

## A Study of Adverse Clinical Consequences of Neodymium Doped Yttrium Aluminum Garnet (Nd : YAG) Laser Treatment for Posterior Capsular Opacification : A Rural Hospital Based Approach

Preeti A Rawandale Patil<sup>1</sup>, Surendra P Wadgaonkar<sup>2</sup>, Sanjay V Vaghmare<sup>3</sup>, Sonam R Rathod<sup>4</sup>

### Abstract

**Introduction:** Posterior capsular opacification (PCO) is the most common delayed complication after ECCE surgery with or without PC-IOL. Neodymium Doped Yttrium Aluminum Garnet (Nd : YAG) laser for posterior capsulotomy is widely used and it has been gradually replacing surgical capsulotomy because it is safe, non-invasive and effective procedure with minimal complications of vitreous loss and endophthalmitis as compared to surgical capsulotomy. Complications of Nd : YAG laser posterior capsulotomy are raised intraocular pressure (IOP), corneal damage, iritis, intraocular lens (IOL) pitting or dislocation, cystoid macular edema (CME), disruption of the anterior vitreous face, retinal detachment (RD), endophthalmitis and vitreous hemorrhage. The purpose of the present study is to evaluate the complication rate following Nd : YAG laser capsulotomy. **Aims and Objectives:** To assess the complication following Nd : YAG laser capsulotomy. **Material and Methods:** The study has been performed in our institute between September 2013 to September 2015. 100 eyes of 100 patients with PCO were considered for Nd : YAG laser capsulotomy after minimum period of 6 months following uncomplicated extracapsular cataract extraction. Following the capsulotomy, all patients were routinely given topical antibiotics-steroid combination and topical anti-glaucoma drops. Patients were reviewed after 1 hr for assessment for tonometry, slit lamp biomicroscopy. Anterior chamber reaction were looked. IOP assessment was done after 1hr, 1week, 1month and 6month. Rise in IOP was noted. If IOP was raised for hours and returned to normal at the end of 7 days, it labelled as transient IOP rise. Persistent IOP rise was labeled if sustained high IOP on follow up visits. Patients were also looked for visual acuity, any incidence of iritis, retinal detachment, cystoid macular edema. **Results:** In our study, most frequent complication was rise in IOP. The immediate IOP rise (IOP one hour after Nd : YAG laser capsulotomy) was recorded in 31% of patients. Mean summated laser energy in a group of patients with immediate IOP rise (62.39) was significantly high as compared to group of patients with normal IOP. In our study, pitting of IOL was seen in 6% of patients. Mean summated laser energy level in patients with pitting of IOL was 80.67 mJ as compared to 52.36 mJ in patients without IOL pitting. The mean summated laser energy was significantly higher ( $p=0.002$ ) in a group of patients with IOL pitting. In our study, iritis was noted in 7% of patients. The mean summated laser energy was significantly higher ( $p<0.001$ ) in a group of patients with iritis. The mean summated laser energy level in patients with iritis was 85.14J as compared to 51.72 mJ in patients without iritis. In our study, CME was seen in 3% of patients. Mean summated laser energy in patients with CME was 74.67 mJ versus 53.42 mJ in patients without CME (97%). Mean summated laser energy was not significantly higher in patients with CME ( $p=0.098$ ). In our study, anterior hyaloid face rupture was noted in 9% of patients, but none of the patient had vitreous in anterior chamber. Mean summated laser energy level in patients with anterior hyaloid face rupture was 75.11 mJ which was significantly higher ( $p=0.002$ ) as compared to 51.98 mJ in patients without rupture of anterior hyaloid face ( $n=91$ ). **Conclusion:** Complications with Nd : YAG laser capsulotomy are minimal and transient. Complications such as raised intraocular pressure, pitting of IOL, iritis, anterior hyaloid face rupture more common if mean summated energy level was high. The total laser energy delivered were not risk factor for the development of cystoid macular edema. Healthy pseudophakia eyes generally do not have retinal detachment after Nd : YAG laser capsulotomy. To minimize the complications, lowest possible laser energy level should be used for Nd : YAG laser capsulotomy.

**Keywords:** Posterior Capsular Opacification (PCO); Nd:YAG Laser; Capsulotomy

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**Received on** 10.04.2019, **Accepted on** 04.05.2019

### How to cite this article:

Preeti A Rawandale Patil, Surendra P Wadgaonkar, Sanjay V Vaghmare, *et al.* A Study of Adverse Clinical Consequences of Neodymium Doped Yttrium Aluminum Garnet (Nd : YAG) Laser Treatment for Posterior Capsular Opacification : A Rural Hospital Based Approach. *Ophthalmol Allied Sci.* 2019;5(2):208-217.

