

Neodymium–Yttrium-Aluminium-Garnet (Nd:YAG) Laser Lysis of Retained Cortex Following Phacoemulsification Cataract Surgery

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Abstract:

Background: Cataract is the leading cause of reversible blindness worldwide, with phacoemulsification being the most common surgical technique. Retained cortical material, though infrequent, remains a significant postoperative complication that can impair visual recovery and lead to secondary ocular morbidity if untreated. Nd:YAG laser lysis has emerged as a minimally invasive alternative to conventional surgical aspiration for managing retained cortex.

Aim: To evaluate the efficacy and safety of Nd:YAG laser lysis in the management of retained cortical material following phacoemulsification cataract surgery.

Methods: This prospective observational study was conducted at the Department of Ophthalmology, Anugrah Narayan Magadh Medical College and Hospital, Gaya, over a period of 13 months. A total of 115 patients with retained cortical material after phacoemulsification were included. Nd:YAG laser lysis was performed under topical anesthesia, and patients were followed up for 3 months. Visual acuity, intraocular pressure (IOP), and postoperative complications were recorded. Statistical analysis was performed using SPSS version 23.0, with $p < 0.05$ considered significant.

Results: The mean pre-laser best corrected visual acuity (BCVA) of 0.48 ± 0.12 logMAR improved significantly to 0.18 ± 0.09 logMAR at 1 month and 0.12 ± 0.07 logMAR at 3 months ($p < 0.001$). A transient IOP rise was observed immediately post-procedure (mean 17.9 ± 2.6 mmHg), which normalized within one week. Minor complications were noted in 10.4% of patients, including anterior chamber reaction, transient IOP spikes, and posterior capsular pits, all of which resolved without long-term sequelae.

Conclusion: Nd:YAG laser lysis is a safe, effective, and minimally invasive procedure for managing retained cortical material after phacoemulsification, resulting in significant visual improvement with minimal complications.

Recommendations: Nd:YAG laser lysis should be considered the preferred first-line intervention for retained cortical remnants post-phacoemulsification, provided patients are carefully selected and monitored for transient IOP changes. Further multicentric studies with larger sample sizes are recommended to validate these findings.

Keywords: Nd:YAG laser, Retained cortex, Phacoemulsification, Visual acuity, Postoperative complications.

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Introduction

Cataract remains the leading cause of reversible blindness worldwide, accounting for nearly 45% of visual impairment in low- and middle-income countries despite advances in surgical techniques [1]. Phacoemulsification has emerged as the standard of care for cataract surgery due to its safety, rapid recovery, and superior visual outcomes when compared with conventional extracapsular extraction [2]. However, retained cortical material following phacoemulsification continues to be a clinically significant postoperative complication,

occurring in 0.3–1.5% of cases [3]. If not managed promptly, retained cortex can lead to inflammation, secondary glaucoma, cystoid macular edema, and compromised visual recovery [4].

Traditional management of retained cortical remnants has included manual aspiration or anterior vitrectomy when cortical material is substantial. However, these approaches may increase the risk of complications such as corneal edema, capsular rupture, and prolonged surgical time [5]. In recent

years, the use of (Nd:YAG) laser lysis has gained attention as a minimally invasive alternative for the management of retained cortex. The Nd:YAG laser produces photodisruptive energy that effectively fragments or displaces cortical material into the anterior chamber, where it is gradually resorbed by the eye's natural mechanisms [6].

Several studies have demonstrated that Nd:YAG laser lysis offers distinct advantages, including being an outpatient procedure, reducing surgical manipulation, and minimizing the risk of intraocular complications [7]. Moreover, with proper energy titration, the procedure has been shown to restore visual acuity effectively while maintaining ocular safety [8]. Recent advances in laser delivery systems and improved understanding of postoperative ocular physiology have further strengthened the role of Nd:YAG laser in addressing such complications [9].

In the Indian context, where the burden of cataract surgery is exceptionally high due to population demographics and limited resources, strategies that ensure safe and efficient postoperative outcomes are particularly important. Retained cortex, though uncommon, can significantly affect patient satisfaction and increase the economic burden of care when additional surgical interventions are required [10]. Therefore, evaluating the efficacy and safety of Nd:YAG laser lysis in managing retained cortex after phacoemulsification is crucial for improving patient outcomes and reducing complication-related morbidity. This study was undertaken to assess the role of Nd:YAG laser lysis in patients with retained cortex following phacoemulsification cataract surgery, with particular emphasis on visual outcomes, intraocular pressure changes, and procedure-related complications.

Methodology

Study Design: This was a hospital-based, prospective observational study.

