IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 16, Issue 12 Ver. IV (Dec. 2017), PP 14-20
www.iosrjournals.org

Role of Nd: Yag Laser in the Management of Posterior Capsular Opacification

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Abstract: *This research was aimed to assess the effect on visual acuity following Nd: YAG laser capsulotomy, total amount of laser energy required for capsulotomy, and to assess the complications of fallowing laser capsulotomy. It included 70 patients with posterior capsular opacification admitted in M.L.B. Medical College, Jhansi between July 2016 to April 2017 .The study group patients were asked relevant history, examination of the eye with the help of slit lamp, refraction, Best corrected visual acuity, tonometry, and fundus examination, and Nd:YAG laser capsulotomy was done. In this study 33 male and 37 female were taken. Mean age was 58.41 years. Most of the patients presented with visually significant posterior capsular opacification 6-12 months of the cataract surgery. Percentage of patients achieved the final visual acuity (BCVA) of 6/6 to 6/12 were 58.57% and percentage of patients with no visual improvement were 4.29%. 52.86% patients required the total laser energy of 01-25 mJ to make adequate opening in posterior capsule. Most common complication of Nd:YAG laser was IOP spike, post laser iritis, glare and vitreous floaters.*

Keywords*: IOP spike, Nd: YAG laser, Posterior capsular opacification, Best corrected visual acuity, Iritis*.

Date of Submission: 01-12-2017 Date of acceptance: 02-12-2017

I. Introduction

Posterior capsular opacification, referred to as 'secondary cataract' or 'after cataract', develops over the clear posterior capsule a few months to a few years after an uneventful cataract surgery. Posterior capsule opacification (PCO) and posterior chamber intraocular lens (PC IOL) decentration still remain two major complications of successful extracapsular cataract surgery (ECCE) or phacoemulsification[1-6]. Ridley, who performed the first intraocular lens implantation in 1949, himself noted these complications in his earliest patients[7]Clinical studies have reported an incidence varying between 10% - 50% of posterior capsule opacification following ECCE or phacoemulsification with PC IOL implantation[1,2,3,8-11]. Its incidence has been reported to reach as high as 50% five years after surgery[13,14].In younger age groups, almost 100% opacification occurs within 2 years after surgery. This is thought to be because of the higher proliferative capacity of the lens epithelial cells in the young compared with the old.

II. Pathogenesis Of Posterior Capsule Opacification:

Most secondary cataracts are caused by proliferation of equatorial lens epithelial cells, forming the pearl form of posterior capsule opacification[12]. Posterior capsule plaques or fibrous plaque detected in patients after ECCE are not uncommon in the developing countries[13] and such plaques are rarely seen in the industrialized world. The epithelium of the lens consists of anterior epithelial cells known as A-cells which are single continuous cell line. These cells are continuous with the cells of the equatorial lens bow. The cells of equatorial lens bow are the E-cells, which comprise of the germinal cells undergoing mitosis as they peel off from the equator. They continuously form peripheral cortical fibers. A-cells tend to remain in place and not migrate and are prone to change toward fibrous tissue (fibrous tissue metaplasia) when disturbed. In contrast E-cells of equatorial lens bow tend to migrate along the posterior capsule and form pearls form of posterior capsule opacification. These equatorial cells are the primary source of classical secondary cataract especially the pearl form of posterior capsule opacification[12].The two morphologically distinct types of the PCO are fibrosis and Elschnig's pearls, which occur independently or combination. Westling A.K. and Calissendroff B.M.(1991) in their study found no association between age or sex of patients, while Jamal S.A. and Solomon L.D. (1993) identified younger age (50 year or less), larger optic and smaller IOL as significant capsular pearling.