## Introduction

Posterior capsular opacification (PCO) is the most common delayed complication after ECCE surgery with or without PC-IOL. Visually significant PCO is defined as post-operative best corrected visual acuity decreased by two snellen's lines.<sup>1</sup> Patients who have PCO with significantly reduced visual acuity need posterior capsulotomy that is, opening up of the posterior capsule so as to improve vision. Posterior capsulotomy can be done by two ways: Neodymium doped yttrium aluminum garnet (Nd : YAG) laser capsulotomy and Surgical capsulotomy.

Nd : YAG laser for posterior capsulotomy is widely used and it has been gradually replacing surgical capsulotomy because it is safe, non-invasive and effective procedure with minimal complications of vitreous loss and endophthalmitis as compared to surgical capsulotomy [2].

In Nd : YAG laser capsulotomy, a small opening is created in the center of the opacified posterior capsule by a Nd : YAG laser pulse with energy of few millijoules (mJ) for a duration of few nanoseconds. Various factors such as IOL fixation, subtype of PCO can affect the energy level used for capsulotomy. Some studies recommend lower starting energy level for capsulotomy to minimize the incidence of complications of Nd : YAG laser capsulotomy [3].

Complications of Nd : YAG laser posterior capsulotomy are raised intraocular pressure (IOP), corneal damage, iritis, intraocular lens (IOL) pitting or dislocation, cystoid macular edema (CME), disruption of the anterior vitreous face, retinal detachment (RD), endophthalmitis and vitreous hemorrhage [4,5,6].

The purpose of the present study is to evaluate the complication rate following Nd : YAG laser capsulotomy.

## Aims and Objectives

To assess the complication following Nd : YAG laser capsulotomy.

## Material and Methods

The study has been performed in our institute between September 2013 to September 2015. 100 eyes of 100 patients with PCO were considered for Nd : YAG laser capsulotomy after minimum period of 6 months following uncomplicated

extracapsular cataract extraction. Before Nd:YAG laser capsulotomy, all patients were analysed in following manner:

### History

Demographic information like name, age, sex, occupation, address was obtained from each patient.

### Visual Acuity

Visual acuity of all patients were recorded using snellen's chart or illiterate E chart of both eye.

### Slit Lamp Examination

Slit lamp examination was done for examination of the anterior segment. The extent and intensity of the subtypes of PCO (membranous i.e. pearl, fibrous and fibro-membranous) was evaluated by slit-lamp grading as it is commonly performed method in clinical practice. Many slit lamp grading systems exists but none have been proven to be gold standard [7]. We used the slit lamp grading criteria described by Kruger *et al.* [8] in 2000. Kruger *et al.* used grading system 0 to 3 for evaluation of PCO. Grade 0=absent, Grade 1=very mild, Grade 2=moderate, Grade 3=dense white. The capsule behind the optic was evaluated within a central area of 3 mm diameter and also evaluated in the periphery. Distinction was given to the grading of elschnig pearls and fibrosis [8].

Grading criteria was important in deciding the initial energy level for subtypes of PCO which was necessary for Nd:YAG laser capsulotomy.

Tonometry: Intraocular Pressure was measured by using goldmann applanation tonometer. Normal range of IOP was considered to have range of 10-21 mm of mercury (mmHg).

### Fundus Examination

Fundus was examined using direct or indirect ophthalmoscope to rule out the cause of reduced vision other than PCO. Ultrasound B-scan was done in patients with dense PCO.

### Inclusion Criteria

1. Patients operated by Extracapsular cataract extraction with Posterior chamber intraocular lens implantation
2. Patients with significant PCO.
3. Age between 40 to 80years.

### Exclusion Criteria

1. Patients operated by Extra Capsular Cataract Extraction without Posterior chamber intraocular lens implantation.
2. Past history of any ocular surgery other than cataract.
3. Any clinical evidence suggestive of glaucoma.
4. Any other anterior or posterior segment pathology.
5. Eyes with any ocular adnexal disorder.
6. History of diabetes, pemphigus, collagen vascular diseases, stevens johnson's syndrome or immunocompromised patient.

### Preparation of the Patient

After complete evaluation, patient was taken for laser capsulotomy. The procedure was explained to the patient. Patient is informed that procedure is painless, with each shot he or she may hear small clicks. The informed consent is taken. Pupil were dilated with 1% tropicamide and 2.5% phenylephrine.

