

Outcome Following Nd: YAG Laser Capsulotomy in Posterior Capsular Opacification in a Tertiary Hospital

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Abstract

Background: Posterior Capsular Opacification (PCO) is a common delayed complication of cataract surgery, often impairing vision. Nd:YAG laser capsulotomy is the standard treatment to restore visual function. To assess visual outcomes, laser energy parameters and complications following Nd: YAG laser capsulotomy in PCO patients.

Materials and methods: A prospective observational study was conducted at Chittagong Medical College Hospital (CMCH) from April 2022 to March 2023, involving 92 pseudophakic patients aged ≥ 40 years with significant PCO (BCVA $< 6/9$). Patients were followed for 4 weeks post-procedure. Data on visual acuity, Intraocular Pressure (IOP) laser energy, shots used and complications were recorded.

Results: The mean age was 60.2 ± 7.5 years, with a near-equal gender distribution. The most common PCO type was Elschnig pearl (56.5%) and Grade 3 was the most frequent severity (46.7%). The average energy used was 46.92 ± 16.34 mJ with 25.72 ± 7.31 shots. BCVA improved significantly, with 97.8% achieving 6/6–6/12 by Week 4. Mean IOP peaked at 4 hours post-laser but normalized by Week 4. Most patients (66.3%) had no complications, others had IOP spikes (14.1%) iritis (12%) IOL pitting (10.9%) or corneal edema (6.5%).

Conclusion: Nd:YAG laser capsulotomy is a safe, effective and noninvasive procedure that significantly improves vision in PCO with minimal transient complications.

Key words: Intraocular Pressure (IOP); Nd:YAG laser capsulotomy; posterior capsular opacification (PCO); Visual outcome.

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Introduction

Globally, cataract and refractive error are the most prevalent causes of moderate to severe vision impairment, which has increased due to changing social demographics and population ageing.¹ Bangladesh is not an exception. Cataract (73.4%) was the predominant cause of visual impairment in Bangladesh.² The most preferred surgical approach for treating cataracts is Extracapsular Cataract Extraction (ECCE) combined with Posterior Chamber Intraocular Lens (PCIOL) implantation.³ ECCE involves removing the lens, leaving an intact posterior capsule, creating an anatomical barrier between anterior and posterior segments, which opacifies postoperatively to form a dark cloud known as posterior capsular opacification.⁴ It may take almost 2 months to 5 years to develop PCO after cataract surgery and the prevalence of PCO was reported to range from 8.3% to 33.7%.⁵

The exact mechanism behind PCO is unclear, but it is believed to occur from the growth and proliferation of lens epithelial cells post-cataract surgery, which migrate to the posterior capsule and produce elschnig pearls and fibrous type PCO.⁶ It results in decreased vision, glare, and other symptoms as like as the original cataract. PCO results in the deterioration of vision and no effective methods are exist to prevent it.⁷ Results of a recent study suggests that younger age, glaucoma, hydrophilic intraocular lenses and a history of uveitis are the possible associated factors for developing visually significant PCO.⁸ Nd: YAG laser is now most commonly applied treatment modalities for PCO. Though Nd:YAG laser capsulotomy is a non invasive, less time consuming and can be practiced as an outdoor procedure, it has also some complications.⁹ Several complications are associated with laser capsulotomy, such as transient rise in IOP, enhanced risk of retinal detachment, cystoid macular oedema, lens damage/ pitting, endophthalmitis, vitreous prolapse into the anterior chamber and anterior hyaloid disruption.¹⁰

To identify various factors associated with development of PCO after cataract surgery, types of and grade of PCO, required laser energy and laser shots and to evaluate visual outcome of Nd: YAG capsulotomy and post laser complication, the current study was conducted in a tertiary level hospital in Chattogram, Bangladesh.

Materials and methods

This is a prospective observational study. Patients aged 40 years or above with visually significant PCO (Vision <6/9) confirmed by slit lamp, at least 3 months post-surgery and treated with Nd: YAG laser capsulotomy at CMCH were included. Exclusion criteria were poor general health, ocular conditions affecting vision (e.g. Corneal scars, glaucoma, uveitis, retinal diseases) uncooperative behavior, pregnancy or refusal to participate.