As yet there is no reliable treatment to prevent PCO. Ideally the best way to prevent PCO would be to remove all the lens epithelial cells and cortical remnants at the time of surgery.
But in clinical studies,

2.1 Incidence of PCO formation can be affected by:

1. Polishing the posterior capsule after lens cortex cleaning had slight value in delaying or preventing capsular opacification
2. Capsulorhexis with a slightly smaller diameter than the IOL optic appears to be better than a large-size capsulorhexis in reducing the incidence of PCO.
3. Posterior continuous curvilinear capsulorhexis (CCC) with optic capture of the heparin-coated IOL was successful in preventing secondary opacification of the visual axis in pediatric cataract cases.
4. Compared the incidence of PCO after ECCE and phacoemulsification and found that visually significant PCO occurred in eyes having ECCE.
5. Pharmacological agents, antimetabolites and other agent also have been shown to reduce PCO. These are 5-FU, Methotrexate, Colchicine, Mitomycine-C and Daunorubicin.
6. Modification of the surface of different types of IOL by coating with Heparin, Indomethacin or fibroblast growth factor conjugated with saporin, have been shown to reduce postoperative inflammation and PCO.
7. Convex posterior chamber IOL can inhibit posterior capsule opacification and close apposition of peripheral anterior and posterior capsule flaps leads to posterior capsule opacification.

2.2 Nd: YAG laser capsulotomy:

The basic principle of Nd: YAG LASER is photo-disruption.

The neodymium: yttrium-aluminum-garnet (Nd: YAG) laser is a solid-state laser with a wavelength of 1064 nm that can disrupt ocular tissues by achieving optical breakdown with a short, high-power pulse. Optical breakdown results in ionization, or plasma formation, in the ocular tissue. This plasma formation then causes acoustic and shock waves that disrupt tissue. Fankhauser performed his first YAG capsulotomy. The procedure caught on quickly because the alternative was surgical dissection of the posterior capsule, which is a more inherently invasive procedure. With the older intraocular lenses, opacification rates could be as high as 50%. Generally a laser consists of an active medium that can be excited optically and electrically (which is technically called 'pumping'). The active medium is placed between two specially coated mirrors for transmission of specific wavelength. Traditionally, the optics of the delivery system of an Nd: YAG irradiation apparatus consists of binocular stereoscopic microscope with two helium-neon (He-Ne) laser aiming/focusing beams.

III. Material & Methods

This prospective study included 70 cases of posterior capsular opacification admitted in the Department of Ophthalmology, Maharani Laxmi Bai Medical College, Jhansi, Uttar Pradesh, India over a period of 10 months from July 2016 to April 2017. The procedures followed were in accordance with the ethical standards committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975, as revised in 2000. The necessary permission from the Ethical and Research Committee was obtained for the study.

3.1 The main Objectives of the study included: a) To assess the effect on visual acuity following Nd: YAG laser capsulotomy. b) Total amount of laser energy required for capsulotomy, and c).To assess the complications following laser capsulotomy.

3.2 Inclusion criteria:

1. Patients having significant PCO and complaining of gradual diminution of vision after a certain period of appreciably good vision following successful cataract extraction surgery with IOL implantation were included in the study.
2. Both male and female patients were included in the study.
3. The age group of the patients to be studied was between 31 to 90 years.

3.3 Exclusion criteria:

Patients classified in the fallowing groups were not included in the study group:

1. Patients with complaints of diminution of vision without gaining good vision following cataract surgery were excluded from the study.
2. Patients with decreased visual acuity due to any ocular or systemic pathology.
3. Patients with posterior segment disorder**.**

3.4 Contraindications to laser capsulotomy.

Absolute Contraindications	Relative Contraindications
• Corneal scars, irregularities, or edema that interfere with target visualization or make optical breakdown unpredictable • Inadequate stability of the eye	• Glass intraocular lens • Known or suspected cystoid macular edema • Active intraocular inflammation

	• High risk for retinal detachment

An assessment of present complaints, ophthalmological check up as external examination of the eyes, visual acuity, torch light examination, slit lamp examination, refraction, direct ophthalmoscopy, and tonometry, was done.

3.4 Procedure:

1. Explanation of the procedure and informed consent taken (reason, step, and duration of the procedure).
2. Pupil was dilated with 1% Tropicamide and 10% Phenylephrine.
3. One drop of topical beta-blocker was instilled just before doing the capsulotomy procedure.
4. Patient's eye was anaesthetized by using topical 2% lignocain drops.
5. Patient must be seated comfortably with chin rest. A darkened/semi darkened room is improves surgeon's visualization of the target.
6. Head strap was used when required to maintain forehead positioning.