### Anaesthesia

Topical anaesthesia with one drop of 4% xylocaine. Positioning: Nd : YAG laser capsulotomy was performed with the patient in a seated position. Adjustment of stool, chin rest and foot rest was done for patient's comfort. Head strap was applied. Darken the room optimally.

### Equipment

An abraham Nd : YAG capsulotomy lens is used in conjunction with a coupling agent, such as 2% hydroxypropyl methylcellulose, to form a seal on the eye. Lens helps to keep the eye open, the lens has a 10.0-mm helium-neon YAG-coated plano-convex 1.8 × magnification button positioned at the center of the lens, which focuses the beam spot size on the posterior capsule.

### Capsulotomy technique

Posterior capsule was focused with helium-neon (He-Ne) beam. The intersection of the helium-neon beam where the two red spots becomes one that spot was used and it is the focal point of laser energy. Tension lines were identified and cut across tension lines. The usual strategy is to create cruciate openings at 12<sup>o</sup>clock periphery. Progress downwards towards 6<sup>o</sup>clock position. Cut across 3<sup>o</sup>clock and 9<sup>o</sup>clock position. Any tag which remain in pupillary space, laser fired at the flap to cut them and cause them to retracted fall back periphery. Free floating tags were avoided. In this way, capsulotomy of 3 mm size was done with single pulse Q-switched Nd : YAG laser (Visulas YAG II plus, Carl Zeiss, Germany). The energy and pulses were increased gradually according to the thickness of capsule until an opening was achieved.

The starting initial energy level, number of pulses used to create capsulotomy and mean laser energy level was noted in each case.

### Post Laser follow-up

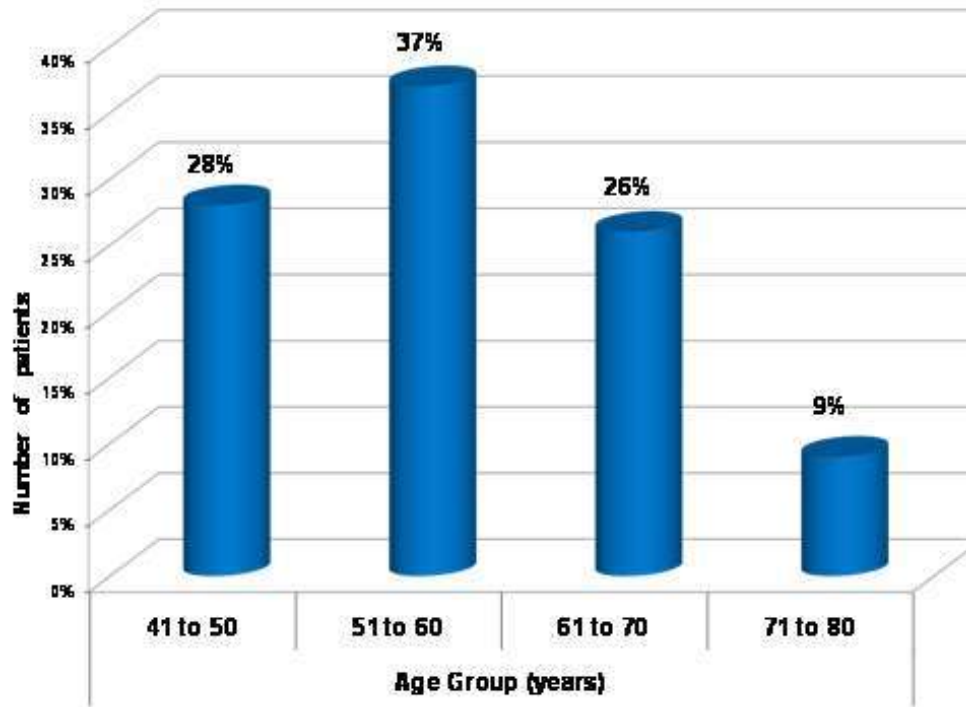
Following the capsulotomy, all patients were routinely given topical antibiotics-steroid combination and topical anti-glaucoma drops. Patients were reviewed after 1 hr for assessment for tonometry, slit lamp biomicroscopy. Anterior chamber reaction were looked. IOP assessment was done after 1hr, 1week, 1month and 6month. Rise in IOP was noted. If IOP was raised for hours and returned to normal at the end of 7 days, it labelled as transient IOP rise. Persistent IOP rise was labeled if sustained high IOP on follow up visits. Patients were also looked for visual acuity, any incidence of iritis, retinal detachment, cystoid macular edema.

