A SHORT SYNOPSIS OF Nd: YAG LASER CAPSULOTOMY

V. Sridevi¹

¹Associate Professor, Department of Ophthalmology, Rajah Muthiah Medical College & Hospital, Annamalai Nagar, Chidambaram.

ABSTRACT

BACKGROUND

Posterior capsule opacification (PCO) is a frequently encountered complication of cataract surgery. However, Nd: YAG Laser capsulotomy is accepted as the treatment of PCO. Although Nd: YAG laser capsulotomy is noninvasive, it carries a risk of some complications. The purpose of this article is to have a bird's eye view of Nd: YAG Laser capsulotomy and its effects on the eye.

MATERIALS AND METHODS

The present study comprised of a total number of 50 patients of Nd: YAG laser in the treatment of posterior capsular opacification after cataract surgery, who attended the Department of Ophthalmology, Rajah Muthiah Medical College and Hospital from 2015 to 2016.

RESULTS

A total of 50 patients were treated. Out of the 50 eyes that were studied, 25 were Right eyes and 25 were Left eyes. Most of the capsulotomies were done at the level of energy between 1.6 mJ to 2.4 mJ, consisted of 32 eyes. 10 capsulotomies were done at the level of 1.2 mJ to 1.5 mJ, while 8 capsulotomies were done at the level of 2.5 mJ to 3.1 mJ. The minimum amount of energy used was 1.2 mJ and maximum amount of energy used was 3.1 mJ.

CONCLUSION

Although this procedure is safe, it is associated with complications like transient intraocular pressure rise, pitting of the intraocular lenses, mild iritis which are not vision threatening and they are transient. Therefore, this treatment modality is cost effective and safe.

KEYWORDS

Nd: YAG Laser, Posterior Capsule Opacification (PCO).

HOW TO CITE THIS ARTICLE: Sridevi V. A short synopsis of Nd: YAG laser capsulotomy. J. Evolution Med. Dent. Sci. 2017;6(63): 4593-4597, DOI: 10.14260/Jemds/2017/994

BACKGROUND

The frequently encountered long-term complication after cataract surgery continues to be posterior capsular opacification.¹ This problem has not yet been conquered though it can be treated by Nd: YAG laser capsulotomy.

No single mechanism has been described so far. Some studies believe that a multicellular secondary membrane results from migration and fibrosis of lens epithelium on the posterior capsule. There can be a single layer of anterior capsule epithelial cells which migrate into posterior capsule forming myofibroblasts. This case series gives a synopsis of treatment of PCO by Nd: YAG laser.²

Six Factors to Reduce PCO³

Surgery-Related Factors ("Capsular" Surgery)	IOL-Related Factors ("Ideal" IOL)
<ul style="list-style-type: none"> Hydrodissection-enhanced cortical cleanup In-the-bag fixation Small CCC with edge on IOL surface 	<ul style="list-style-type: none"> Biocompatible IOL to reduce stimulation of cellular proliferation Maximal IOL optic-posterior capsule contact, angulated haptic, "adhesive" biomaterial to create a "shrink wrap" IOL optic geometry square, truncated edge

Incidence

PCO causes decline in visual acuity by blocking the central visual axis. These cells on proliferation may cause effects like striae, folds or displacement of IOL.

It has been found that the incidence of PCO (20%) is low in patients within 3 years and increases steeply by 38% after 9 years⁴ and 16% over 7 years period.⁵

In this present ophthalmic scenario of modern surgical techniques and wide array of IOL designs, PCO and Nd: YAG laser capsulotomy rate is declining to 10%.⁶

Financial or Other, Competing Interest: None.

Submission 13-07-2017, Peer Review 28-07-2017,

Acceptance 31-07-2017, Published 07-08-2017.

Corresponding Author:

V. Sridevi,

Associate Professor

Department of Ophthalmology,

Rajah Muthiah Medical College & Hospital,

Annamalai Nagar,

Chidambaram-608002.