3.5 Size of capsulotomy:

The size of capsulotomy should match the size of the pupil in the physiological state. It should be about 4 mm since the mean pupil size in scotopic condition is 3.9 mm ($\pm$0.5).

Focusing with the help of slit lamp, optical beam was focused on the posterior capsule and laser shots were given. To begin a capsulotomy, lowest energy/pulse (about 1.0 mJ) was used and as and when required energy was gradually increased.

3.6 Post capsulotomy care and examination:

One drop of the topical anti-glaucoma medication (Beta-blocker) was instilled.

A topical NSAID (Flurbiprofen) was advised 4 times a day for 7 days following the procedure.

Slit lamp examination, tonometry and evaluation of visual acuity was done in post laser capsulotomy period at 1 hour, 24 hour, 1 week, and 2 weeks following capsulotomy.

Final refraction and analysis was done 2 week after the capsulotomy.

IV. Results

A total 70 patients of the age group 31-90 years with significant PCO were included in the study.

Following types of Posterior capsular opacification were distinguished in the study.

1. Elschnig's pearls type of PCO
2. Fibrosis.
3. Mixture of Elschnig's pearls and Fibrosis type

To correlate the amount of PCO with diminution of vision all the PCO cases were divided into 3 graded in the decreasing order of visual acuity in the following order (table 4.1).

Table 4.1 Types of PCO and visual acuity

Grades of PCO	Visual acuity
Mild	6/18 – 6/24
Moderate	6/36 – 6/60
Severe	<6/60 – 1/60

Table 4.2 Gender ratio of patients (n=70)

	Male	Female	Total
Number	33	37	70
Percentage	47 %	53%	100%

Table 4.2 shows gender distribution of the patients in the study group.

There were 33 (47%) males and 37 (53%) females. The male female ratio was 1:1.12

Table 4.3 Time interval between cataract surgery and PCO formation (n=70)

Time interval between cataract surgery and appearance of symptoms	Number of patients	Percentage
< 6 Months	08	11.43
6-12 months	22	31.43
12-18 months	17	24.29
18-24 months	09	12.86
2-3 years	10	14.29
3-5 years	04	5.71

Total	**70**	**100**

According to table 4.3, It has been observed that most of the patients presented with visually significant PCO within 6-12 months of the cataract surgery (31.43%), closely followed by 24.29% of the patients who developed PCO within 12-18 months of cataract surgery.
The mean time interval for development of PCO after cataract surgery was found to be 16.28 months in this study.

Table 4.4 Types of posterior capsular opacification (n=70)

Types of PCO	**Number of patients**	**Percentage**
Elschnig's pearls	14	20
Fibrosis	33	47.14
Mixture of Elschnig's pearls & fibrosis	23	32.86
Total	**70**	**100**

Table no 4.4 describes that the present study shows the maximum number of PCO patients having fibrosis type of capsular opacification (47.14%), which was closely followed by a mixture of Elschnig's pearls and fibrosis type of PCO. Least number of patients were observed having Elschnig's pearls type of PCO (20%).

Table 4.5 Grading of PCO according to visual acuity (n=70)

Grades	**Number of eye**	**Percentage**
Mild(VA 6/18-6/24)	7	10
Moderate(VA 6/36-6/60)	33	47.14
Sever(VA<6/60-1/60)	30	42.86
Total	70	100

Table no 4.5 -On grading PCO into mild, moderate and sever according to visual acuity, the common entity encountered was moderate grade PCO (47.14%) followed by sever grade PCO (42.86%) having visual acuity < 6/60.Only 10% of the patients had mild PCO having visual acuity better than 6/24.

Table 4.6 Laser power setting for various categories of PCO (n=70)

Types of PCO	No. of patients	Percentage	1-2 mJ	>2-3 mJ	>3-5 mJ	>5-7mJ
Mild opacification	7	10	5	2	0	0
Moderate opacification	35	50	15	14	6	0
Thickfibrotic opacification	28	40	4	15	9	0
Total	**70**	**100**	**24**	**31**	**15**	**0**

Table no 4.6 describes, We have divided PCO into 3 categories, mild opacification, moderate opacification, and thick fibrotic type opacification. Table describes the initial laser power setting used for posterior capsulotomy in various categories of PCO. Out of 70 patients, maximum number of patients had moderate opacification of posterior capsule (50%), closely followed by thick fibrotic type of opacification (40%). Only 7 patients (10%) had mild opacification of posterior capsule.The basic power settings of Nd: YAG laser and total amount of laser energy needed foe adequate opening in the posterior capsule depend on thickness/density of the posterior capsular opacification.

