, surgical technique, and intraocular lens characteristics. Studies have reported that approximately 20–50% of adults develop clinically significant posterior capsular opacification within 2–5 years after cataract surgery, although the prevalence has decreased in recent years because of

improved surgical methods and the use of modern hydrophobic acrylic intraocular lens with sharp posterior optic edges (2,3). In developing countries, including India, the burden of posterior capsular opacification remains substantial because of the large volume of cataract surgeries performed and variations in surgical practices. Reported Indian studies have demonstrated posterior capsular opacification rates ranging from 20% to 40% during the first few postoperative years (4).

Morphologically, posterior capsular opacification is broadly classified into regenerative and fibrotic forms. Regenerative posterior capsular opacification is characterized by the formation of Elschnig pearls and Soemmering ring due to proliferation of residual equatorial lens epithelial cells, whereas fibrotic posterior capsular opacification results from fibrous metaplasia and contraction of residual anterior capsule epithelial cells (5,6). Both forms can interfere with the visual axis and lead to decreased visual acuity, glare, halos, reduced contrast sensitivity and difficulty performing routine visual tasks.

Nd:YAG laser posterior capsulotomy has become the accepted gold-standard treatment for visually significant posterior capsular opacification because it is non-invasive, rapid and highly effective in restoring the transparency of the visual axis (7). The procedure employs photodisruptive laser energy to create an opening in the opacified posterior capsule, thereby allowing unobstructed transmission of light to the retina. Visual improvement following Nd:YAG laser capsulotomy has been consistently documented in numerous clinical studies, making it one of the most commonly performed ophthalmic laser procedures worldwide (8,9).

Although Nd:YAG laser capsulotomy is generally considered safe, several postoperative changes and complications have been reported. One of the most common concerns is transient elevation of intraocular pressure influence intraocular pressure, which may occur because of blockage of the trabecular meshwork by capsular debris, inflammatory cells or vitreous particles released during the procedure (10). Other reported complications include inflammation, cystoid macular edema, retinal detachment, retinal tears, vitreous prolapse, intraocular lens pitting and displacement of the intraocular lens (11,12).

Changes in the position of the intraocular lens after posterior capsulotomy may influence refractive status and anterior chamber depth anterior chamber depth. Posterior movement of the intraocular lens can alter the effective lens position, potentially resulting in measurable refractive changes. Similarly, alterations in macular thickness may occur because of transient inflammatory responses and disruption of the blood-retinal barrier after laser treatment (13,14). The extent and clinical significance of these changes remain subjects of ongoing investigation, with published studies reporting variable findings.

Most available studies have focused on individual ocular parameters following Nd:YAG capsulotomy. However, relatively few investigations have comprehensively evaluated simultaneous changes in visual acuity, intraocular pressure, spherical equivalent, anterior chamber depth, and macular thickness within the same patient population. Furthermore, limited data are available from western Rajasthan and similar regional settings. Therefore, the present study was undertaken to evaluate the effect of Nd:YAG laser posterior capsulotomy on these important ocular parameters and to contribute locally relevant evidence regarding the safety and effectiveness of this widely performed procedure.

MATERIALS AND METHODS

Study Design and Setting

This hospital-based prospective interventional study was conducted in the Department of Ophthalmology, Jawaharlal Nehru Medical College and Associated Group of Hospitals, Ajmer, Rajasthan. Ethical approval was obtained from the Institutional Ethics Committee before commencement of the study.

Study Duration

The study was conducted from June 2024 to May 2025. An additional period was utilized for data compilation, statistical analysis, and manuscript preparation.

Study Population

Patients diagnosed with visually significant posterior capsular opacification following cataract surgery and attending the ophthalmology outpatient department were screened for eligibility.

Sample Size

A total of 100 patients fulfilling the inclusion and exclusion criteria were enrolled using convenient sampling.

Inclusion Criteria

- Age ≥18 years.
- Patients with posterior capsular opacification following uncomplicated cataract surgery.
  Willingness to provide informed written consent.

