Nd-YAG laser posterior capsulotomy and visual outcome

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Abstract

Introduction: Posterior capsular opacification is the most common delayed complication of cataract surgery with IOL implantation. This results due to proliferation and migration of reminant epithelial cells that form clump and fibrosis on the posterior lens capsule leading to posterior capsular opacification(PCO).

Method: The cases for Nd-Yag laser posterior capsulotomy were collected from amongst those attending the ophthalmology OPD of Nehru chikitsalay, Gorakhpur in period of one year (May 2015 to June 2016). Patients were selected on the basis of inclusion criteria according to study requirement and observations were made for outcomes.

Observations: The observations made on the basis of our study are as follows:

- Maximum eyes (52%) were in the age group 50-60 years.
- Male (61.7%) outnumbered female(38.3%) in ratio of 3:2.
- Maximum number of cases need YAG laser capsulotomy between the period of 36 months -60 months.
- Thick white opacification type of PCO required maximum energy and maximum shots.
- Post-YAG Laser capsulotomy visual improvement is 87.3% in 6/12 to 6/6.
- 5.1% cases shows no change.
- Most frequent complications is rise of intra ocular pressure.

Conclusion:

- Depending upon the thickness/density of PCO three types of PCO's were encountered.
- Most frequent complication is rise of IOP, which is mainly seen in eyes exposed to total laser energy level of >40mJ or above, this rise of IOP respond well to timolol 0.5%.
- When the energy levels are raise, the complications also raises, thus to minimize this number of settings should be increased.
- It is safe and readily acceptable to patients.

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Introduction

Intraocular lens implantation is widely popular visual rehabilitation following cataract extraction.

One of the most common delayed complication of SICS with intraocular lens implantation is proliferation and migration of reminant epithelial cells that may form clumps or fibrosis on the posterior lens capsule leading to posterior capsule opacification.

There are three main sources of cells with a potential to cause opacification of capsular bag.

1. Cuboidal epithelial cells lining the anterior capsule these have no propensity for migration, they undergo fibrous metaplasia and proliferate in situ.
2. The cells at the equatorial lens bow have an increased level of mitotic activity. These cells are migratory, therefore they grow along the posterior capsule giving rise to bladder cells.
3. Finally, the residual cortical fibers from the equatorial lens bow becomes dislodged and float freely with in the bag. They may remain localized or migrate centrally into the visual axis.

Posterior capsule opacification(PCO) produce a wide ranging visual symptoms of differing severity ,usually by directly blocking the visual axis. Opacification of the ocular media affects the visual recovery by impending light through the eye.

The retention and subsequent proliferation of cells(lens epithelium) with in the bag gives rise to posterior capsular opacification. This process of thickening of posterior capsule is further enhanced by the surgical insult causing a blood aqueous barrier break down. Inflammatory products such as leucocytes, proteins, erythrocytes and fibrin released during and in around 20% form membrane.

At least 28% of eyes develop PCO with in 5years after surgery, although nearly 100% opacification occurs in cases of children.

The incidence of posterior capsular opacification ranges from 15-30% in 3-5years after surgery. The interval between surgery and opacification time ranges from 3months to 4years with an average opacification time being 26 months.

PCO can be treated by primary and secondary capsulotomy, but these procedures are associated with a lot of disadvantages. Various treatment modalities are suggested for posterior capsule opacification e.g. surgical dissection and Nd-YAG laser. Today Nd-YAG

laser posterior capsulotomy is the most widely accepted procedure owing to its easiness, effectiveness and non-invasive technique to improve the visual acuity.

The name ND-YAG is derived from the Neodymium ion which is doped in to an Yttrium Aluminium Garnet crystal. The development of 1064 nm solid state ND -YAG laser took place in 1970's at the Bern eye clinic under Di Franz Frankhouser.