Table 4.7 Total laser energy required for capsulotomy (n=70)

Total amount of laser energy given	Number of patients	Percentage
1-25 mJ	37	52.86
26-50 mJ	23	32.86
51-75 mJ	10	14.28
Total	**70**	**100**

Table 4.7 describes the total amount of Nd: YAG laser energy used for posterior capsulotomy. Out of 70 patients, 37 (52.86%) required the total laser energy of 01-25 mJ to make adequate opening in the posterior capsule, 23 patients (32.86%) required the total energy of 26-50 mJ while only 10 patients (14.28%) required higher energy of 51-75 mJ.

The mean total energy used was 28.35 mJ. The total amount of laser energy used was comparatively more in patients with moderate and thick fibrotic capsular opacification.

Table 4.8 Post laser best corrected snellen acuity (n=70)

Post laser snellen acuity	No. of patients	Percentage
6/6-6/12	41	58.57
6/18-6/24	23	32.85
6/36-6/60	3	4.29
No improvement	3	4.29
Total	**70**	**100**

The table 4.8 shows that maximum patients achieved the final visual acuity of 6/6-6/12 (58.57%) while 23 patients achieved final snellen acuity of 6/18-6/24 (32.85%).
Only three patients were observed having final snellen acuity of 6/36-6/60 (4.29%).
There was no improvement in visual acuity even after trying best correction in 3 eyes (4.29%).

Table 4.9 Relationship of IOP spike with total energy used for capsulotomy

Energy levels	No. of patients	No. of patients with IOP rise >5 mm Hg	Percentage
1-25 mJ	37	1	2.7
26-50 mJ	23	3	13.04
51-75 mJ	10	3	30
Total	**70**	**7**	**10**

Table 4.9 shows the relation of IOP spike with the total laser energy used for capsulotomy.IOP spike in the study was defined when after laser capsulotomy; there was raise in IOP more than 5 mm Hg from the baseline IOP.Out of 37 patients in which the total laser energy used was 1-25 mJ, the IOP spike was observed in only 1 patients (2.7%) and out of 23 patients where total energy used was 26-50 mJ the IOP spike was noticed in 3 patients (13%), while in 10 patients where higher total laser energy of 51-75Mj was used, the IOP spike was observed in significantly higher percentage of 30% overall. A total of 10% patients showed IOP spike.

Table 4.10 Other complication of Nd: YAG laser capsulotomy

Complications	No. of patients
Post laser iritis	1
Glare	2
Pitting over Intraocular lens	1
Vitreous floaters	1
Hyphaema	-
Cystoid macular edema	-
Retinal detachment	-
Macular hole	-

Table 4.10 describes the complication apart from IOP spike, following laser capsulotomy.
Only few complications were observed in our study. There was mild iritis in one patient. Glare in two patients, pitting over IOL in one patient and vitreous floaters in one patient. Other known complication of Nd:YAG laser capsulotomy as reported by various authors like Hyphaema. CME, Retinal detachment and macular hole were not observed in present study.

V. Discussion

Posterior capsular opacification (PCO) is the most commonly reported vision-disturbing sequel of modern cataract extraction. It is a condition with multifactorial etiology which is usually disabling after good postoperative visual gain. Incidence of PCO reported in different studies is variable from 12% to 50% developing within 3 month to 4 years postoperatively. Though with recent upgraded and improved cataract surgery and various modification in IOL material and designs, incidence of PCO has reduced markedly as compare to past. The Nd: YAG laser is currently considered the best way of posterior capsulotomy.
A laser is used to make a hole in the clouded back lining of the lens capsule (posterior capsule) to allow light to pass through the membrane to nerve layer of retina. Nd: YAG laser posterior capsulotomy is an out patients procedure. It does not require anesthesia and it is painless. In our study 70 eyes of the 70 patients belongings to different classes were selected for Nd: YAG laser posterior capsulotomy.