Data was collected from the department of Ophthalmology at CMCH from April 2022 to March 2023. All the consecutive patients were assessed for the eligibility. Before Nd:YAG laser capsulotomy, informed written consent was obtained, and detailed ocular and medical histories were recorded. Best Corrected Visual Acuity (BCVA) was assessed and intraocular pressure was measured by Goldmann applanation tonometer. Complete slit lamp and fundus examinations were done. PCO was classified by type—fibrous, Elschnig pearl, or mixed.⁶ And graded as a four-point scale: 1 = No/slight PCO without reduced red reflex, 2 = Mild PCO reducing red reflex, pearls at IOL edge, 3 = Moderate fibrosis or pearls inside IOL edge but clear visual axis, 4 = Severe fibrosis or pearls covering visual axis, with severely reduced red reflex.¹¹ Pupil dilation was done with Tropicamide 0.8% and Phenylephrine 5%, and topical anesthesia (0.5% proparacaine) was used. The procedure involved a cruciate capsulotomy (2.5–3 mm) starting from 12 to 6 o'clock with energy adjusted as needed. Post-procedure, patients received topical steroids and anti-glaucoma drops if indicated. Visual acuity and intraocular pressure were assessed at 1st hour, 4th hour, 1st day, 1st week, and 4th week, along with evaluations for any complications. Data was collected through a structured case record form containing questionnaire and checklist.

Data were analyzed using SPSS version 25.0. Continuous variables were expressed as mean $\pm$ SD and categorical variables as frequency and percentage. Graph was used as appropriate.

Ethical approval was taken before starting the study from the Ethical Review Committee of Chittagong Medical College (Memo no. CMC/PG/2022/810 dated 10/04/2022).

Results

The study included 92 patients with a mean age of 60.2 ± 7.5 years (Range: 45.0–74.0) nearly evenly split between males (51.1%) and females (48.9%). Most patients (76.1%) underwent SICS with PCIOR and received PMMA IOLs (76.1%).² PCO formation most frequently occurred between >6 months and 1-year post-cataract extraction (31.5%). Elschnig pearl was the predominant PCO type (56.5%) with Grade 3 being the most common grade (46.7%).

Pre-laser, no patient had BCVA of 6/6–6/12. Post-laser, BCVA significantly improved, with 46.7% achieving 6/6–6/12 by Day 1, rising to 85.9% by Week 1 and reaching 97.8% by Week 4.

The mean energy required was 46.92 ± 16.34 mJ (Range: 26.0–84.0 mJ) and the mean shots required were 25.72 ± 7.31 (Range: 15.0–44.0).⁵ Fibrous PCO types required higher energy and more shots compared to Elschnig pearl.

Mean IOP transiently rose from a pre-treatment baseline of 15.09 mm Hg, peaking at 18.09 mm Hg at 4 hours post-operation, before returning to 14.24 mm Hg by 28 days post-operation.

A majority of patients (66.3%) experienced no complications.⁸ Observed complications included intraocular pressure spikes (14.1%) iritis (12%) IOL pitting (10.9%) and corneal edema (6.5%).

Table I Demographic characteristics of the patients (n=92)

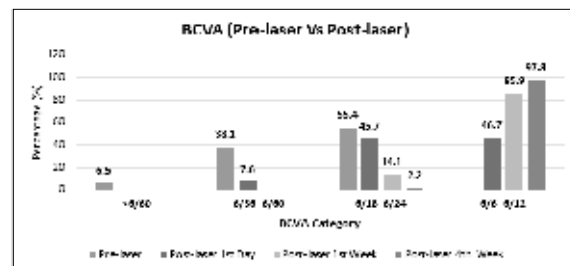
Variable	Frequency	Percentage (%)
Age, Year		
45-54 Years	22	23.9
55-64 Years	38	41.3
65-74 Years	32	34.8
Mean $\pm$ SD		60.2 $\pm$ 7.5
Range		45.0-74.0
Gender		
Male	47	51.1
Female	45	48.9

Data were expressed as frequency and percentage if not mentioned otherwise. SD: Standard Deviation.