The clinically useful laser effects in biologic tissues includes photochemical effects (Photoradiation & Photoablation), thermal effects (photocoagulation, photovapourization), ionizing effects (photodisruption). Photodisruption can be defined as the use of high peak power ionizing laser pulses to disrupt tissue. The most widely employed laser medium to produce optical photo distruption is Neodymium. Yttrium –Aluminium -Garnet(Nd-YAG) laser with the major fundamental output 1064nm in the infrared range. One of the most frequent and most successful application of the photo disruptive property of Nd-YAG laser is, laser posterior capsulotomy done in the treatment of opacified post capsules and secondary cataract.

Nd-Yag laser capsulotomy has many advantages over primary or secondary capsulotomy. It is noninvasive and less time consuming and can be done as an outdoor procedure with better patient acceptability.

There are many complications associated with Nd-Yag laser. Rise in intraocular pressure occurs in first few hours after the procedure and there are chances of persistent dangerous pressure elevation. Retinal detachment and cystoid macular edema are well known complication following the YAG laser capsulotomy. A large number of pulse can produce corneal endothelial damage. IOL damage may occurs.

The management with Nd-Yag laser is now widely applied as latest technique now a days.

So in an attempt to find out different factors for posterior capsular opacification after SICS with IOL. Like types of PCO, laser energy required and visual outcome of YAG capsulotomy as well as complications of YAG laser application, this study is being taken up.

Study period- 1year

Study design-Cross-Sectional Study.

Sample size- 256 eyes.

$N=4Pq/L^2$

Where P=proportion of patients who get benefited from Nd-YAG laser capsulotomy.

P=80%. (ref; Hossain MI, Hossain MA, Hossain MJ outcome Nd-YAG laser capsulotomy JAFMC Bangladesh, Vol 5, No.2(December)2009; 29-31.

q=100-P.

L=Allowable error as 5% for study.

$N=4\times80\times20/5\times5$

N=256. Eyes.

Aims and Objectives

The aims & objectives of this study are:

1. To assess the visual outcome after ND-Yag laser capsulotomy.
2. Types & grades of post capsule thickening.
3. Laser energy shots related complications.

Incidence and Factors Influencing P.C.O.: The incidence of posterior capsular opacification after SICS with IOL was analysed by several authors.

Nishi (1986) noted a significantly lower incidence of posterior capsule opacification after SICS in eyes with a posterior chamber IOL (7%) than in eyes without an IOL (15%). Liesegang and co-authors (1993) noted the opacification with and with-out IOL to be 14.5% and 22.1% respectively. Polishing the capsule at the initial surgery does neither decrease the frequency of opacification nor delay it.

Peng Q; Pandey SK; Visessook N: (2000) analyse the surgical prevention of posterior capsule opacification and intraocular lens optic barrier effect as a second line of defense. He concluded that the barrier effect of the IOL optic appears to be of critical importance in retarding in growth of cells, functioning as a second line of defense when cortical cleanup is incomplete. Analysis of PCIOL obtained postmortem showed that a square, truncated optic edge seemed to provide the maximum impediment to cell growth behind the IOL optic.

Lieberman HL; Sanders DR; Kraff MC (1985) studied that an age-related tendency toward membrane formation, with nearly 100% of paediatric patients developing capsular clouding within 2 years of surgery. In general, the older the human patient, the lower the frequency of capsular opacification. The rate may drop below 10% in patients over the age of 70

Auffarth GU; Nimsgern C; Tetz MR; Volcker HE: (1997) analysed the energy levels for Nd:YAG laser capsulotomy in secondary cataract. They examined 172 patients, aged 67.3+/ -15.9 years, concerning energy levels required for Nd: YAG laser capsulotomy. They analysed the influence of age, implant duration, IOL fixation and ocular conditions on total energy and repetition rate of Nd:YAG laser capsulotomy. Nd:YAG laser capsulotomies were performed on average 28.2+/ -17.7 months postoperatively: The average total energy used was 12.7+/ -9.4 mJ. Visual acuity (Pre-YAG- was 0.3+/ -0.2. In the control group there was no correlation between energy and implant duration or age (P>0.43). 26 patients required a second Nd: YAG laser capsulotomy.