### Results

#### Age distribution

**Table 1:** Age group wise distribution of patients undergoing Nd : YAG laser capsulotomy.

Age Group	Frequency	Percent
41 - 50	28	28.0
51 - 60	37	37.0
61 - 70	26	26.0
71 - 80	9	9.0
Total	100	100.0



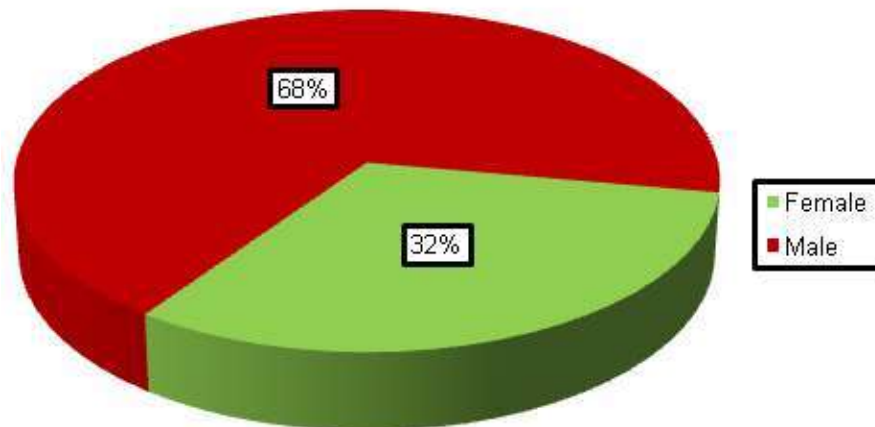
Graph 1: Age group wise distribution of patients undergoing Nd : YAG laser capsulotomy.

Table 1 & Graph 1: Shows that out of 100 patients with PCO, maximum number of patients (37%) were of 51 to 60 years of age group. Mean age in the study was 58 years with 9.07 SD and ranging within 42 to 79 years

### Sex Distribution

Table 2: Sex wise distribution of patients undergoing Nd:YAG laser capsulotomy.

Sex	Frequency	Percent
Female	32	32.0
Male	68	68.0
Total	100	100.0

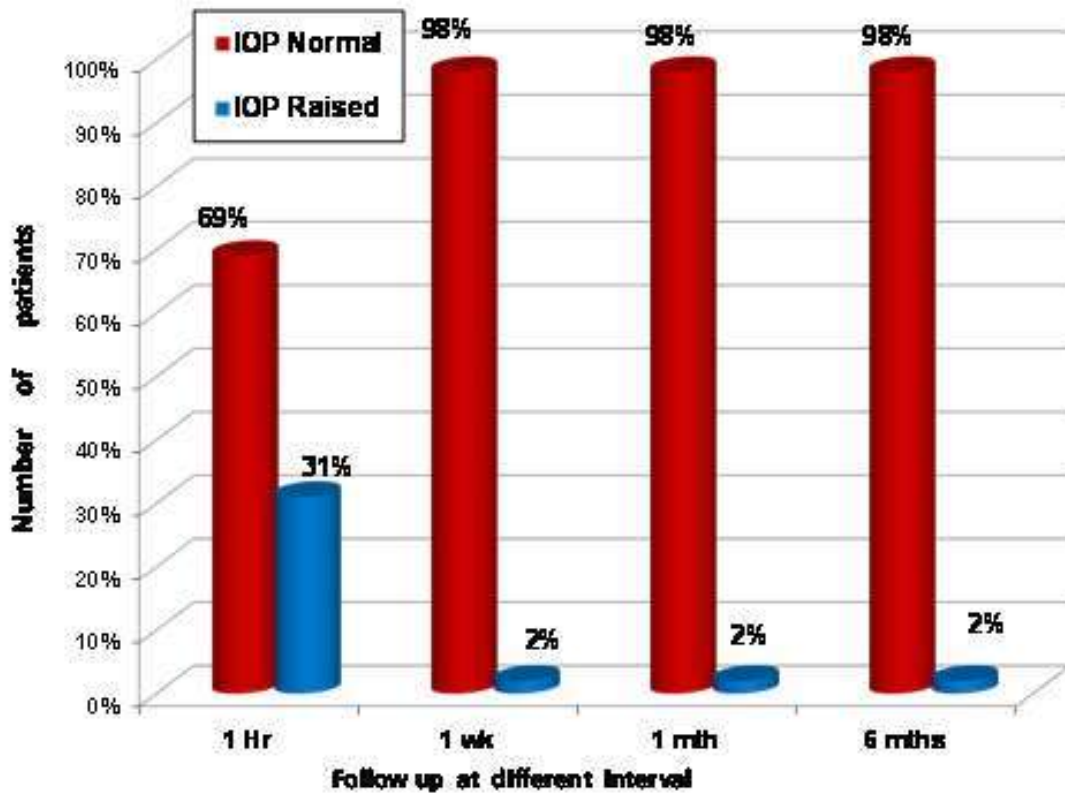


Graph 2: Sex wise distribution of patients undergoing Nd:YAG laser capsulotomy.

