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Original Research Article

A clinical study on the intraocular pressure changes following Nd:YAG laser capsulotomy

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ABSTRACT

Background: Posterior capsular opacification (PCO) is the most frequent late postoperative complication following cataract surgery. Nd: YAG laser capsulotomy remains the cornerstone of treatment of PCO. However, it can be associated with significant complications like intraocular pressure(IOP) rise, lens pitting, retinal detachment etc. Raised IOP is a common complication that occurs post laser.
Aim: To assess the IOP changes after Nd: YAG laser capsulotomy in patients diagnosed with PCO.
Study Design: Prospective follow up hospital based study between October 2018 -April 2020.
Materials and Methods: 50 patients attending the Ophthalmology OPD at a tertiary care hospital with visually significant PCO after cataract extraction were selected. Following an written consent, patients underwent laser and the number of shots, energy levels were recorded. They were followed up immediately, one, two hours and one week for IOP changes, vision improvement and complications.
Statistical Analysis: SPSS software v.23 and Microsoft office 2007. Tests used were Chi- square, ANOVA and F test.
Results: Post laser, there was a significant rise of mean IOP with increasing time, energy and number of shots and it reduced to near baseline levels at the end of one week. BCVA at one week was in the range of 6/24p to 6/6. Complications were transient iritis (4%), vitritis(2%) and IOL pitting (2%).
Conclusion: In majority, IOP returned to near baseline levels at the end of one week. High skill, regular follow ups, proper focusing of laser, lesser number of shots and energy levels can reduce the incidence of complications.

1. Introduction

Posterior capsular opacification (PCO) is the most frequent late postoperative complication associated with decreased vision following cataract surgery. It's incidence in adults ranges between 7.1–22.6% at five years.[1] PCO occurs due to lens epithelial cell proliferation and migration.[2]

Nd: YAG laser capsulotomy remains the cornerstone of treatment of PCO and has replaced surgical capsulotomy. However, it can be associated with intraocular pressure (IOP) rise, vitritis, iritis etc.[3] Prescribing anti-glaucoma medications post capsulotomy is a common practice. This study will help to anticipate post procedural IOP rise in specific patients and to target and treat them selectively.

2. Materials and Methods

2.1. Study design

This is prospective, cross-sectional, follow up study of 50 eyes of 50 out patients with PCO following cataract surgery in the Department of Ophthalmology at a tertiary

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care hospital during the study period between October 2018 to April 2020. Informed written consent was taken from all patients. Ethical clearance was obtained from the Institutional ethical clearance committee. The study was carried out in accordance with the principles of the Declaration of Helsinki.

2.2. Sample size calculation

With 95% confidence level and margin of error of ±10%, a sample size of 50 subjects will allow the study of the intraocular pressure changes following Nd:YAG laser capsulotomy with finite population correction(N=100).[4]

By using the formula:

$n = \frac{z^2 p(1-p)}{d^2}$

where

Z = z statistic at 5% level of significance

d is margin of error

p is anticipated prevalence rate

All characteristics were summarized descriptively. For continuous variables, the summary statistics of mean ± standard deviation (SD) were used. For categorical data, the number and percentage were used in the data summaries and diagrammatic presentation. Chi-square ($\chi 2$) test was used for association between two categorical variables.

The difference of the means of analysis variables between more than two independent groups was tested by ANOVA and F test of testing of equality of Variance.

If the p-value was < 0.05, then the results were considered to be statistically significant otherwise it was considered as not statistically significant. Data was analysed using SPSS software v.23 (IBM Statistics, Chicago, USA) and Microsoft office 2007.

2.3. Inclusion criteria

Patients of either sex, forty years or above, who come with postoperative visually significant PCO after cataract extraction. Visually significant PCO is defined as a decrease in the post operative best corrected visual acuity (BCVA) by two lines in Snellen's distant vision chart.

2.4. Exclusion criteria

2.4.1. Patients with

1. Congenital / developmental or traumatic cataract.
2. Anterior segment pathology like corneal scar, irregularity, edema, keratitis, conjunctivitis.
3. Glaucoma or uveitis
4. Suspected CME
5. Vitreous opacity, haze, myopic degeneration or optic atrophy.