Study Setting: The study was carried out in the Department of Ophthalmology at Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, over a period of 13 months. All patients presenting with retained cortical material after phacoemulsification cataract surgery during the study duration were considered for inclusion.

Participants: A total of 115 patients who developed retained cortex after undergoing phacoemulsification cataract surgery and fulfilled the eligibility criteria were enrolled. Each patient was explained about the procedure and written informed consent was obtained prior to inclusion in the study.

Inclusion Criteria

- Patients of either gender aged ≥ 40 years undergoing phacoemulsification cataract surgery.
- Patients who developed retained cortical material postoperatively.
- Patients willing to undergo Nd:YAG laser lysis and participate in follow-up examinations.

Exclusion Criteria

- Patients with pre-existing corneal pathology or poor corneal clarity that interfered with laser application.
- Patients with pre-existing glaucoma, uveitis, or retinal pathology.
- Patients with complicated cataract surgeries such as posterior capsular rupture requiring anterior vitrectomy.
- Patients unwilling or unable to provide informed consent or comply with follow-up visits.

Bias: To minimize selection bias, all consecutive patients meeting the eligibility criteria during the study period were included. Information bias was reduced by ensuring that data collection and clinical examinations were carried out by the same team of ophthalmologists using standardized protocols.

Data Collection: Data were collected using a structured proforma, which included demographic details, preoperative ocular findings, intraoperative observations, and postoperative complications. Detailed ocular examinations were conducted at baseline and during follow-up visits using slit-lamp biomicroscopy, applanation tonometry, and funduscopy.

Procedure: Nd:YAG laser lysis was performed in all patients with retained cortex after phacoemulsification. The procedure was carried out under topical anesthesia using a slit-lamp-mounted Nd:YAG laser system. Laser energy was titrated according to the density and adherence of cortical material, with care taken to minimize collateral damage. Patients were prescribed topical corticosteroids and antibiotics post-procedure and were followed up at regular intervals to assess visual outcome, intraocular pressure changes, and resolution of cortical material.

Statistical Analysis: All collected data were compiled and analyzed using (SPSS) version 23.0. Continuous variables were expressed as mean $\pm$ standard deviation (SD), whereas categorical variables were expressed as frequency and percentage. The chi-square test was used to analyze categorical variables, and the Student's t-test was applied for continuous variables. A p value of <0.05 was considered statistically significant.

Results

A total of 115 patients who developed retained cortical material after phacoemulsification cataract surgery were included in the study. The mean age of

the participants was 61.4 ± 8.2 years (range: 45–78 years). Among them, 68 (59.1%) were males and 47 (40.9%) were females, giving a male-to-female ratio of approximately 1.4:1. The majority of patients (54.8%) were in the 60–69 years age group.

Table 1: Demographic Characteristics of the Study Participants (n = 115)

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)	40–49	14	12.2
	50–59	23	20.0
	60–69	63	54.8
	≥ 70	15	13.0
Gender	Male	68	59.1
	Female	47	40.9

Most patients were elderly, with more than half in the 60–69 years group. A slight male predominance was noted.

Laterality and Preoperative Characteristics: Out of 115 cases, 66 (57.4%) involved the right eye and 49 (42.6%) involved the left eye. The mean pre-laser (BCVA) was 0.48 ± 0.12 logMAR, and mean (IOP) was 15.7 ± 2.3 mmHg.

Post-Laser Visual Outcome: Following Nd:YAG laser lysis, a significant improvement in visual acuity was observed. At the 1-month follow-up, the mean BCVA improved to 0.18 ± 0.09 logMAR, and at 3 months, further improvement was seen (0.12 ± 0.07 logMAR). Statistical analysis revealed a highly significant improvement ($p < 0.001$, paired t-test).

Table 2: Comparison of Visual Acuity Before and After Nd:YAG Laser Lysis

Time Point	Mean BCVA (logMAR) $\pm$ SD	p value
Pre-laser	0.48 ± 0.12	—
1-month Post-laser	0.18 ± 0.09	<0.001
3-month Post-laser	0.12 ± 0.07	<0.001

Visual acuity significantly improved post-laser, highlighting the efficacy of Nd:YAG laser lysis in restoring vision.

(IOP) Changes: Mean IOP showed a mild, transient rise immediately after the procedure (17.9 ± 2.6 mmHg) but returned to baseline levels by 1 week and remained stable thereafter. No patient required long-term anti-glaucoma medication.