Table 2 & Graph 2: Shows that 68% were male and 32% were female in present study.

**Table 3:** Changes in IOP at different interval after Nd:YAG laser capsulotomy

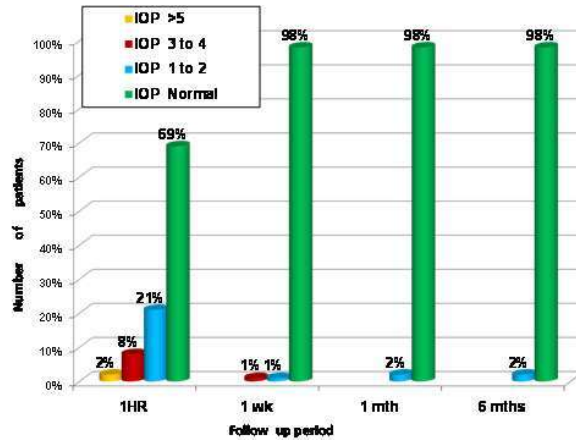
IOP	1 hour		1 wk		1 month		6 month	
	N	%	N	%	N	%	N	%
Normal	69	69.0%	98	98.0%	98	98.0%	98	98.0%
Raised	31	31.0%	2	2.0%	2	2.0%	2	2.0%
Total	100	100.0	100	100.0	100	100.0	100	100.0

**Graph 3:** Changes in IOP at different interval after Nd : YAG laser capsulotomy

**Table 3 & Graph 3:** Shows that 1 hour after Nd:YAG laser capsulotomy, raised IOP was seen in 31% (n=31) of patients. At the end of 1 week, most of the patients (98%) was returned to the normal IOP and 2% of patients shows persistently raised IOP.

**Table 4:** Raised IOP levels at different intervals in patients after Nd : YAG Laser Capsulotomy

Raised IOP by	1 hr		1 wk		1 month		6 months	
	N	%	N	%	N	%	N	%
>5 mmHg	2	2.0	-	-	-	-	-	-
3 to 4 mmHg	8	8.0	1	1	-	-	-	-
1 to 2 mmHg	21	21.0	1	1	2	2.0	2	2.0
Normal	69	69.0	98	98.0	98	98.0	98	98.0
Total	100	100.0	100	100.0	100	100.0	100	100.0

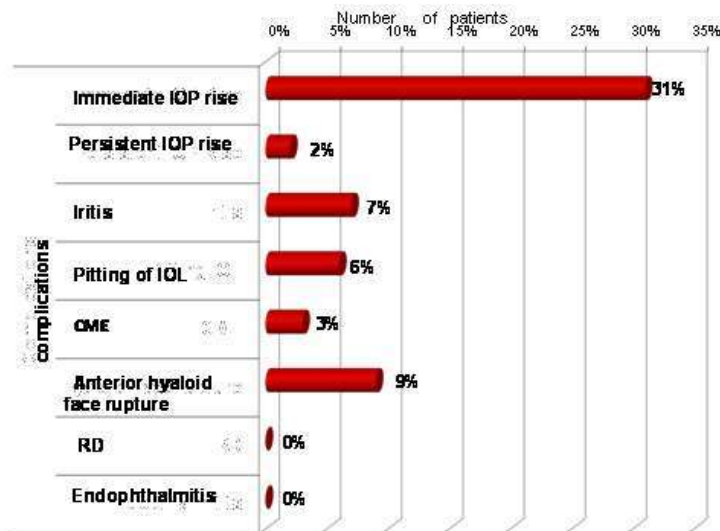


Graph 4: Raised IOP levels at different intervals in patients after Nd : YAG Laser Capsulotomy

Table 4 & Graph 4: Shows that 1hr after Nd : YAG laser capsulotomy, 2% of patients had IOP rise by more than 5 mmHg, 8% of patients by 3 to 4 mmHg and 21% of patients by 1 to 2mmHg. Rest had normal IOP. At 1 week, 1% patient had 3 to 4 mmHg of IOP rise while other 1% had 1 to 2 mmHg of IOP rise. At 6 month 2% of patients had persistently raised IOP by 1 to 2 mmHg.