Exclusion Criteria

- Diagnosed glaucoma or known steroid responders.
- Corneal opacities, retinal pathology, uveitis or optic neuropathy.
  Ocular conditions likely to influence visual outcomes independently of posterior capsular opacification

Clinical Evaluation

A detailed clinical history was obtained from all participants. Comprehensive ophthalmic examination included:

- Best corrected visual acuity using Snellen visual acuity chart.
- Slit-lamp biomicroscopic examination.
- Fundus examination by direct and indirect ophthalmoscopy.
- Autorefractometry for determination of refractive status.
- Calculation of spherical equivalent as spherical power plus half of cylindrical power.
- Measurement of anterior chamber depth using Pentacam.
- Measurement of macular thickness using optical coherence tomography.

Nd:YAG Laser Posterior Capsulotomy Procedure

Pupillary dilation was achieved using a combination of tropicamide 0.8% and phenylephrine 5%. Nd:YAG laser posterior capsulotomy was performed using a slit-lamp-mounted laser delivery system with the patient in a sitting position. A central circular opening was created in the opacified posterior capsule along the visual axis.

Laser energy was initiated at 1 mJ per pulse and gradually increased according to the density of the posterior capsule, with a maximum energy setting of 6 mJ per pulse. Laser focus was maintained slightly posterior to the capsule to minimize the risk of intraocular lens damage.

Follow-Up Protocol

Patients were evaluated at the following intervals:

- Pre-procedure baseline
- 1 hour post-procedure
- 1 week post-procedure
- 1 month post-procedure

At each visit, best corrected visual acuity, influence intraocular pressure, spherical equivalent, anterior chamber depth, and macular thickness were assessed and documented.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 26. Quantitative variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Paired t-test was used for comparison of continuous variables at different follow-up intervals. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1. Demographic Characteristics of Study Participants (N=100)

Variable	Number (%)
Male	38 (38%)
Female	62 (62%)
Total	100 (100%)
Age Group (Years)	**Number (%)**
18–35	1 (1%)
36–45	2 (2%)
46–55	4 (4%)
56–65	18 (18%)
66–75	65 (65%)
>77	10 (10%)
Mean Age ± Sd	67.37 ± 16.05

Table 2. Best Corrected Visual Acuity Before and After Nd:YAG Laser Capsulotomy

Bcva	Before	1 Hour	1 Week	1 Month
6/6	0	3	55	100
6/9	0	43	41	0
6/12	25	14	4	0
6/18	23	15	0	0
6/24	20	10	0	0
6/36	14	13	0	0
6/60	16	2	0	0

Table 3. Changes in Spherical Equivalent Following Nd:YAG Laser Capsulotomy

Follow-Up Interval	Mean SE (D)	SD
Preoperative	-0.27	0.279
1 Week	-0.195	0.272
1 Month	-0.195	0.272

Comparison	P-Value
Preoperative Vs 1 Week	0.040
1 Week Vs 1 Month	1.000

Table 4. Changes in Intraocular Pressure Following Nd:YAG Laser Capsulotomy

Follow-Up Interval	Mean IOP (Mmhg)	SD
Preoperative	14.6	2.01
1 Hour	17.0	1.95
1 Week	15.9	1.89
1 Month	15.1	2.01

Comparison	P-Value
Preoperative Vs 1 Hour	<0.001
Preoperative Vs 1 Week	<0.001
Preoperative Vs 1 Month	<0.001

Table 5. Changes in Anterior Chamber Depth and Macular Thickness Following Nd:YAG Laser Capsulotomy

Follow-Up Interval	Anterior Chamber Depth (Mm) Mean ± SD	Macular Thickness (Mm) Mean ± SD
Preoperative	3.01 ± 0.061	263 ± 12.7
1 Hour	3.07 ± 0.050	271 ± 10.6
1 Week	3.03 ± 0.053	266 ± 11.9
1 Month	3.01 ± 0.056	263 ± 12.4

Parameter	P-Value
Anterior Chamber Depth (Preoperative Vs 1 Hour)	<0.001
Anterior Chamber Depth (Preoperative Vs 1 Month)	0.011
Macular Thickness (Preoperative Vs 1 Hour)	<0.001
Macular Thickness (Preoperative Vs 1 Month)	<0.001

DISCUSSION

Posterior capsular opacification remains the most common delayed complication of cataract surgery despite continuous advances in surgical techniques and intraocular lens design. Nd:YAG laser posterior capsulotomy is the accepted standard treatment for visually significant posterior capsular opacification because of its effectiveness in restoring visual function. The present prospective interventional study evaluated the effects of Nd:YAG laser posterior capsulotomy on visual acuity, spherical equivalent, intraocular pressure, anterior chamber depth and macular thickness in 100 patients.