The intensity and number of YAG energy applications depend on the type of capsule opacification. To begin a capsulotomy an energy setting of 1 mJ and single shots are advisable. Lowest level energy pulse that will open the capsule should be advisable. Most capsulotomies can be performed with single Q-switched pulses between 1 and 3 mJ. Shots should be placed at the tension lines result in the largest opening per shot since the tension causes the initial

opening to retract. An adequate opening can be made with 5 to 20 shots. The burst-mode should not be used in the presence of an intraocular lens since the damage threshold for PMMA decreases with repetitive pulses through the same area.

With the He-Ne aiming beam anymore. Denser fibrotic opacification may require higher energy or multiple bursts.

Operative Complications: Damage to Intra Ocular Lens is the most frequent operative complication after Nd: YAG Laser Capsulotomy.

Ashkinadze; Vladimov; Likhachev et al (1966) reported damage to Intraocular lenses may take the form of melted voids, microcracks, and large pulverized regions.

Intraocular lens damage decreases with the surgeon's experience and may be avoided by better focusing and by using low energy.

Fallor and Hoft (1985) demonstrated that a minimum separation of 0.25 mm between the lens and the posterior capsule prevents lens damage in 100%.

1. Acute Post-operative Complications: Important acute post-operative complications of Nd:YAG laser posterior capsulotomy are retinal detachment and rise of intraocular pressure. The other minor acute post-operative complications are ciliochoroidal effusion and macular hole formation.

Retinal Detachment: Rickman-Barger L et al (1989), described the incidence of Retinal detachment after Nd:YAG Laser Posterior Capsulotomy According to them the incidence varies between 0.08 and 1%.

The other major postoperative complication of YAG Laser Posterior Capsulotomy is elevation of the intraocular pressure (I0P). The rise of the pressure (more than 5 mm Hg) is maximum at two to six hours after surgery. It declines within 24 hours and the elevation usually resolves within a few days (1984)

The rise of the ocular pressure occurs much more frequently in pre-existing glaucoma cases (1984). This is nicely *demonstrated in the series of 3000 YAG capsulotomies performed by Shah et* al (1986), where they found a rise of pressure in 16.9% of the glaucoma cases and in only 6% of the non-glaucomatous.

Keates and Co-workers (1984), a pressure rise of 5 mm Hg or more was recorded in 31 eyes (out of 190) following laser capsulotomy. Many of the eyes had antiglaucoma treatment or surgery. A measurement of the ocular pressure at one hour predict the ultimate rise in pressure. If at one hour the pressure increase exceeds the base-line measurement by more than 5 mm Hg, the total increase is usually in excess of 10 mm Hg. If one hour increase is less than 5 mm Hg, the maximal increase is usually under 10 mm Hg. Occasionally the pressure elevation may be delayed and may be missed. These findings are in agreement with the statistical analysis of the core study data. It is advisable to instill one drop of beta-blocker at the time of capsulotomy when the patient has no pre-existing glaucoma. Glaucomatous patients are given maximal medical therapy including acetazolamide and are monitored for at least two hours after treatment. High risk patients should be watched for atleast four hours. All patients should be checked the day following laser treatment.

Cystoid macular edema (CME) after YAG capsulotomy has a low incidence.' Shah and co-workers" found it in 0.68% of cases. In most of the cases it is a failure to diagnose a preoperative CME. In a retrospective study, Lewis and co-workers studied 136 patients who underwent Nd:YAG laser capsulotomy (3 eyes had preoperatively. Eighty eyes were followed for six months and CME did not develop in any of the eyes. A low mean total energy (76 mJ) was used for posterior capsulotomy.

Recently there have been some reports (1986-1988) of the onset of endophthalmitis after posterior capsulotomy due to the release of anaerobic organisms (Propionibacterium) which had been sequestered in the posterior capsule and released as a result of Nd:YAG laser posterior capsulotomy. If an intraocular indolent inflammation flares up after YAG capsulotomy the possibility of Propionibacterium endophthalmitis should be suspected.

Material and Method

The cases for Nd-Yag laser posterior capsulotomy collected from amongst those attending the ophthalmology OPD of our hospital in period of one year. Consent of the patient taken.

