

Research Article

Variation in Intraocular Pressure and Energy Usage Following Nd:YAG Capsulotomy in Pseudophakic Patients

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ABSTRACT

Background: The most frequent late complication of cataract surgery in pseudophakic patients is posterior capsule opacification.

Objective: To assess intraocular pressure changes after Nd: YAG laser capsulotomy and correlate with the total energy applied in pseudophakic eyes.

Materials and Methods: This prospective observational study was conducted in Department of Ophthalmology, People's University of Medical n Health Sciences Nawabshah, Pakistan from November 2025 to April 2026. All 120 pseudophakic patients with posterior capsule opacification that was significant for vision had Nd: YAG laser capsulotomy. Intraocular pressure was measured preoperatively and at 1, 4 and 24 hours postoperatively. The total laser energy used was determined and analyzed.

Results: The mean intraocular pressure increased from 14.3 ± 2.1 mmHg prior to surgery to 17.1 ± 2.8 mmHg at 1 hour and decreased to 14.7 ± 2.2 mmHg at 24 hours. There was a significant correlation between the increase in intraocular pressure after surgery and the laser energy level. There were no major complications in 90.8% of the patients and improvement of visual acuity.

Conclusions: Nd: YAG laser capsulotomy is a safe and effective treatment for posterior capsule opacification. The intraocular pressure elevation is a common event, closely related to the total laser energy, and usually subsides with proper postoperative management.

Keywords: Nd:Yag Laser Capsulotomy, Posterior Capsule Opacification, Pseudophakia, Laser Energy, Cataract Surgery.

INTRODUCTION

Posterior capsule opacification (PCO) is the most common late complication that occurs following cataract surgery using an intraocular lens (IOLens). Although the incidence of PCO has been reduced by the advent of modern surgical techniques and the development of new intraocular lens materials, it remains a very common problem in pseudophakic patients and may result in a progressive loss of visual function, glare, contrast sensitivity, and quality of life. The condition is caused by fibrotic and pearl formation of the lens epithelial cells that remain, which grow and spread over the back of the lens capsule, blocking the visual axis (1). Nd: YAG laser capsulotomy is one of the most

common laser procedures performed in ophthalmology, with a high success rate and low complication rate. The laser beams in the process are focused to create a hole in the opacified posterior capsule, enabling light to pass to the retina without being blocked.

Immediate improvement in visual acuity and visual function after treatment is seen in most patients. Although the procedure has its benefits, it always has some complications. Transient and permanent adverse effects have been reported, including elevated intraocular pressure (IOP), cystoid macular edema, retinal detachment, intraocular lens damage, inflammation, vitreous prolapse, and refractive changes. These include the short-term increase

in IOP, which is one of the most common complications and is closely monitored after surgery (2). In addition to improving visual clarity, Nd: YAG capsulotomy can also have an effect on the refractive status of pseudophakic eyes. Posterior capsule disruption may lead to intraocular lens movement and small refractive changes that can affect postoperative visual function.

A recent systematic review and meta-analysis showed that while the majority of refractive changes following Nd: YAG capsulotomy are relatively small in size, the changes in SE and lens position may depend on the size of the capsulotomy, the amount of laser energy delivered, and the type of IOLTA used. The results of this study show the need to assess both visual improvement and refractive stability following surgery (3). In some patients, there are minimal changes, while others may show measurable refractive changes, necessitating a change in refractive prescription. Some suggested contributors include capsulotomy diameter, posterior movement of the intraocular lens, and pre-existing ocular characteristics. The findings suggest that postoperative assessment is critical to achieve the best possible visual rehabilitation and patient satisfaction following laser treatment (4). Capsulotomy and refractive stability have remained a topic of interest in recent literature. The investigators suggest that the refractive changes seen after the procedure could be explained by a change in the effective lens position after the posterior capsule is disrupted. These changes are not usually clinically relevant for the majority of patients, but can be significant for patients with premium intraocular lenses or patients who desire an accurate refractive result. Therefore, knowledge of postoperative eye changes has become a significant part of patient management (5). Transient intraocular pressure elevation is one of the most clinically significant of all reported complications, and an elevation in IOP could adversely affect optic nerve function, especially in patients with glaucoma or OHT. This pressure increase is thought to be caused by the blockage of the trabecular meshwork by inflammatory cells, capsular debris, pigment particles, and vitreous material that is released during laser therapy. Temporary inflammatory reactions and changes in aqueous humor dynamics also may play a role.