5.1Age and sex Distribution

The rate of opacification is more in younger age group and it declines with increasing age (Emery j et al.,1978), while Westling A.K. and Calissendorff B.M.(1991) found no association between age or sex of patients with the risk of secondary cataract.

Pop l et al (2002) reported that PCO is more frequent in the age group of 60-70 years where the surgery for cataract is performed more often.Confirming the previous studies, the present study also shows that PCO was more common in the age group of 51-70 years (68.57), because of cataract surgery being performed more often in this age group.

Nicula C and Nicula d (1999) in their study reported 95 males and 105 female while Awan A.A. et al (2001) reported more 43% male and 57% female in their study group. Similarly, the present study also shows female preponderance, as out of 70 patients, who underwent laser capsulotomy, there were 33 males (47.14%) and 37 female (52.86%). The male female ratio was found to be 1:1.12

5.2 Types of posterior capsular opacification*:*

Nicula c et al (19990 found in their study that capsular fibrosis was the most common type of PCO that was present in 86% of the case.In present study the thick fibrotic type of PCO was the most common type of PCO observed (47.14%) closely followed by am mixture of Elschnig's pearls and fibrosis (32.86%) while Elschnig's pearls type of PCO were seen least commonly 20%.

5.3 Laser energy used for capsular opacification:

The laser energy used for capsulotomy depends directly to density of posterior capsular opacification as observed by Frank Goss (1987). Auffarth G.U. et al., analyzed the energy levels and the average total energy used for Nd: YAG laser capsulotomy was 12.7 $\pm$ 9.4 mJ. The total amount of laser energy required varied from 1-25 mJ to 51-75 mJ in present study. Out of 70 patients, maximum patients (52.86%) required the total laser energy between 0-25 mJ for capsulotomy. The mean total energy used was 28.35 mJ. The total amount of laser energy used was comparatively more in patient with moderate and thick fibrotic capsular opacification, which is in accordance with the previous studies.

5.4 Visual outcome and complication of Nd: YAG laser capsulotomy:

Result of various studies shows that YAG laser capsulotomy is one of the best method of treatment of posterior capsule opacification. Though it had its associated complication and risk but in comparison to visual outcome, complication rates are very less. Keates R.H. et al (1994) reported improvement in visual acuity in 87.2 % cases, with 82.9 % achieving a visual acuity of 6/12 or better and cumulative complication in the laser treated population were very low (CME 2.3%,Secondary glaucoma 3.6%, retinal detachment 0.4%, overall rate 4.8%) Similarly the present study also shows improvement in visual acuity in 97.71 cases, with 58.57 achieving final visual acuity of 6/12 or better. Complication rates were low as transient IOP spike was seen in 10%(Most common complication), out of them majority returned to baseline by 24 hrs. The other reported complication were seen in only 7.14% cases (iritis, glare, pitting over IOL and vitreous floaters)No serious complications were noticed in our study.

VI. Conclusion

1. In present study, it has been concluded that-
2. Posterior capsular opacification was found to be more frequent in the age group of 51-70 years. With the advancement of the age i.e. after 70 year, PCO was reported less often. Significant PCO was most commonly seen after 6-12 month of cataract surgery.
3. Most common type of PCO reported was of fibrous type.
4. Energy require per impulse for capsulotomy was observed to increase with the increasing density of PCO.
5. Maximum number of patients required the total energy of 1-25 mJ for successful capsulotomy. The total amount of laser energy for successful capsulotomy was directly proportional to the density of PCO.
6. The majority of patients (95%) showed significant improvement in visual acuity after capsulotomy, and about 58.57% patients had final BCVA of 6/6-6/12.
7. Out of 70 patients, 3 (4.29%) showed no improvement in BCVA, because of thick fibrotic posterior capsule.
8. Post laser IOP spike was seen in 10% of cases within 1 to 4 hours post laser capsulotomy, majority which attained the basal level in 24 hours.
9. IOP rise was significantly associated with the amount of total energy used.
10. The other complications seen were mild iritis, glare, pitting over IOL, and vitreous floaters.
11. The present study depicts the Nd;YAG laser capsulotomy as a good, successful treatment of PCO, because it was found to be modern, non-invasive, effective mode of treatment of PCO with lesser complications and it does not require hospitalization.

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