Selection of patients:

a. Those patients are selected who had undergone SICS with PCIOL in whom post-operative vision was good but vision had declined over a period of few months to years.
b. The patients then selected for ND-Yag capsulotomy .All eyes with complications (other than PCO) were excluded from the study.

Examination

a. History of lens implantation
b. Visual acuity and refraction
c. Intraocular pressure recording
d. Slit lamp examination

Instruments

1. Snellen's chart-for visual acuity (BCVA).
2. Trail set autorefractometer.
3. Slit lamp biomicroscopy –to exclude any other pathology a part from PCO.
4. Opthalmoscope direct and indirect.
5. Schiotz tonometer-to record pre and post-laser intraocular pressure of the eyes.
6. B Scan ultrasound examination.

7. NIDEK'S YC-1800 ophthalmic YAG laser system

Method

A. Pre Op:

- Consent of the patient taken and procedure explained to patient.
- Visual acuity recording done by snellen's chart for distant vision and with near vision chart for near vision.
- IOP recorded
- the pupil is adequately dilated before surgery with tropicamide 1% eye drop 3times at 10min interval(B/E)
- After dilation of pupils both indirect & direct ophthalmoscopy is performed to rule out/exclude any pathology of post segment, and type and grade of PCO.
- Now patient is comfortably be seated on stool infornt of the laser slit lamp with chin on chin rest and forehead on forehead rest and head band applied.
- Now e/d paracaine(proparacaine) one drop is instilled once in operating eye.

B. Intra-op

- The patient fixes the red light/green light by other eye(non-operating)
- The slitlamp is focused and the YAG is switched on.
- The energy level's fed in to the computer. Usually 7 to 1mj, lower power setting are used initially and later increased as required.
- Capsulotomy started by marking the centre of pupil, shots are applied around it. Starting from 12'o'clock position and going clockwise until a satisfactory opening is made.
- Energy and shots were recorded.

C. Post-op:

Post op visual activity is recorded for both distant & near vision immediate post op

- Now again IOP is recorded.
- Then VA(visual acuity) is recorded after 1hour
- Then VA is recorded next day then after 15 days then 30days post op.
- pt is examined on slit lamp for complication of ant segment, uveitis for keratic precipitates, flare and haemorahage on 7th Post op day.
- IOP is recorded at every visit after recording visual acuity and near vision.
- post segment pathologies & post op complication has also been ruled out at every visit, after recording, first visual activity, near vision secondly IOP, by dilating the pupils.

D. Post laser treatment

- Topical nepafenac eye drop 4 times a day for 15days to all the patient.
- The post op IOP recording will be done at interval of 1hour, 4hours and at 24hours.
- Those eyes were rise in IOP is by more than 5mm of Hg were treated with Timolol 0.5% eyedrop twice daily for 7days.

Observations

During the period of study spanning from May 2015 to June 2016,256 eyes of posterior capsular opacification were identified and recorded. Out of 256 eyes 160 eyes were operated in our hospital and 96 eyes were operated elsewhere. These 256 eyes underwent YAG laser posterior capsulotomy and the observation made are as follows.

Table 1

Total No. of eyes having PCO	Operated in our hospital	Operated elsewhere
256	160	96

Total 1207 eyes underwent SICS with/without IOL implantation, during the period of study, out of which 160 had significant posterior capsular opacification. Thus the incidence of PCO in cases operated in our hospital is 13.25%.

Table 2: Incidence of PCO

Total No. of patients operated in our hospital	Patients having PCO
1207	160(13.25%)

Table 3: Age distribution of the patients

Age (years)	No. of Patients	Percentage
60-70	102	40%
50-60	133	52%
<50	21	8%
Total	256	100%

Maximum eyes (52%) were in the age group 50-60 years.

Table 4: Sex distribution

Sex	No. of patients	Percentage
Male	158	61.7%
Female	98	38.3%
Total	256	100%

Male (61.7%) outnumbered female(38.3%) in ratio of 3:2.