Elevated IOP is typically mild and transient, but early detection and treatment are critical to

avoid vision-threatening complications (6). In addition to intraocular pressure, Nd: YAG capsulotomy can affect several anterior segment parameters. The procedure has been reported to cause changes in anterior chamber depth, refraction, and even retinal morphology. Many of these changes are minor and clinically not relevant, but are important to understand the biomechanical changes induced by laser energy in pseudophakic eyes. Regular visual acuity and intraocular pressure (IOP) checks should be completed with a full assessment of the anterior chamber characteristics, refraction and retinal status following surgery (7).

Laser energy delivered during capsulotomy has come to be recognized as an important factor that affects postoperative outcome. A greater overall laser energy could be associated with greater liberation of capsular debris, greater inflammatory response, and an increased risk of transient increase in IOP. A few investigators have reported that high energy is correlated with high pressure change after the procedure and may increase safety if less energy were used, but still provide adequate capsulotomy. Results validate the need for optimizing the laser parameters in normal clinical use (8). The IOP elevation after Nd: YAG capsulotomy has also been investigated in the different patient groups. In most studies, pressure elevation typically occurs within the first several hours after treatment, peaks in the early postoperative period and slowly returns to normal within a few days.

However, there is a wide range of pressure increases between people, depending on the characteristics of the eye, the laser parameters, and the prophylactic medications used. This has resulted in the idea that there is a need for different postoperative monitoring protocols (9). The Nd: YAG laser capsulotomy is performed primarily for improved vision; however, the outcome of surgery cannot be evaluated solely by the visual acuity. Recent studies have shown that visual recovery and postoperative safety parameters, especially intraocular pressure, should be taken into account when assessing the results of the procedure. A laser that could be directed appropriately to create a proper capsulotomy with minimal tissue disruption could yield maximum visual outcomes at a low rate of complications and enhance patient care (10).

In recent years, extensive reviews have been published, which have established the central role of Nd: YAG laser technology in modern ophthalmology. The reviews, however,

emphasize the significance of procedural skills, energy selection and postoperative surveillance in minimizing risks and adverse events in clinical practice (11). A few clinical studies have also investigated the association between laser treatment and anterior segment parameters. It is suggested that multiple anatomical and physiological changes occur following the disruption of the posterior capsule, as shown by data, which indicate that Nd: YAG capsulotomy can influence various parameters, including the refraction, anterior chamber depth, and intraocular pressure. The findings support the idea that postoperative examination should not be limited to just visual acuity testing, but should also include a thorough eye examination (12).

Certain patient groups require more post Nd: YAG capsulotomy care. People with diabetes mellitus might show abnormal inflammatory reactions and might be more prone to pressure changes or complications in the retina after laser therapy. There have been reports of measurable IOD changes after surgery in diabetic patients, highlighting the importance of careful monitoring and management of these patients on an individual basis (13). Similarly, diabetic pseudophakic eyes have been studied, and it has been demonstrated that Nd: YAG laser capsulotomy can affect a number of clinical parameters, including visual acuity, central macular thickness, refraction and intraocular pressure. These findings reflect the diversity of the postoperative response and the importance of a comprehensive eye examination in patients with systemic diseases after laser capsulotomy (14).

Evidence is consistent that most patients improves visually, although there will be a transient increase in pressure after surgery. The findings corroborate the need for routine IOP monitoring, especially in the early postoperative period, when the likelihood of IOP elevation is highest (15). Recent developments in ophthalmic imaging have also allowed for the study of subtle changes in the cornea and anterior segment after laser therapy. It has been reported that the morphological and topographic parameters of the corneal endothelium are altered early after Nd: YAG capsulotomy, indicating that laser energy may have an effect on other tissues in the eye besides the posterior capsule. These results continue to support the concept of employing the minimum laser energy required for effective capsulotomy (16). Although there is increasing evidence for Nd: YAG laser

capsulotomy, the exact relationship between total laser energy and intraocular pressure changes after capsulotomy is always unknown. Due to differences in study populations, laser techniques, follow-up schedules, and outcome measures, the results found in the literature have been inconsistent. Moreover, there are relatively few data available from local populations with different patient characteristics and clinical practices (17).

Objective: To assess intraocular pressure changes after Nd: YAG laser capsulotomy and correlate the total amount of laser energy used with changes in intraocular pressure after surgery in pseudophakic eyes.