Table 5: Complications in patients after Nd : YAG Laser Capsulotomy.

Complications	Frequency	Percent
Immediate IOP Rise	31	31%
Persistent IOP Rise	2	2%
Iritis	7	7%
Pitting of IOL	6	6%
CME	3	3%
Anterior hyaloid face rupture	9	9%
RD	0	0%
Endophthalmitis	0	0%

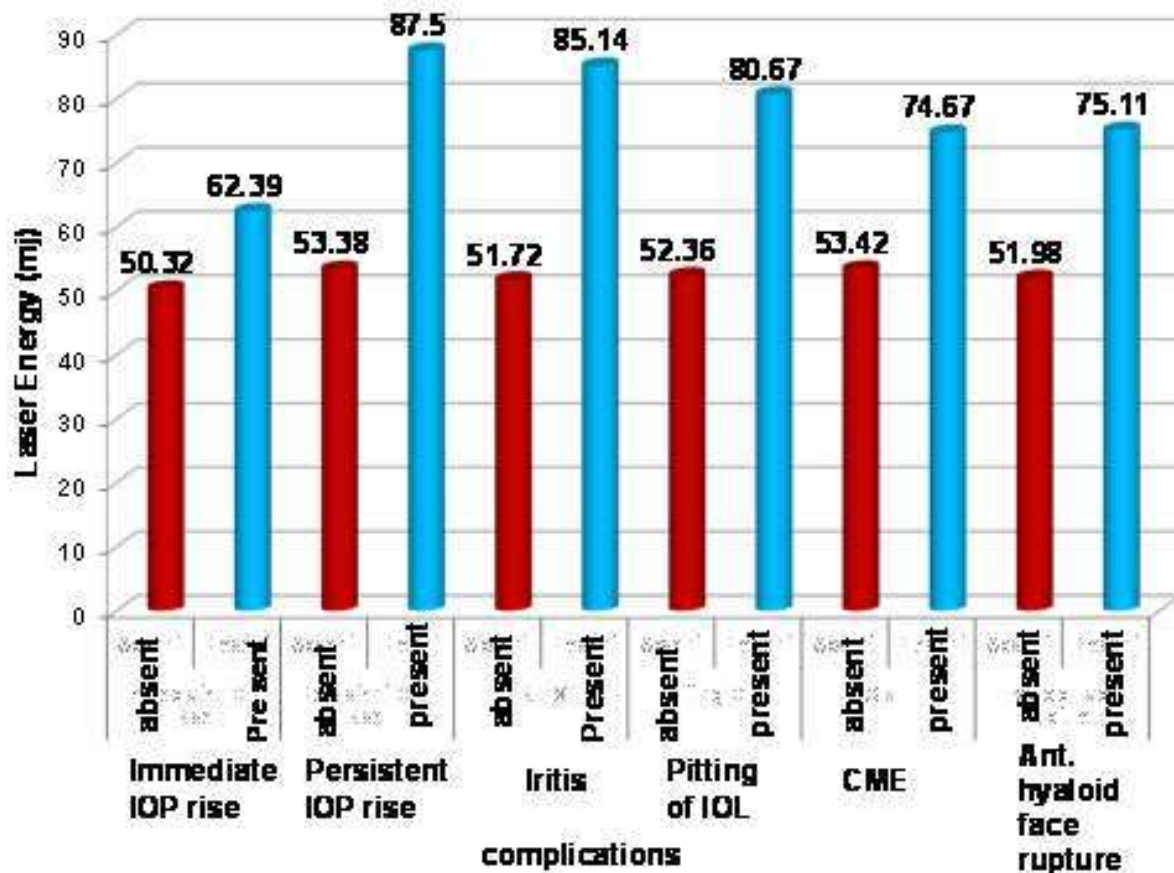


Graph 5: Complications in patients after Nd : YAG Laser Capsulotomy.

Table 5 & Graph 5: Shows most frequently occurred complication after Nd:YAG laser capsulotomy in our study was immediate IOP rise (31%) followed by anterior hyaloids face rupture (9%), iritis (7%) and pitting of IOL (6%). None of the patient in the present study developed RD and endophthalmitis.

