

Research Article**STUDY OF ND: YAG LASER ENERGY LEVELS REQUIRED FOR DIFFERENT TYPES OF POSTERIOR CAPSULE OPACIFICATION****Sushant Durkar^{1*}, Vibhavari Barhate², Yogendra Vabale³, Smita Pawar⁴, Saurabh Shinde⁵, Karina Dalwai⁶**^{1,5,6}Junior resident, ²Senior Resident, ³Professor, ⁴Professor &HOD, Dept. of Ophthalmology, MIMER Medical College, Pune**Corresponding Author: Dr. Sushant Durkar****Junior resident, Dept. of Ophthalmology, MIMER Medical College, Pune.****Received date: 20-10-2025, Accepted date: 31-10-2025, Date of publication: 05-11-2025****Abstract****Purpose:**

To assess the average Nd:YAG laser energy required for various morphological forms of posterior capsule opacification (PCO) and to evaluate post-laser changes in best-corrected visual acuity (BCVA) and intraocular pressure (IOP).

Methods:

A descriptive observational study was carried out in the Ophthalmology Outpatient Department of a tertiary care rural hospital. Forty-two eyes with clinically confirmed PCO after cataract surgery were included and categorized as membranous, fibrous, or fibro-membranous types. All patients underwent Nd:YAG laser posterior capsulotomy using a standardized technique. Total laser energy applied was documented. BCVA and IOP were assessed pre-procedure, one hour post-procedure, and one week later. Data were analyzed using SPSS software, with statistical significance defined as $p < 0.05$.

Results:

The mean total laser energy delivered was 48.00 ± 6.50 mJ for membranous PCO, 82.80 ± 9.10 mJ for fibrous PCO, and 74.80 ± 8.20 mJ for fibro-membranous PCO. All groups demonstrated significant improvement in BCVA following capsulotomy ($p < 0.001$). A transient IOP rise was observed one hour post-laser (mean increase: 2.5–3.6 mmHg, $p < 0.001$), which normalized by one week ($p > 0.05$). No serious adverse events were recorded.

Conclusion:

Nd:YAG laser posterior capsulotomy is a safe, effective, and non-invasive method for treating PCO. Fibrous PCO demands the highest mean energy, while membranous PCO requires the least. Individualized energy titration based on PCO type enhances visual outcomes and reduces complications. Short-term IOP elevation is temporary but warrants post-procedure monitoring, especially in glaucoma-prone individuals.

Keywords:

Posterior capsule opacification, Nd:YAG laser, capsulotomy, intraocular pressure, visual acuity, cataract surgery

INTRODUCTION

Posterior capsule opacification (PCO) is the most frequent cause of late visual decline following cataract extraction. It is commonly referred to as a *secondary cataract* or *after-cataract* [1,2]. PCO develops due to the proliferation, migration, and differentiation of residual lens epithelial cells on the posterior capsule, resulting in decreased vision, glare, and reduced contrast sensitivity [3]. Despite major improvements in phacoemulsification and intraocular lens (IOL) designs, PCO continues to affect a significant proportion of patients after surgery [4]. Studies estimate its incidence to be approximately 20.7% two years after cataract surgery and nearly 28.5% at five years [5].

Morphologically, PCO is categorized into two principal types — fibrous and pearl (membranous). Fibrous PCO results from abnormal proliferation and contraction of lens epithelial cells, leading to folds or wrinkles on the posterior capsule. In contrast, pearl (membranous) PCO is characterized by the presence of swollen, degenerated epithelial cells that form a pearl-like appearance near the equatorial region [6].

Nd:YAG (neodymium-doped yttrium-aluminum-garnet) laser capsulotomy remains the gold standard for managing visually significant PCO. It is a non-invasive outpatient procedure that provides rapid restoration of vision, with success rates exceeding 95% [7,8]. The Nd:YAG laser emits light at 1064 nm and disrupts the opacified posterior capsule by inducing plasma formation and optical breakdown within ocular tissues [9].

Although generally safe, this procedure can occasionally lead to complications such as IOL damage or displacement, transient or persistent IOP elevation, glaucoma, retinal edema, cystoid macular edema, and, rarely, retinal detachment [10–12].

The current study was designed to evaluate the average laser energy required for different morphological types of PCO, analyze associated changes in BCVA and IOP, and determine how total energy delivery influences post-procedure outcomes.

METHODOLOGY

Study Design:

A descriptive, observational study was conducted at the Ophthalmology Outpatient Department of a tertiary care rural hospital. Ethical clearance was obtained from the Institutional Ethics Committee, and written informed consent was taken from all participants.

Sample Size and Selection:

A total of 42 eyes from 42 patients with PCO following cataract surgery were included. Based on earlier reports on Nd:YAG capsulotomy energy levels, a minimum of 14 eyes per PCO type (membranous, fibrous, and fibro-membranous) was required to detect a 10%

difference in mean energy with a standard deviation of 68.83 ± 8.84 [7]. Patients were recruited by purposive sampling.

Inclusion Criteria:

- Patients with clinically diagnosed PCO at least three months post-cataract surgery.