MATERIALS AND METHODS

Study Design: Prospective Observational study.

Study Setting: Department of Ophthalmology, People's University of Medical n Health Sciences Nawabshah, Pakistan.

Duration of the Study: From November, 2025 to April 2026.

Inclusion Criteria: The study included patients over 40 years of age, both male and female, with pseudophakic eyes who had been diagnosed with visually significant posterior capsule opacification (VSPCO) and were candidates for Nd: YAG laser capsulotomy. Patients were enrolled if they had an uncomplicated cataract surgery with a posterior chamber intraocular lens (PCIOLTA) implant at least six months prior to presentation and had given informed, written consent.

Exclusion Criteria: Patients with glaucoma, ocular hypertension, active ocular infection or inflammation, retinal disease affecting vision, previous intraocular surgery (except cataract extraction), traumatic cataract, or previous laser procedures were excluded. Patients who were taking anti-glaucoma drugs, had significant corneal opacity that made intraocular pressure measurement difficult, had not been followed up or refused to participate were also excluded.

Methods

All patients and the hospital's ethics review committee were informed and eligible patients were examined in detail prior to Nd: YAG laser capsulotomy. The operations were carried out by one highly experienced ophthalmologist using a standard Nd: YAG laser system. The total energy of the laser delivered to each

capsulotomy was recorded in millijoules (mJ). IOP was measured before and 1, 4 and 24 hours after laser treatment. Patients were observed for immediate postoperative complications and the standard postoperative topical medications were given as per departmental protocol. The structured data collection form was used to record information on the demographic characteristics, total laser energy used, and intraocular pressure values. All the data were coded and analyzed using SPSS version 26.

RESULTS

During the study period, 120 pseudophakic patients with visually significant posterior capsule opacification underwent Nd: YAG laser capsulotomy. In 65 (54.2%) patients, the right eye was treated, and in 55 (45.8%) patients, the left eye was treated. The average interval from cataract surgery was 2.9 ± 1.4 years. The mean total laser energy delivered during capsulotomy was 42.3 ± 10.6 mJ, ranging from 22 mJ to 68 mJ.

Table 1: Baseline Demographic and Clinical Characteristics of the Study Participants (n = 120)

Variable	Frequency (%) / Mean $\pm$ SD
Age (years)	62.8 $\pm$ 8.7
45-54 years	24 (20.0)
55-64 years	49 (40.8)
≥ 65 years	47 (39.2)
Male	68 (56.7)
Female	52 (43.3)
Right eye	65 (54.2)
Left eye	55 (45.8)
Duration after cataract surgery (years)	2.9 $\pm$ 1.4
Mean laser energy (mJ)	42.3 $\pm$ 10.6

The mean intraocular pressure (IOP) at baseline prior to laser treatment was 14.3 ± 2.1 mmHg. The mean intraocular pressure was 17.1 ± 2.8 mmHg at 1 h after Nd: YAG capsulotomy, which was the highest level recorded after the procedure. At 4 hours, the mean pressure was 15.9 ± 2.5 mmHg, and at 24 hours, it was further reduced to 14.7 ± 2.2

mmHg, close to baseline levels. In total, 28 (23.3%) patients had an intraocular pressure increase greater than 5 mmHg at 1 hour after surgery, and in 5 (4.2%) patients, the intraocular pressure remained elevated at 24 hours. All cases responded well to antiglaucoma topical medication, and no patient required further surgical treatment.

Table 2: Changes in Intraocular Pressure Following Nd:YAG Laser Capsulotomy

Time of assessment	Mean IOP (mmHg) $\pm$ SD
Pre-procedure	14.3 $\pm$ 2.1
1 hour	17.1 $\pm$ 2.8
4 hours	15.9 $\pm$ 2.5
24 hours	14.7 $\pm$ 2.2

There was a clear trend between total laser energy and postoperative intraocular pressure. The mean pressure change for patients treated with ≤ 35 mJ was 1.4 ± 0.8 mmHg, while patients treated with 36-45 mJ had 2.8 ± 1.1 mmHg. Patients treated with >45 mJ showed the highest pressure rise, averaging 4.6 ± 1.7 mmHg. The total laser energy was statistically significantly associated with an increase in

intraocular pressure after surgery ($p < 0.001$). Capsulotomy resulted in an improvement of visual acuity of 2 or more Snellen lines in 109 (90.8%) patients. Anterior chamber inflammation was noted in 9 (7.5%) patients, and transient floaters were noted in 12 (10%) patients. There were no reports of retinal detachment, endophthalmitis, or any serious vision-threatening complications.