Table 5: Types of PCO

Type of PCO	No. of patients	Percentage
Pearl with/without ring of sommering	147	57.4%
Fibrosis type	83	32.4%
Thick white sheet opacification	26	10.2%
Total	256	100%

Most of the cases found in our study has pearl with/without Ring of Sommering(57.4%).

Table 6: Time elasped between surgery and YAG laser capsulotomy

Time Interval	No. of cases
0-6 Months	26
6 Months-15 Months	32
15 Months-36 Months	76
36 Months-60 Months	112
>60 Months	10
Total	256

Maximum number of cases need YAG laser capsulotomy between the period of 36 months -60 months.

Table 7: Laser energy/shots required

Type of PCO	Total Energy(mJ)	No. of shots
Pearl with/without sommering ring	2-18	3-12
Fibrosis type	18-90	6-30 (>one sitting)
Thick white sheet opacification	25-130	>10-40 (>one sitting)

Pearl with/without ring of sommering require minimum energy and minimum shots.

Thick white opacification type of PCO required maximum energy and maximum shots.

Table 8: Pre laser visual acuity

Best corrected visual acuity	No. of patients	Percentage
<6/60	160	62.3%
6/60-6/18	96	37.7%
Total	256	100%

Maximum number of cases have pre laser visual acuity<6/60(62.3%).

Table 9: Post –laser visual acuity

Best corrected visual acuity	Group-I <6/60(160 Eyes)	Group-II 6/60-6/18(96 Eyes)	Total %
6/12-6/6	132	92	224(87.3%)
6/36-6/18	17	2	19(7.6%)
6/60 to further low	11	2	13(5.1%)
Total	160	96	256(100%)

Post-YAG Laser capsulotomy visual improvement is 90% in 6/12 to 6/6.

5.1% cases shows no change.

Table 10: Intraocular pressure rise in post laser period

		Number of patients with IOP rise by more THAN 4mmHg		
Energy levels	Total no. of patients	½ Hour post laser	4 Hours post laser	24 Hours post laser
0-10mJ	10	-	-	-
10-20mJ	18	4	7	-
30-40mJ	112	9	18	-
40-50mJ	49	29	41	7
50-60mJ	28	5	15	-
60-90mJ	18	3	9	4
90-130mJ	21	4	5	2
>130Mj	-	-	-	-
Total	256	54(21%)	95(37%)	13(5%)

The above table shows intraocular pressure rise in post laser period. All patients exposed to energy levels more than 40mJ showed an increase in intraocular pressure in four hours post laser period.13 patients reported late intraocular pressure rise after 24 hours. This may be attributed to the Timolol Maleate(0.5%) eye drop given to the patients.

Table 11: Complications following the laser capsulotomy

Post-YAG Complications	No. of patients		Percentage
Rise of IOP	Duration	No. of patients	
	At ½ hours	54	21%
	At 4 hours	95	37%
	At 24 hours	13	5%
Pitting of the IOL	32		12.5%
Corneal edema	17		6.8%
Pupillary block glaucoma	21		8.2%
Iris Bleeding	20		7.6%
Iritis	12		4.8%
Pain	7		2.6%
Cystoid macular edema	5		2%

Most frequent complications is rise of intra ocular pressure. It occur in 21% at ½.

Hour, 37% at hour and 5% at 24 hour. The other complications are pitting of IOL(12.5%),Corneal edema(6.8%), Pupillary block glaucoma (8.2%), Iris bleeding(7.6%), Iritis(4.8%), Pain(2.6%) and Cystoid macular edema(2%).

Discussion

Posterior capsular opacification is frequently observed after SICS with/without IOL implantation. The most common delayed complication of SICS is posterior capsular opacification. The cases have been selected from those operated in our hospital and from OPD clinic. 256 patients were taken for study. Out of which 160 patients were operated in our hospital and 96 were operated elsewhere but came as OPD case (Table 1). In our study the incidence rate of PCO was 13.25%(160 cases) out of 1207 cases operated at our hospital(Table 2). This low incidence in our study is not the true reflection because the study period is less , the incidence rises from 3-5 years, secondly out of the 1207 patient operated, many did not come for follow up as most of them are from the rural area and are happy with 6/24-6/18 vision.