Detailed history was elicited. Ocular examination both pre and post laser at each follow up included assessment of visual acuity, IOP, slit lamp evaluation and fundoscopy. Using slit lamp, PCO was morphologically classified as Elschnig Pearls, dense membranous, membranous or fibrous type.

Once PCO was confirmed, Nd: YAG laser posterior capsulotomy was advised. Case proforma was filled and informed written consent was obtained. After pupillary dilation with 10% Phenylephrine or 0.5% or 1% Tropicamide eye drops, Q- Switched Nd: YAG laser was performed under topical anesthesia. Power setting and number of exposures were varied depending on the thickness of the posterior capsule. The energy levels, number of laser shots used, capsulotomy size, pre and post laser vision, IOP values and other complications were recorded. Follow ups were immediately, 1 hour, 2 hour and 1 week post laser.

3. Results

Among the 50 patients, majority were females i.e.56% (28) than males 44% (22).

In this study, 30 (60%) were above 60 years of age,15 were in the age group of 41-60 years (30%) and 5 patients (10%) were less than or equal to 40 years. The age group ranged from 40 -83 years with a mean of 62.3 (+/- 12.4). Maximum number of the patients with significant PCO were above 60 years.

Majority of subjects had PCO in left eye (58%) than right eye (42%).

The interval between cataract extraction and capsulotomy ranged from 6 months to 60 months with a mean of 24 months (+/-12).

44% of patients had Elschnig's pearl type, 30% had dense membranous type, 16% had membranous type, 10% had fibrous type of PCO.(Table 1)

The energy required for capsulotomy ranged from 0.6 to 16.2mJ with a mean of 2.4(+/-0.9). Majority of patients, ie. 42% received energy levels in the range of 2.1-3mJ for capsulotomy 14% received more than 5mJ,14% received energy levels in the range of 3.1-5mJ, received 1.1-2mJ each and only 6% received energy levels of 0.5-1mJ.

Our study showed that the highest amount of energy and laser shots were used in majority of Dense membranous type of PCO (8%). The lowest amount of energy(≤2mJ) were used in majority of membranous type (12%).(Table 2)

The number of shots required for capsulotomy ranged from 1 to 4 with a mean of 2.6(+/-0.7). Majority of patients, i.e.19 patients (38%) received 3 shots followed by 16(32%) patients who received 2 shots, 11(22%) received 4 shots and 4(8%) received 1 shot during capsulotomy.

The highest number of shots, i.e. 4 were used in majority of Dense membranous type of PCO (18%). The least number of shots i.e. 1 were used in majority of membranous type (8%).(Table 3)

The capsulotomy size ranged from 3 to 5mm with a mean of 3.4(+/-0.5). Majority of patients in this study, i.e. 56%

had a capsulotomy size of 3mm,40% had 4mm and only 4% had 5mm.

In our study, the mean IOP according to time from pre-laser to 2 hours post laser was highly significant with p value <0.001 and the mean IOP reduced to baseline or near baseline IOP levels at 1 week (Table 4).

In our study, it was found that the mean IOP according to energy was raised with increasing amount of energy. At 2 hours and 1-week post laser, the mean IOP was significantly increased with greater amount of energy with p values of 0.008 and 0.034 respectively. The IOP values returned to baseline or near baseline values at end of 1 week (Table 5).

The mean IOP according to number of shots was raised with increasing number of laser shots. At 1 week the mean IOP was significantly increased with greater number of shots with p value of 0.045. The IOP values returned to baseline or near baseline values at end of 1 week (Table 6).

Visual acuity pre-laser was in the range of counting fingers to 6/12p. Pre laser vision was counting fingers in 13,6/60p in 5,6/60 in 10,6/36p in 9,6/36 in 8,6/24 in 4 and 6/12p in 1 respectively.

After laser, the best corrected visual acuity (BCVA) at 1 week, was in the range of 6/24p to 6/6. In our study at 1 week, majority of eyes i.e. 11 eyes (22%) improved to 6/9p.1(2%) eyes showed improvement to 6/6,3(6%) improved to 6/9, 9(18%) improved to 6/12,7(14%) improved to 6/12p, 5(10%) improved to 6/18,10(20%) improved to 6/18p, 2(4%) improved to 6/24 and 6/24p each.