The majority of patients in the present study were females (62%), with a mean age of 67.37 ± 16.05 years. Similar demographic distributions have been reported in previous studies, where elderly individuals represented the largest proportion of patients requiring Nd:YAG laser capsulotomy due to the age-related occurrence of cataract and subsequent development of posterior capsular

opacification (1,2). The predominance of elderly patients highlights the cumulative nature of posterior capsule opacification following cataract surgery.

A significant improvement in visual acuity was observed following Nd:YAG laser posterior capsulotomy. Before treatment, most patients had visual acuity ranging from 6/12 to 6/60, whereas all patients achieved 6/6 vision at one month. Comparable studies have reported marked visual rehabilitation after laser capsulotomy in the majority of patients with visually significant posterior capsular opacification (3,4). Restoration of a clear visual axis following disruption of the opacified capsule explains the substantial improvement in postoperative vision.

The present study demonstrated a mild but statistically significant change in spherical equivalent during the first postoperative week, which subsequently stabilized by one month. Similar findings have been reported previously, showing minimal refractive alterations following Nd:YAG laser capsulotomy with stabilization during follow-up (5). These refractive changes may be related to subtle alterations in effective lens position after disruption of the posterior capsule. However, the magnitude of change was clinically insignificant and did not adversely affect visual outcomes.

Intraocular pressure showed a significant transient rise immediately after the procedure, increasing from 14.6 ± 2.01 mmHg preoperatively to 17.0 ± 1.95 mmHg at one hour. A gradual decline toward baseline values was subsequently observed. Similar transient influence intraocular pressure elevations have been documented in earlier studies, which reported temporary increases in influence intraocular pressure following Nd:YAG capsulotomy due to blockage of the trabecular meshwork by capsular debris and inflammatory material (6–8). The reduction in influence intraocular pressure during follow-up indicates that these changes are generally self-limiting. Nevertheless, careful postoperative monitoring remains essential, particularly in patients with glaucoma or ocular hypertension.

Anterior chamber depth increased significantly immediately after capsulotomy and gradually returned toward baseline values during follow-up. These findings support the hypothesis that Nd:YAG laser treatment may induce slight posterior displacement of the intraocular lens following release of capsular tension. Previous studies have similarly demonstrated small changes in intraocular lens position and anterior chamber depth after laser capsulotomy (5). Although statistically significant, these anatomical alterations were minimal and unlikely to be clinically relevant.

The present study also demonstrated a transient increase in macular thickness after Nd:YAG laser posterior capsulotomy, with gradual normalization by one month. Similar findings have been reported in earlier studies, which observed increased macular thickness during the early postoperative period, particularly when higher laser energy levels were used (8). The temporary increase in retinal thickness is likely related to inflammatory mediator release and transient disruption of the blood-retinal barrier. Importantly, no clinically significant cystoid macular edema or permanent retinal complications were observed in the present study.

Overall, the findings of this study confirm that Nd:YAG laser posterior capsulotomy is a highly effective procedure for the management of visually significant posterior capsular opacification. Although transient changes in intraocular pressure, anterior chamber depth, refractive status and macular thickness may occur, these alterations are generally mild, self-limiting, and clinically insignificant. Appropriate postoperative follow-up remains important to identify patients who may require additional monitoring or treatment.

CONCLUSION

The present study demonstrates that Nd:YAG laser posterior capsulotomy is a safe, effective, and reliable treatment modality for visually significant posterior capsular opacification. The procedure resulted in substantial improvement in visual acuity, with all patients achieving excellent visual outcomes by one month of follow-up.

Nd:YAG laser capsulotomy was associated with mild transient changes in intraocular pressure, spherical equivalent, anterior chamber depth, and macular thickness. These alterations showed a tendency to normalize during follow-up and did not result in clinically significant adverse effects. The transient rise in intraocular pressure observed immediately after the procedure highlights the importance of short-term postoperative monitoring, particularly in high-risk patients.

Overall, the procedure provides rapid visual rehabilitation with a favorable safety profile. Routine follow-up and appropriate management of early postoperative changes can further enhance patient outcomes. Larger multicentric studies with longer follow-up periods are recommended to evaluate the long-term effects of Nd:YAG laser posterior capsulotomy on ocular anatomy and visual function.

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