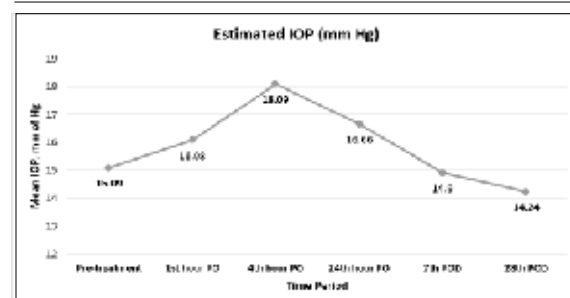
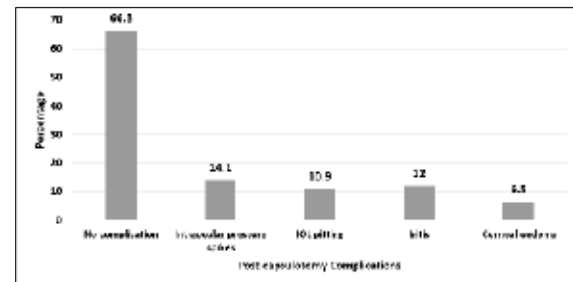
Table II Baseline clinical characteristics of the patients (n=92)

Variables	Category	Frequency	Percentage (%)	
Type of Operation	SICS with PCIOL	70	76.1	
	Phaco with PCIOL	22	23.9	
Type of IOL Used	PMMA	70	76.1	
	Foldable	22	23.9	
Time Period Between		6 months	13	14.1
Cataract Extraction and PCO Formation	>6 months – 1 year	29	31.5	
	>1 year – 2 years	16	17.4	
	>2 years – 3 years	23	25.0	
	>3 years – 4 years	11	12.0	
Time Period Between		>6 months – 1 year	27	29.3
Cataract Extraction and Nd:YAG Laser Capsulotomy	>1 year – 2 years	19	20.7	
	>2 years – 3 years	17	18.5	
	>3 years – 4 years	29	31.5	
Type of PCO	Fibrous	34	37.0	
	Elschnig pearl	52	56.5	
	Mixed	6	6.5	
Grade of PCO	Grade 2	39	42.4	
	Grade 3	43	46.7	
	Grade 4	10	10.9	

Data were expressed as frequency and percentage if not mentioned otherwise. SD: Standard Deviation.

**Figure 1** BCVA (Pre-laser vs Post-laser) (n=92)**Table III** Nd: YAG laser capsulotomy procedure related characteristics (n=92)

Parameter	Overall (n=92)	Elschnig Pearl	Fibrous	Mixed
Energy required (mJ)	46.92 ± 16.34 (Range: 26.0–84.0)	36.17 (26.0–41.5)	69.3 (60.0–78.0)	64.17 (54.0–84.0)
Shots required	25.72 ± 7.31 (Range: 15.0–44.0)	21.0 (15.0–24.0)	34.67 (30.0–44.0)	33.37 (27.5–39.3)

**Figure 2** Changes of Estimated Mean IOP upto 4th week**Figure 3** Post capsulotomy complications upto 4th week follow up