**Table 6:** Mean summated laser energy in groups with and without complications.

Complications	Group	N	Mean summated laser energy	Std. Deviation	P value
Immediate IOP rise	Absent	69	50.32	22.46	0.010
	Present	31	62.39	18.35	
Persistent IOP rise	Absent	98	53.38	21.6	0.029
	Present	2	87.50	3.54	
Iritis	Absent	93	51.72	20.91	<0.001
	Present	7	85.14	2.97	
Pitting of IOL	Absent	94	52.36	21.45	0.002
	Present	6	80.67	6.44	
CME	Absent	97	53.42	21.92	0.098
	Present	3	74.67	7.09	
Anterior hyaloid face rupture	Absent	91	51.98	21.79	0.002
	Present	9	75.11	7.25	

**Graph 6:** Mean summated laser energy in groups with and without complications.

**Table 6 & Graph 6:** Shows that there was a statistically significant ( $p < 0.01$ ) difference in the mean summated laser energy level in patients with complication of immediate rise, persistent rise, iritis, pitting of IOL and hyaloid face rupture as compared with patients do not have these

## Discussion

Nd : YAG laser capsulotomy is the treatment of choice for PCO [9]. Nd : YAG laser capsulotomy is appears to be safe, non-invasive and effective procedure. In Nd : YAG laser capsulotomy, opening is created in the opacified posterior capsule by focusing pulses of few millijoules of energy posterior to the posterior capsule.

A total of 100 patients having PCO after cataract surgery were evaluated in the present study. Maximum number of patients (37%) were in the age group of 51 to 60 years with mean age in the study was 58 years. Burq *et al.* showed a mean age of  $59.5 \pm 6.2$  years [10].

In present study, male patients were maximum 68% and 32% were females. There was a study done in UK in which 53.8% were females and 46.2% were males [11].

Complications of Nd : YAG laser capsulotomy are discussed below:

### *Raised Itraocular Pressure*

In our study, most frequent complication was rise in IOP. The immediate IOP rise (IOP one hour after Nd : YAG laser capsulotomy) was recorded in 31% of patients, out of which in 21% of patients IOP was increased by 1–2 mmHg, in 8% by 3–4 mmHg and in 2% of patients by more than 5 mmHg. Mean summated laser energy in a group of patients with immediate IOP rise (62.39) was significantly high as compared to group of patients with normal IOP. All these patients with immediate IOP rise were treated with timolol eye drops (beta-blockers) twice a day for one week.

At the end of one week, almost all patients achieved normal IOP except 2% which showed raised IOP. On subsequent follow up, 2% patient showed persistent rise of IOP and were referred to glaucoma clinic. Mean summated laser energy in a group of patients with persistent IOP rise (87.50 mJ) was significantly higher as compared to mean summated laser energy in group of patients with normal IOP (53.38 mJ).

Slomovic and Parrish found that 55% of patients had significantly raised IOP following Nd:YAG laser therapy [12]. In a study by Hasan *et al.*, there was a significant rise in IOP of more than 5 mmHg. In all patients, IOP was returned to baseline level after one week of treatment with topical beta-blockers [13].

Awan *et al.* showed that post laser IOP rise was

controlled by topical beta-blockers and steroids effectively [14].

Channell and Beckman showed that higher IOP was associated with increased laser energy used during YAG procedures [15]. Silverstone *et al.* observed that higher IOP was associated with larger capsulotomy which required higher energy levels [16].

Ari *et al.* evaluated the effect of energy levels which used for Nd : YAG laser capsulotomy on IOP and macular thickness. The study showed that the severity and duration of IOP rise was less when the total laser energy was less than 80 mJ [17].

However, study by Holweger and Marefat showed that there was no relationship existed between total YAG laser energy used and the rise in IOP [18].

Possible mechanism which contribute to raised IOP is clogging of anterior chamber by particles liberated from posterior capsule breakdown or by inflammatory mediators released from acoustic shock waves which altered the trabecular meshwork.

Rise in IOP following Nd : YAG laser capsulotomy can be prevented by using minimum laser energy and topical beta blockers such as timolol or apraclonidine one hour before and again after the procedure.

### *Pitting of IOL*

In our study, pitting of IOL was seen in 6% of patients. Mean summated laser energy level in patients with pitting of IOL was 80.67 mJ as compared to 52.36 mJ in patients without IOL pitting. The mean summated laser energy was significantly higher ( $p=0.002$ ) in a group of patients with IOL pitting.

In a study conducted by Bhargava *et al.*, the incidence of IOL pitting was 7.8%. The mean total laser energy level in patients with IOL pitting was  $61.6 \pm 26.4$  mJ and was significantly higher as compared to mean total laser energy level in patients without IOL pitting ( $42.8 \pm 26.7$  mJ) [3].