Post laser, among the 50 patients, 80% received Ofloxacin-Dexamethasone eye drops, 54% received NSAID eye drops,10% received oral Acetazolamide and only 4% received other topical eye drops like Prednisolone acetate 1% and Timolol 0.5%.

The present study also showed that out of 50 eyes, other complications such as transient iritis occurred in 4% of eyes, IOL pitting and transient vitritis was encountered in 2% cases each.

Table 1: Distribution of cases according to Type of PCO

Type of PCO	N	%
Dense membranous	15	30
Elschnig's Pearls	22	44
Fibrous	5	10
Membranous	8	16
Total	50	100

4. Discussion

In our study of 50 patients who underwent Nd:YAG laser capsulotomy for PCO, majority were females i.e.56% (28) than males 44%(22).

Shivcharan et al in 2012 stated that 60% of his patients were female and 40% were male patients with PCO.[5]

Younas Khan et al stated that of the 58 patients in his study, 19(32.8%) were male and 39 (67.2%) were female in patients with PCO.[6] This study correlates with these studies.

In this study, out of 50 patients, 30 (60%) were above 60 years of age,15 were in the age group of 41-60 years (30%) and 5 patients (10%) were less than or equal to 40 years. The age group ranged from 40 -83 years with a mean of 62.3 (+/-12.4).

Prajna NV et al proposed that maximum number of patients were in the age group between 51 to 60 years with mean age 63.31 years.[7]

Dharmaraju et al (2016) concluded that out of 100 patients, 78% were in 50 to 60 years of age. The present study correlates well with these studies.[8]

We found that the interval between cataract extraction and capsulotomy ranged from 6 to 60 months with a mean of 24 months (+/-12).

Jagat Ram et al reported that the mean time for developed of visually significant PCO is 30 months.[9]

Dangel et al. reported an average time of onset of opacification following cataract extraction to be 27 months.[10]

Dowood et al reported that opacification occurred during the period of 3-18 months with a mean of 16.3 months.[11] This was comparable to the findings of this study.

In the present study, 44% of patients had Elschnig's pearl type of PCO, 30% had dense membranous type,16% had membranous type,10% had fibrous type.

K. Sridhar et al stated that Elschnig's Pearl type of PCO is the most common type (65%) than Fibrous type (20%) and Mixed type (15%).[8]

Pandey et al proposed that out of 560 patients, 314(56.07%) patients presented with Elschnig Pearls, 237(42.33%) had capsular fibrosis and 9(1.60%) had capsular wrinkling.[12] This study correlates with both the studies.

However, Rafiq et al reported 62% eyes with fibrous type of PCO and 35% eyes with pearl type of PCO.[13]

Majority of patients, ie.42% received energy levels in the range of 2.1-3mJ for capsulotomy. This corresponds to the previous studies as mentioned below.

Gore reported in 2012 that the laser power setting required is between 1 to 2.5 mJ or if mode is locked then between 3to5 mJ.[14]

Khanzada et al reported the energy level required ranged from 1.5 to 5 mJ and mean was 3.2 mJ.[15] This study showed that the highest amount of energy(>8mJ) were used in majority of Dense membranous type of PCO(8%).

The lowest amount of energy(≤2mJ) were used in majority of membranous type (12%).

Among 50 patients it was observed that the highest number of shots, i.e. 4 were used in majority of Dense membranous type (18%).

Table 2: Energy levels (mJ) and type of PCO

Energy levels (mJ)	Dense Membranous		Elschnig's Pearls		Fibrous		Membranous	
	N	%	N	%	N	%	N	%
0.3 - 2	0	0	4	8	0	0	6	12
2.1 - 4	0	0	17	34	2	4	2	4
4.1 - 6	5	10	1	2	1	2	0	0
6.1 - 8	6	12	0	0	1	2	0	0
>8	4	8	0	0	1	2	0	0
Total	15	30	22	44	5	10	8	16

mJ: milli Joules

Table 3: Number of shots and type of PCO

No. of Shots	Dense Membranous		Elschnig's Pearls		Fibrous		Membranous	
	N	%	N	%	N	%	N	%
1	0	0	0	0	0	0	4	8
2	0	0	13	26	0	0	3	6
3	6	12	8	16	4	8	1	2
4	9	18	1	2	1	2	0	0
Total	15	30	22	44	5	10	8	16