Discussion

Cataract management and complication of it is focused upon visual rehabilitation. PCO is one of the commonest significant complication after cataract surgery and Nd:YAG laser capsulotomy is the most accepted treatment modality.¹² Improvement of vision is the main goal of successful Nd:YAG laser capsulotomy for PCO.¹³ Present study was carried out in 92 patients who underwent SICS or phacoemulsification with PCIOL implantation in CMCH, Chattogram or elsewhere, had PCO confirmed by slit lamp examinations and direct and indirect ophthalmoscopy. Chief complaints of all the cases were diminished vision which varied from hand movements to 6/18. Nd:YAG laser capsulotomy was done for all cases. These patients were followed up for a period of 4 weeks. Present study demonstrated that PCO can be managed safely and effectively by Nd: YAG laser capsulotomy with remarkable improvement in visual outcome. Present study results confirm previous studies and further strengthen the notion that BCVA improves significantly after Nd:YAG laser posterior capsulotomy in otherwise healthy pseudophakic eyes with PCO with fewest complications.^{5,12,14–16} The mean age of the patients was 60.2±7.5 years in the present study and 76.1% of the patients were within 55–74 years. This is the age at which patient usually present with cataract and most of the cataract surgery done in this age group. Present study findings agreed with the study of Dharmaraju et al.⁷ The gender distribution of the study population was male 47 (51.1%) and female 45 (48.9%) with a ratio of 1.04:1. Majority of the patient had SICS with PCIOL (76.1%) while remaining underwent phacoemulsification (23.9%). Several studies had shown that PMMA intraocular lens significantly increases the incidence of PCO compared with foldable IOL.^{6,7} Present study

result was confirmed by previous study and showed that PMMA lens was used in majority of the cases (76.1%) while remaining (23.9%) have had foldable lens used during cataract surgery.⁷ Such a result was quite predictable as because SICS with PMMA lens are more practiced all over the country than phacoemulsification. In the present study, the time period between cataract extraction and opacification of the posterior capsule ranged from 6 months to 4 years. In the present study, 13 (14.1%) patients developed PCO at 6 months of cataract surgery, in 29 (31.5%) patients' duration between cataract surgery and PCO was >6 months to 1 year, 16 (17.4%) patients developed PCO between 1-2 years, 23(25%) patients had time interval of 2-3 years and in 11(12%) patients PCO developed within 3-4 years. Present study findings were similar to several previous studies.^{4,9}

However in the study of Dharmaraju et al. the time interval between cataract surgery and PCO development was 3 months to 1 year.⁷ The incidence of PCO in early postoperative period may be due to use of low quality IOL and poor polishing of posterior capsule.¹⁷ Period between cataract extraction and Nd: YAG laser capsulotomy ranged from 6 months to 4.33 years and the posterior capsulotomy was performed on average of 24 months after cataract extraction in the current study. Fifty-two (56.5%) eyes had Elsnig Pearl type and 34(37%) eyes had Fibrous type and 6 (6.5%) eyes had Mixed type of PCO in the present study. The study of Dharmaraju et al. and Soni et al. agreed with the findings of present study where Elsnig pearl was the most common type, than Fibrous type and Mixed type of PCO.^{7,9} However several studies had reported that Fibrous type was the most common type of PCO in their study.¹⁷ Thirty nine (42.4%) patients were diagnosed as mild (Grade-2) PCO, 43(46.7%) patients had moderate (Grade-3) PCO and 10(10.9%) patients had severe (Grade-4) PCO in our study. Present study findings were consistent with the study of Patil et al. and Dharmaraju et al.^{7,13}

The findings of this study robustly demonstrate the profound and progressive improvement in BCVA following Nd:YAG laser capsulotomy. Prior to the procedure, a significant majority of

patients (93.5%) presented with BCVA worse than 6/12, with no patient achieving the optimal 6/6–6/12 range. This dramatically shifted post-intervention, with 46.7% of patients reaching 6/6–6/12 within just 24 hours, indicating an immediate benefit from the optical pathway clearance. The visual gains continued to consolidate, as evidenced by 85.9% of patients achieving 6/6–6/12 BCVA by the first week and an outstanding 97.8% by the fourth week. Similar to the present study high rate of visual improvement was reported by previous studies.^{4,5,13} In our study there was no further decrease in visual acuity than pre laser visual acuity. This may be due to exclusion of cases with pre-existing ocular disease from the study. However, in the study of Soni et al. few cases showed further deterioration of vision after laser capsulotomy due to pre-existing cystoid macular edema.⁹ Also Alam and Jarwal had demonstrated post laser visual deterioration in few cases due to pre-existing retinal disease in their study.^{12,14}