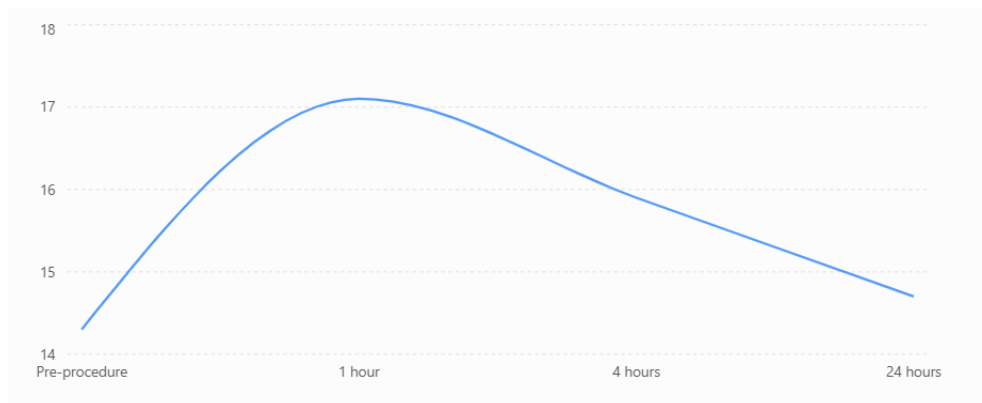
Table 3. Association between Total Laser Energy and Rise in Intraocular Pressure

Total laser energy (mJ)	Patients n (%)	Mean IOP rise (mmHg)
≤ 35	33 (27.5)	1.4 $\pm$ 0.8
36-45	51 (42.5)	2.8 $\pm$ 1.1

>45	36 (30.0)	4.6 ± 1.7
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The results showed that IOP peaked during the first hour after surgery and then slowly normalized over the next 24 hours. A correlation between higher laser energy levels and higher transient pressure elevation was observed at all energy levels, indicating that

less total laser energy is required to obtain an adequate capsulotomy while maintaining a comparable visual improvement without an increase in postoperative ocular hypertension risk.



DISCUSSION

The current study investigated changes in intraocular pressure after Nd: YAG laser capsulotomy and the correlation between total laser energy applied and intraocular pressure change in pseudophakic eyes. Intraocular pressure was highest at 1 hour after surgery and returned to baseline within 24 hours. Additionally, patients receiving higher total laser energy had a greater postoperative increase in intraocular pressure than those receiving lower energy. The results indicate that the laser energy delivered has an important effect on early postoperative changes in intraocular pressure. However, when the posterior capsule is disrupted, inflammatory cells, pigment particles, and capsular debris enter the anterior chamber and may, for a short time, block aqueous humor outflow through the trabecular meshwork, leading to raised intraocular pressure.

Most of the changes are transitory, and the reason for the spontaneous normalization of intraocular pressure in the majority of patients within the first postoperative day is that the right postoperative care is performed (1). The mean intraocular pressure rose from 14.3 mmHg preoperatively to 17.1 mmHg one hour after laser capsulotomy and then gradually decreased during the follow-up period in the present study. Siddiqui et al. also reported an increase in intraocular pressure in a significant proportion of pseudophakic patients after Nd: YAG capsulotomy, especially during the first few hours after surgery. Their results justify

monitoring intraocular pressure after laser therapy as a routine practice to identify patients who need temporary antiglaucoma therapy (2). The goal of Nd: YAG capsulotomy is to restore visual clarity, but the surgery can also affect refractive status and the position of the effective lens. Previous systematic reviews have shown that posterior capsule disruption can cause small, clinically insignificant refractive changes in most patients.

However, refractive stability is still crucial, especially in patients who require premium intraocular lenses and/or have high visual demands. In the present study, the improvement in visual acuity did not result in clinically significant adverse refractive outcomes, indicating the safety of the procedure (3). The same findings have been reported by several investigators regarding refractive outcomes after Nd: YAG laser capsulotomy. However, Mahany and Mohamed noted minor refractive changes after the procedure, but the visual improvement is significant enough to more than offset them. They also stressed the importance of patient counseling regarding possible postoperative refractive fluctuations, which could enhance patient satisfaction and postoperative expectations (4).