Table 4: Mean IOP according to time

IOP(mmHg)	Range	Mean	Standard deviation (SD)
Pre Laser	8-18	12.6	2.6
0 Hours	8-20	13.4	2.9
1 Hour	8-26	14.1	3.6
2 Hour	10-28	15.2	4.5
1 Week	10-22	13.2	2.9

(mmHg: millimetres of Mercury) (IOP: Intraocular pressure)
P value from Pre-op to 2hours= <0.001(Highly Significant

Table 5: Mean IOP according to energy

IOP(mmHg)	Energy (mJ)					p value
	0.5-1.0	1.1-2.0	2.1-3.0	3.1-5.0	>5.0	
Pre Laser	11.71±1.89	12±2.87	13.36±2.34	14.36±1.34	16±4.24	0.239
0 Hours	12.29±2.14	12.8±3.16	13.45±2.7	14.45±1.6	17±4.24	0.101
1 Hour	12.29±2.14	13.6±3.75	13.64±2.66	14.64±3.56	18±5.66	0.087
2 Hour	12.57±2.76	14.8±4.34	14.36±1.96	15.36±1.96	18±5.66	0.008*
1 Week	11.71±1.38	13.4±2.84	13.09±2.59	14.09±1.9	16±4.24	0.034*

*significant (mJ: milli Joules)

Table 6: Mean IOP according to number of shots

IOP(mmHg)	No. of Shots				p value
	1	2	3	4	
Pre Laser	11.71±1.89	12±2.87	13.36±2.34	16±4.24	0.206
0 Hours	12.29±2.14	12.8±3.16	13.45±2.7	17±4.24	0.409
1 Hour	12.29±2.14	13.6±3.75	13.64±2.66	18±5.66	0.383
2 Hour	12.57±2.76	14.8±4.34	14.36±1.96	18±5.66	0.385
1 Week	11.71±1.38	13.4±2.84	13.09±2.59	16±4.24	0.045*

*:significant

The least number of shots i.e. 1 were used in majority of membranous type of PCO (8%).

In a retrospective study on 215 eyes with PCO, Bhargava et al found that different PCO subtypes required different initial and total laser energy levels as well as number of laser shots depending on thickness of the posterior capsule (1.8, 3.1 and 2.7 mJ for membranous, fibrous, fibro- membranous opacities respectively). They recommended lower single pulse energy levels rather than higher total energy in order to minimize the rate of complications.[16] This is comparable to our findings.

In this study it was found that the mean IOP according to energy was raised with increasing amount of energy. At 2 hours the mean IOP was significantly increased with greater amount of energy. The IOP values returned to baseline or near baseline values at end of 1 week.

Farooq et.al in 2015 stated that some rise of IOP does occur in most of the cases undergoing YAG- capsulotomy as occurred in their 65 out of 90 patients (72.2%) and 30 (45%) of these had a significant rise (>5mmHg) worth monitoring. Those receiving higher amount of laser energy were more prone to develop IOP elevations in early post laser period. The pressure rise was noted in the first four hours in most of the cases, although it could rise as late as 24hours post laser application.[17] Thus correlating well with the findings in the current study.

In the present study, the mean IOP according to number of shots was raised with increasing number of laser shots. At 2 hours the mean IOP was significantly increased with greater number of shots. The IOP values returned to baseline or near baseline values at end of 1 week.

Borgohain et al in 2017 reported that complications can be minimized by minimizing energy and number of precisely focused shots.[3]

Shetty et.al in 2016 observed that in the patients who received more no of shots, the IOP rise persisted even after 7 days and these patients were observed for 7 days and then started on anti- glaucoma medication.[18] This is in correlation with this study.

In contrast to our findings, Rathod et al. in 2016 reported that the number of pulses applied for the Nd:YAG laser posterior capsulotomy had no significance on the IOP changes.[4]

In this study since the capsulotomy size were 3-5mm, we could not find any significant association between capsulotomy size and IOP.