In the current study, total energy used at average was 46.92 mJ, ranging from 26.0 to 84.0 mJ. Maximum energy was required for mixed type of PCO and Elsnig pearl type of PCO required minimum energy. Study of Dharmaraju et al. had also observed that elsnig pearl type PCO required minimum energy than fibrous and mixed PCO.⁷ Total shot required at average was 25.72 and ranging from 15-44 in our study. Elsnig pearl require minimum shot than fibrous and mixed type PCO. Present study agreed with the study of Soni et al. where Pearl with/without ring of sommering required minimum number of shots, while the thick white sheet type of opacification requires the maximum number of shots.⁹

Out of 92 patients, 61 (66.3%) patients had no post capsulotomy complications in the present study. Though reliable, Nd:YAG capsulotomy can lead to complications like IOP spike, lens damage, change in refraction, macular edema, retinal tear, and retinal detachment.^{4,5,7,9,12–17} IOP spikes or transient acute elevations of IOP was the most common post capsulotomy complication (14%) in the present study. Raised IOP after Nd:YAG capsulotomy occurred due to deposition of debris in the trabecular meshwork, trabeculitis, neurovascular mechanism, papillary block and inflammatory swelling of the ciliary body.¹⁵ In our

study, it was observed that mean IOP started rising immediately after Nd: YAG, reaching a peak at 4th hours. Several previous studies also observed that IOP spike was usually occurred in patients who received more number of shots and more laser energy.^{9,13} Those patients who received higher energy had significant rise in IOP and given treatment in form of anti-glaucoma medication immediately after procedure to prevent optic nerve damage. Patients with antiglaucoma medication had decreased IOP at first POD from the 4th hour post-operative value but still it was more than baseline level. Mean IOP at 1st week was apparently near to pre treatment level in all patients with or without anti glaucoma medications. At 4th week follow up, no patients have had persistent rise of IOP. In a study conducted by Soni et al. persistent rise of IOP was observed in few cases due to papillary block glaucoma caused by anterior hyaloid face rupture.⁹ In the current study, pitting of IOL was the other prominent complication. Out of 92 cases 10 (10.9%) cases developed IOL pitting during laser capsulotomy. Lens pitting causes glare effect and if pitting is in the center, it may decrease the vision.⁹ The reason for this type of complication is that all of the patients who had IOL pitting were less compliant than the others. Iritis was observed in 11(12 %) cases and corneal oedema in 6 (6.5 %) cases after 24 hour of capsulotomy. In our study we did not observe any case of retinal detachment and cystoid macular oedema. This may be due to exclusion of risk factor and shorter duration of follow up after capsulotomy. Several previous studies also didn't observe any serious complication like retinal detachment and cystoid macular oedema.^{7,14} However the incidence of cystoid macular oedema after laser capsulotomy had been observed in many studies.^{5,9,13} The findings of the present study agreed by several previous studies and observed that complications associated with Nd:YAG laser capsulotomy was minimal and transient which can be managed on outpatient basis in regular follow-up.^{5,9}

Limitation

Limitations of the study include a short 4-week follow-up period, single-center design limiting generalizability and potential influence of antiglaucoma medications on post-capsulotomy IOP changes.

Conclusions

Nd:YAG laser capsulotomy effectively improves vision in PCO patients, with minor, transient complications such as IOP rise, lens pitting, and mild iritis that are not vision-threatening.

Recommendation

Nd:YAG laser is a safe, effective, and noninvasive option for managing PCO; using minimal, well-focused shots at low energy is advised to reduce complications. Larger multicenter studies with longer follow-up are recommended for validation.

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Contributions of authors

PM- Conception, acquisition of data, drafting & final approval.

MSA- Data analysis, drafting & final approval.

TT- Design, critical revision & final approval. □

US-Critical revision, drafting & final approval.

PG-Data analysis, drafting & final approval.

Disclosure

All the authors declared no conflict of interest.

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