Similarly, Moshirfar et al. found that the majority of refractive changes following capsulotomy were due to minor intraocular lens movement rather than to permanent optical complications. Their review confirms the view that Nd: YAG capsulotomy is a highly

predictable procedure with good long-term visual outcomes (5). The more the laser energy is accumulated, the higher the pressure rise in patients. Azeez et al. also reported that the inflammatory response rises with laser energy and the transient intraocular pressure (IOP) rise was more pronounced as laser energy increased. They suggested that using laser energy in the minimum amount and a proper capsulotomy may reduce the post-op complications without compromising the effectiveness of the treatment (6).

The changes of the anterior segment after Nd: YAG capsulotomy have also been studied previously. Selim et al. found that laser treatment resulted in measurable changes in anterior chamber depth and refraction, but most of the changes were mild and clinically insignificant. The findings of these studies indicate that laser capsulotomy does not adversely affect the overall stability of the pseudophakic eye, but does cause temporary anatomical changes, which is substantiated by the excellent post-operative results obtained in the present study (7). As laser energy has been increased, so has the intraocular pressure (IOP) been reported in the literature. In a study of the energy levels in Nd: YAG capsulotomy, Ahmed et al. determined that the higher the cumulative energy the higher the pressure rise after surgery.

They recommended using the minimum energy level for the laser to produce a satisfactory capsulotomy, as demonstrated by the present investigation (8). Saad et al. found that elevations were typically short-lived but were more common with higher laser energy and larger capsulotomy size (9,10). Nd: YAG laser capsulotomy has been consistently proven to be one of the safest and most effective laser treatments for the eyes. But Borkenstein and Borkenstein pointed out that few complications occur if the correct patient is chosen, energy is carefully matched, and patients are monitored following surgery. They also emphasized the need for personalized treatment planning, especially for those who have underlying eye disease or a higher risk of glaucoma (11). Rana also demonstrated that Nd: YAG capsulotomy has a significant impact on a number of parameters in the anterior segment of the eye, such as intraocular pressure, anterior chamber depth and refraction, which are typically within clinically acceptable limits. Their observations are important for a thorough postoperative evaluation to identify temporary physiological

changes and prompt management if needed (12).

Extra attention should be given in the postoperative follow-up in patients with systemic diseases. Diabetic patients may experience greater intraocular pressure (IOP) fluctuations following Nd: YAG capsulotomy than non-diabetic patients, as a result of a different inflammatory response and impaired ocular physiology, reported by Umer et al. Similarly, Çiftci and Filik reported that, although visual outcomes were good, diabetic patients need to be monitored for changes in central macular thickness and intraocular pressure following laser treatment (13,14). Recent clinical trials have further confirmed the safety of Nd:YAG laser capsulotomy and the importance of the need for post-operative monitoring. In the short-term follow-up, Jain et al. demonstrated that the most common postoperative findings were transient increase in intraocular pressure and mild decrease in anterior chamber depth with most of the patients returning to normal levels.

Mutaf et al., also reported that increasing the laser energy could cause temporary changes in corneal endothelium and topography, reinforcing the need to avoid unnecessary exposure to laser energy during treatment (15, 16). The present study has several merits, such as a prospective design, standardized measurement of intraocular pressure, and the evaluation of total laser energy as a predictor of postoperative pressure elevation. But some restrictions must be noted. This study was performed in a single tertiary care hospital and had a small sample size and a brief follow-up time of 24 hours. Long-term follow-up may offer further data on late complications like chronically elevated intraocular pressure, retinal separation, or cystoid macular edema (17).

CONCLUSION

Posterior capsule opacification in pseudophakic patients can be safely, effectively, and minimally invasively treated by Nd: YAG laser posterior capsulotomy. The present study showed that a transient elevation of intraocular pressure is a frequent occurrence after the operation, but is usually temporary, being greatest in the early postoperative period, and returning to near normal levels within 24 hours with proper management. However, there was a significant positive correlation between the total laser energy delivered and the magnitude of the postoperative intraocular pressure rise,

suggesting that the greater the laser energy used, the greater the intraocular pressure rise. Most patients had significant improvement in visual acuity with no serious complications. The results suggest the need for the minimum laser energy to obtain an adequate capsulotomy and the need for routine intraocular pressure monitoring after surgery, especially in patients who may have a higher risk of glaucoma or ocular hypertension. Surgical technique and proper post-operative care can further enhance patient safety and visual results.

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