Karahan et al in 2014 concluded that capsulotomy size was important, as patients subjected to lower amounts of laser energy for perhaps a smaller capsulotomy, may benefit from fewer complications of RD, IOP rise and perhaps to less CME.[19]

In our study the mean IOP according to time from pre-laser to 2 hours was highly significant with p value <0.001 and the mean IOP reduced to baseline or near baseline IOP levels at 1 week.

Murali Krishna et al. (2015) stated that there is a transient peak rise of IOP within 1-3 hour and 1.5- 4 hours after laser capsulotomy respectively and return to baseline value within 1 week in their study. The sudden pressure rise is caused by impaired aqueous outflow and rapid onset suggest that the reduced outflow mostly due to clogging of trabecular meshwork by capsular debris, acute inflammatory cells, heavy molecular weight protein or a combination of these mechanisms.[20] Werneret al concluded their study that 59% patients show rise in IOP that was ≤5 mm Hg and none of the patients show elevated IOP after 1 week.[21]

Wasserman et al stated that there is a transient IOP rise that occurred within 1 hour of the capsulotomy.[22] These findings are comparable to this study.

In this study among 50 patients, pre laser vision was counting fingers in 13,6/60p in 5,6/60 in 10,6/36p in 9,6/36 in 8,6/24 in 4 and 6/12p in 1 respectively. At 1 week, majority of eyes i.e. 11 eyes (22%) improved to 6/9p,1(2%) eyes showed improvement to 6/6,3(6%) improved to 6/9,9 (18%) improved to 6/12,7(14%) improved to 6/12p,5(10%) improved to 6/18,10(20%) improved to 6/18p,2(4%) improved to 6/24 and 6/24p each.

Shani et al. stated that in their study, 97% cases had shown improvement in visual acuity. Visual acuity improved to 6/6 in 16 cases, 6/9 in 36 cases, 6/12 in 16 cases, 6/18 in 10 cases, 6/24 in 8 cases, 6/36 in 7 cases, and 6/60 in 4 cases.[23]

Congdon et al. reported improvement in best corrected visual acuity after Nd: YAG laser capsulotomy.[24]

Rasool et al. showed that immediately post Nd: YAG laser capsulotomy only 7% (14) patients had good BCVA (6/18). After one-week follow-up there was significant improvement of 6/18 in 73% patients.[25]

Buehl et al reported a gain in vision after Nd: YAG capsulotomy. Thus correlating well with our findings.[26]

Among the 50 patients studied, only 2% had IOL pitting, 4% had transient iritis and 2% had transient vitritis. Iritis and vitritis was transient and was found to subside on follow up at 1 week with use of steroid eye drops. Other complications like IOL cracking, RD, CME etc. were not observed.

Aurangzeb et al found prevalence of 7% for IOL damage during YAG laser posterior capsulotomy highest in group 3 than in group 1(4.49%), group 2(4.1%) and group 4 (1. 27%).[27]

Josef et al reported that iritis was found in 1% of the eyes.[28]

Keates et al. found iritis persisting in 0.4% and vitritis persisting in 0.7% after a 6-month postoperative period.[29] Gore et al. reported that transient anterior chamber reaction may be seen post-laser, however persistent iritis or vitritis is rare.[14] These findings are comparable to that observed in this study.

Chambless, however in his study with an average follow-up period of 7 months, found persistent anterior uveitis in 1.4% of the patients.[30]

5. Conclusion

There is a low, but definite risk of some complications such as those observed in this present study like transient IOP rise(most common complication noted), IOL pitting, transient iritis and vitritis. Other serious complications like retinal detachment(RD), cystoid macular edema(CME) were not noted. The mean IOP post laser was found to significantly increase with increasing time, energy levels and number of laser shots. In most eyes, IOP returns to baseline or near baseline levels at the end of one week. Hence, regular follow ups are mandatory. We conclude that good skill, proper patient selection, precise focusing of laser, minimizing number of shots and energy levels can reduce complications. Thus, Nd:YAG laser as a treatment modality for PCO is well suited for a country like ours, where a large number of back log of cataract cases are operated by SICS(small incision cataract surgery) procedure.

6. Source of Funding

None.

7. Conflict of Interest

None.

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