In our study the maximum number of cases having PCO were from the age group of 50-60 years (Table 3) 52%.This may be due to the less number of pediatric cases in our study and lack of follow up by the older age patients.

Most of the cases are male (61.8%) as compared to females (38.2%) (Table 4). It can be explained by the practical fact that males have more outdoor activity as compared to females and males are earning member in family so overall concern for vision is more in males.

In our study the PCO was categorized according to density, as done by other authors. The most common is Elsching's pearls with/without sommering ring(57.4%), next is Fibrosis type(32.4%) and Thick white sheet opacification is least commonly seen(Table 5).

In our study maximum number of cases needing YAG laser capsulotomy lies between 36 months to 60 months(Table 6), which is near to other studies, this latency may be attributed mainly to the low frequency of follow up, and difference in surgical technique and IOL material used.

In present study, the number of shots ranged from 3-40. 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 (Table 7), more than one sitting is required in fibrous and thick white sheet type opacification, as the total energy required in some cases were more than 90mJ. The total amount of energy used for most of the cases was in the range of 30-50mJ. Only few cases in our study required high energy levels, probably this may correlated with the learning curve. Once the surgeon get experienced the energy level required can come down, the other reason may be the fixation of eyes required during the process, if the patient moves the eye, the energy level will be more ,as the shots are wasted, hence fixating lens should be used to decrease the level of energy and shots.

The results of Nd-YAG laser capsulotomy were quite satisfying. Best corrected visual acuity of all the patients underwent YAG laser posterior capsulotomy had been done with appropriate glasses. 87.3% eyes showed improvement in visual acuity by atleast 2 lines on snellen's chart (Table 8 and Table 9). Only few eyes reported further deterioration in vision in postlaser period due to cystoid macular edema.

Most frequent post YAG laser complication encountered in our study is rise of intraocular pressure. The incidence of rise of IOP in our study was 21% (at ½ hour), 37%(at 4 hours), and 3%(at 24hours), rise of IOP was usually in patient who received more number of shots and hence more cumulative laser energy(Table 10). There is temporary mild rise of IOP which is easily treated with timolol 0.5% and pose no problem. In 8.2% case there was persistent rise of IOP, due to the pupillary block glaucoma (Table 11). Pupillary block glaucoma occur due to rupture of anterior hyaloid phase.

In our study the other prominent complication was pitting of IOL. Lens pitting causes glare effect and if pitting is in the center, it may decrease the vision(Table 11). Corneal edema is seen in 6.8% cases, it may occur due to high energy in cases with shallow anterior chamber and thick white sheet type PCO. Iris bleeding is found in 7.6% and iritis in 4.8%.Cystoid macular edema is seen in 2% patients(Table11).

Conclusion

From the observation made in our study, following conclusion have clearly emerged out:

- Posterior capsular opacification is a very common complication following SICS with IOL implantation with an incidence of 13.25%. The incidence of PCO in our study is 13.25% which is not a true reflection of incidence.
- It safe and readily acceptable to patients can be done as a day care procedure, thus preferred over surgical intervention.
- Depending upon the thickness/density of PCO three types of PCO's were encountered.
- Depending upon the PCO type, the basic power setting for laser energy should be applied.
- All attempts should be made to minimize the laser energy used for capsulotomy. In the capsules with tension lines, the laser shots should be delivered perpendicular to these tension lines; as this minimizes the total energy used.
- Most frequent complication is rise of IOP, which is mainly seen in eyes exposed to total laser energy level of >40mJ or above, this rise of IOP respond well to timolol 0.5%, all the effort should be made to minimize the delivered energy.
- When the energy levels are raise, the complications also raises, thus to minimize this number of settings should be increased.
- In a nut-shell, Nd-YAG laser posterior capsulotomy is non-invasive and least time consuming, can be done as outdoor procedure with

better patient acceptability. It remains the choice modality as compared to surgical dissection, thus inspite of few complications, Nd-YAG Laser is the safest and most effective procedure now a days.

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