Exclusion Criteria:

- History of traumatic or pediatric cataract.
- Presence of diabetic retinopathy or age-related macular degeneration (ARMD).
- Posterior capsule rupture, retinal detachment in the fellow eye, or previous vitreoretinal surgery.

Procedure:

All participants underwent comprehensive ophthalmic evaluation, including BCVA, slit-lamp biomicroscopy, and IOP measurement by Goldmann applanation tonometry. A fundus examination with a 90D lens was performed to rule out posterior segment pathology.

Nd:YAG laser capsulotomy was carried out using a ZEISS VISULAS III laser system. Energy levels were titrated according to PCO density, and total energy delivered was documented.

Outcome Measures:

- **Primary outcome:** Mean Nd:YAG laser energy used for different PCO morphologies.
- **Secondary outcomes:** Changes in BCVA and IOP following laser treatment.

Data Analysis:

Pre- and post-laser BCVA and IOP were analyzed using SPSS software. IOP was measured pre-procedure, one hour post-procedure, and one week post-procedure. Statistical comparisons were performed using the Kruskal-Wallis test, with $p < 0.05$ considered statistically significant.

RESULTS

Demographic Characteristics

The study included 42 patients (42 eyes) aged 47–81 years, with a mean age of 64.0 ± 9.2 years. Females comprised 57% ($n = 24$) of the cohort, and males 43% ($n = 18$).

Energy Levels for Different PCO Types

The mean initial laser pulse energy was 1.5 ± 0.35 mJ for membranous PCO, 2.3 ± 0.56 mJ for fibrous PCO, and 2.2 ± 0.43 mJ for fibro-membranous PCO.

Type of PCO	Mean Energy (mJ)	SD (mJ)
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Membranous	1.5	0.35
Fibrous	2.3	0.56
Fibro-membranous	2.2	0.43

The mean total laser energy required was 48.00 ± 6.50 mJ for membranous PCO, 82.80 ± 9.10 mJ for fibrous PCO, and 74.80 ± 8.20 mJ for fibro-membranous PCO.

Visual Acuity Outcomes

Significant improvement in BCVA was observed in all groups ($p < 0.001$):

Type of PCO	Pre-procedure BCVA	Post-procedure BCVA	p-value
Membranous	6/18 (logMAR 0.48)	6/9 (logMAR 0.18)	< 0.001
Fibrous	6/24 (logMAR 0.60)	6/12 (logMAR 0.30)	< 0.001
Fibro-membranous	6/36 (logMAR 0.78)	6/18 (logMAR 0.48)	< 0.001

After capsulotomy, 92.9% of eyes achieved a visual acuity between 6/9 and 6/6.

Intraocular Pressure Changes

A transient rise in IOP was noted one hour after the procedure, which normalized within one week.

Type of PCO	Pre-procedure IOP (mmHg)	Post-procedure IOP (mmHg)	Change in IOP (mmHg)	p-value	Post procedure IOP after 1 week (mmhg)	Change in IOP after 1 week (mmhg)	p-value(1 week)
Membranous	15.25 ± 2.3	17.75 ± 4.7	2.5	< 0.001	15.5 ± 2.1	0.25	0.6043
Fibrous	16.1 ± 2.4	19.7 ± 4.5	3.6	< 0.001	16.8 ± 2.3	0.7	0.1761
Fibro-membranous	15.7 ± 2.6	18.6 ± 4.0	2.9	< 0.001	16.2 ± 2.5	0.5	0.3716

DISCUSSION

PCO remains the most frequent postoperative complication following cataract surgery, despite continuous advancements in surgical methods and IOL materials [1–4]. The current study showed that the mean energy required for Nd:YAG capsulotomy varies according to PCO morphology, with fibrous PCO requiring the highest mean energy. This aligns with

earlier findings indicating that dense, collagenous fibrous opacities demand greater energy for adequate capsule disruption [7,9,13].

All PCO types demonstrated substantial visual improvement post-procedure, reaffirming the efficacy of Nd:YAG capsulotomy for rapid visual rehabilitation [8,10,14]. Nearly 93% of patients achieved 6/9 to 6/6 vision, comparable to previous studies by Shaikh et al. [15] and Raj et al. [16].

The temporary post-procedure IOP rise (2.5–3.6 mmHg) likely resulted from inflammatory mediators and debris obstructing the trabecular meshwork [9,11,17]. However, IOP normalized within a week, consistent with prior literature [10,11,18]. Although no serious complications such as retinal detachment or cystoid macular edema were reported, cautious energy titration remains critical, as excessive total energy may increase the risk of posterior segment complications [11,19].

Limitations:

This study was limited by its small sample size and short follow-up duration. Long-term follow-up with a larger sample is necessary to detect delayed complications and to define standardized energy parameters for each PCO subtype.

CONCLUSION

Nd:YAG laser posterior capsulotomy is a highly effective, non-invasive treatment for posterior capsule opacification, providing rapid and significant visual improvement. Fibrous PCO requires the greatest mean energy, whereas membranous PCO needs the least. Although a transient increase in IOP is common, it resolves spontaneously within one week. Careful adjustment of laser energy based on PCO morphology can optimize outcomes and minimize complications. Regular post-laser IOP monitoring is recommended, especially for glaucoma-prone patients.

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Conflicts of Interest

None declared.

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