In a study of Burq MA *et al.*, the IOL damage following Nd : YAG laser capsulotomy was seen in 19.2% cases [15]. Khan MY *et al.* found IOL pitting in 22.4% cases [19] while in a study of Javed *et al.*, it was seen in 3.33% cases.20

Pitting of IOL is usually asymptomatic and does not affect the visual function. IOL damage following capsulotomy may be because of faulty



focusing of laser beam or use of higher laser energy. It was observed that, by using minimum energy and focusing the beam posterior to the posterior capsule we could reduce the pitting of IOL.

#### *Iritis*

In our study, iritis was noted in 7% of patients. The mean summated laser energy was significantly higher ( $p < 0.001$ ) in a group of patients with iritis. The mean summated laser energy level in patients with iritis was 85.14 mJ as compared to 51.72 mJ in patients without iritis.

Bhargava *et al.* reported the incidence of iritis was 9.9% and mean summated laser energy level was significantly higher ( $p < 0.001$ ) in a group of patients with iritis.<sup>3</sup>

The study conducted by Muhammad L *et al.* showed that anterior uveitis was seen in 8.0% cases, [21] while in a study of Javed *et al.*, anterior uveitis was seen in 46.2% cases following Nd : YAG laser capsulotomy [22].

In our study, iritis was treated with steroid eye drops which tapered over 2–3 weeks and resulted in resolution of iritis in all patients.

#### *Cystoid Macular Edema*

In our study, CME was seen in 3% of patients. Mean summated laser energy in patients with CME was 74.67 mJ versus 53.42 mJ in patients without CME (97%). Mean summated laser energy was not significantly higher in patients with CME ( $p=0.098$ ).

In a study of Bhargava *et al.*, incidence of CME was 2.9% and mean total energy level was significantly higher in patients with CME ( $p < 0.001$ ) [3].

A study of Alimanovic-Halilovic E. reported the incidence of CME was 4.1% [23].

In a study of Steinert *et al.*, 1.2% of patients developed CME after Nd:YAG laser capsulotomy. According to this study, total laser energy delivered was not a risk factor [24].

A study conducted by Raza reported CME in 3% of patients with aphakic and pseudophakic PCO after Nd : YAG laser capsulotomy [25].

In a study of Khan B *et al.* in 2014, CME was seen in 3.89% of patients [26].

In our study, patients with CME were treated with topical anti-inflammatory drugs for 3 weeks. Patients with CME did not show improvement in VA beyond 6/12.

#### *Anterior Hyaloid Face Rupture*

In our study, anterior hyaloid face rupture was noted in 9% of patients, but none of the patient had vitreous in anterior chamber. Mean summated laser energy level in patients with anterior hyaloid face rupture was 75.11 mJ which was significantly higher ( $p=0.002$ ) as compared to 51.98 mJ in patients without rupture of anterior hyaloid face ( $n=91$ ).

Bhargava *et al.* reported the incidence of anterior hyaloid face rupture as 8.8%. Mean summated laser energy level was significantly higher in patients with anterior hyaloid face rupture ( $p < 0.001$ ) [3].

In a study of Alimanovic-Halilovic E, anterior hyaloid face rupture was seen in 7.5% of the cases. He reported that the influence of total laser energy level on complications was statistically significant [23].

#### *Other Complications:*

In our study, none of the patient had retinal detachment or endophthalmitis.

A study conducted by Raza reported the incidence of retinal detachment was 2% after Nd:YAG laser capsulotomy [25]. In a study of Steinert *et al.*, retinal detachment was seen in 0.89% of patients [24].

In a study by Khan WA *et al.*, complications like retinal detachment and endophthalmitis were not observed [25].

In a study of Khan B *et al.*, incidence of RD was 0.45% and that of endophthalmitis was 0.22% [28].

#### **Conclusion**

Nd : YAG laser capsulotomy is the treatment of choice for PCO. Nd : YAG laser capsulotomy results in improvement in visual acuity. Mean initial energy level and mean summated energy level was significantly different for different types of PCO. Mean summated energy level was significantly higher for fibromembranous type of PCO than fibrous and membranous (pearl) types of PCO. Complications with Nd : YAG laser capsulotomy are minimal and transient.

Complications such as raised intraocular pressure, pitting of IOL, iritis, anterior hyaloid face rupture more common if mean summated energy level was high.

The total laser energy delivered were not risk factor for the development of cystoid macular edema.

Healthy pseudophakic eyes generally do not have retinal detachment after Nd : YAG laser capsulotomy. To minimize the complications, lowest possible laser energy level should be used for Nd : YAG laser capsulotomy.

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