Table 3: Mean Intraocular Pressure at Different Time Points

Time Point	Mean IOP (mmHg) $\pm$ SD	p value vs baseline
Pre-laser	15.7 ± 2.3	—
1-hour Post-laser	17.9 ± 2.6	0.032 (significant)
1-week Post-laser	15.9 ± 2.2	0.671 (NS)
1-month Post-laser	15.8 ± 2.1	0.754 (NS)

A short-lived IOP rise was observed immediately post-laser, which normalized without long-term sequelae.

Complications: Out of 115 patients, 12 (10.4%) developed mild complications. These included mild

anterior chamber reaction (6.1%), transient IOP spikes (2.6%), and posterior capsular pits (1.7%). All complications were self-limiting or managed conservatively without significant impact on final vision.

Table 4: Post-Laser Complications Observed (n = 115)

Complication	Frequency (n)	Percentage (%)
Mild anterior chamber reaction	7	6.1
Transient IOP rise	3	2.6
Posterior capsular pits	2	1.7
Total	12	10.4

Nd:YAG laser lysis was found to be safe, with only minor and transient complications noted.

Summary of Findings

- Nd:YAG laser lysis effectively resolved retained cortical material in all 115 patients (100%).
- Statistically significant improvement in visual acuity was achieved ($p < 0.001$).
- Only mild, transient complications were noted in 10.4% of patients, none of which affected final outcomes.
- The procedure was well-tolerated, safe, and effective in restoring postoperative visual function.

Discussion

A total of **115 patients** with retained cortical material after phacoemulsification cataract surgery were evaluated in this study. The mean age of participants was 61.4 years, with the majority belonging to the 60–69 years age group, indicating that cortical retention is more common in elderly individuals with denser cataracts. A slight male predominance was noted, with males constituting 59.1% of the cohort.

Nd:YAG laser lysis was successfully performed in all cases. A significant improvement in visual acuity was observed following the procedure. The mean pre-laser (BCVA) of 0.48 logMAR improved markedly to 0.18 logMAR at 1 month and further to 0.12 logMAR at 3 months, demonstrating that the procedure was highly effective in restoring vision. Statistical analysis confirmed this improvement to be highly significant ($p < 0.001$), reinforcing the therapeutic value of Nd:YAG laser in such cases.

In terms of (IOP), there was a mild but statistically significant transient rise within the first hour post-laser. However, IOP levels normalized within one week and remained stable at subsequent follow-ups. This indicates that while IOP elevation is a common immediate response to laser energy, it is generally self-limiting and does not compromise long-term ocular health when appropriately monitored.

Complications were observed in 10.4% of patients, but they were mostly minor and transient, including mild anterior chamber inflammation, short-lived IOP spikes, and occasional posterior capsular pits. Importantly, none of these complications had a detrimental effect on the final visual outcomes, highlighting the safety profile of Nd:YAG laser lysis when performed with proper precautions.

Nd:YAG laser continues to play a pivotal role in the management of complications after phacoemulsification cataract surgery. A study demonstrated the effectiveness of Nd:YAG laser membranotomy for anterior capsular phimosis, restoring anterior chamber depth and improving

visual acuity with minimal complications [11]. Similarly, Nd:YAG vitreolysis has been applied successfully in patients with symptomatic vitreous floaters post-surgery, showing significant improvement in subjective visual quality and patient satisfaction [12].

Posterior capsule opacification (PCO) remains the most frequent late complication of cataract surgery, and Nd:YAG capsulotomy remains the gold standard of treatment. Recent studies have reconfirmed its efficacy, with high rates of visual improvement and low complication rates [13,14]. Pediatric patients with PCO also benefit from Nd:YAG capsulotomy, with favorable safety and effectiveness profiles, highlighting the versatility of the laser across different age groups [15].

Other studies expand Nd:YAG's role in addressing additional complications. Research into its application in retained anterior capsule opacities demonstrated significant visual improvements and safety in routine use [16]. Further, Nd:YAG laser treatment has been explored for secondary intraocular lens (IOL) opacification and posterior capsule thickening, showing successful outcomes with preservation of lens stability [17]. Finally, Nd:YAG laser application in posterior segment issues, such as dense vitreous strands after phacoemulsification, has been reported to improve visual function and reduce patient complaints, reinforcing its relevance beyond anterior segment complications [18]. Together, these findings emphasize that while direct studies on Nd:YAG lysis of retained cortex remain limited, the expanding body of evidence strongly supports Nd:YAG laser's safety and efficacy for a wide range of post-phacoemulsification complications.

Conclusion

Nd:YAG laser lysis proved to be a safe and effective technique for the management of retained cortex following phacoemulsification cataract surgery. It resulted in significant improvement in visual acuity, with only minor and transient complications observed. The procedure offers a reliable, minimally invasive option for restoring vision and improving postoperative outcomes in affected patients.

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