E-mail: srithithi@gmail.com

DOI: 10.14260/Jemds/2017/994

IOL Designs

Acrylic sharp edge IOL has higher incidence of PCO than eyes implanted with silicone IOL.⁷

PMMA IOLs are better than polypropylene haptic IOLs because the former expand the capsular bag to the maximum extent but hydrogel IOLs lead to re-closure of Nd: YAG capsulotomy opening site.⁸

The best choice to avoid PCO is to have a 360-square edge design IOL. This type of IOL is very useful even in high risk diabetic patients for lowering the rate of occurrence of PCO.⁹

Energy Levels

The lasing energy beam should be set at the minimum level possible and the beam should be focused behind the posterior capsule. An energy of 1.8 mJ is enough to open membranous PCO whereas 3.1 mJ is needed for fibrous PCO. If there is a combination of these two, an initial shot of 3.1 mJ is given followed by more energy to open the fibrotic PCO.¹⁰

Tetzet al (2000) in his case series has found that higher energy is needed for sulcus fixated IOLs.¹¹

The average energy used was 12.7 + 9.4 mJ as analysed by Auffarth et al (2000). He also found that the laser energy needed was high with sulcus fixated IOLs.

The mean summated energy given by Khanzada and coworkers (2008) was 48.8 mJ.¹⁰

It is recommended that the lowest possible single pulse laser energy be used for capsulotomy to minimise complications.¹¹

MATERIALS AND METHODS

The present study comprised of a total of 50 patients of Nd: YAG laser in the treatment of posterior capsular opacification after cataract surgery, who attended the Department of Ophthalmology, Rajah Muthiah Medical College and Hospital from 2015 to 2016.

SELECTION CRITERIA

Inclusion Criteria

All patients with postoperative posterior capsular opacification with vision <6/9.

Exclusion Criteria

- Posterior Capsular Opacification (PCO) associated with corneal scars, irregularities, or oedema that interferes with target visualisation.
- Posterior Capsular Opacification associated with active intraocular inflammation.
- Posterior Capsular Opacification associated with cystoid macular oedema or other complications that is likely to reduce visual acuity.
- An uncooperative patient who is unable to remain still or hold fixation during the procedure, with threat of inadvertent damage to adjacent intraocular structures.

As the prevalence rate of Posterior Capsular Opacification after five years of cataract surgery is 50%, size of the sample works out to be 50 cases. All patients with Posterior Capsule Opacification were subjected to Nd: YAG laser capsulotomy. Their particulars like Name, Age, Sex and Address of all the patients were noted.

Local Examination was done as follows-

- Visual acuity - BCVA was noted from Snellen's chart or Landolt's broken ring depending upon cases.
- Slit-lamp examination-
 - Diffuse examination.
 - Oblique and slit illumination.
 - Retro illumination.

On the Slit-lamp, apart from the other features of anterior segment, PC opacity was noted and was graded into 3 groups.

- Direct Ophthalmoscopy: was done and PCO was graded into 3 groups based on clarity of visualisation of posterior segment.

Grading of PCO

Equal emphasis was placed on ophthalmoscopic evaluation and Slit-lamp appearance. Although the anatomic presence of PCO can be adequately assessed with the Slit-lamp, the ophthalmoscope helped to assess media clarity, which serves as an indirect indicator of functional impairment.

PCO was graded according to the protocol followed in Madurai Intraocular Lens case series. PCO was graded according to following levels of severity based on slit-lamp and dilated direct ophthalmoscopic evaluation.

Grade 0- No PCO, no evidence of PCO seen before and after pupillary dilatation to a minimum of 6 mm. With a direct ophthalmoscope, a clear view of the optic disc, blood vessels and nerve fibre layer is obtained.

Grade 1- No central PCO is seen. PCO is seen only with pupil dilated to a minimum of 6 mm. With a direct ophthalmoscope, a clear view of optic disc, blood vessels and nerve fibre layer is obtained.

Grade 2 - PCO is present in central visual axis detectable with an undilated pupil. With a direct ophthalmoscope, there is a mild obscuration of fundus detail that optic nerve head is clearly seen, but nerve fibre layer and blood vessels are not clearly seen.

Grade 3- PCO is present in central visual axis, with an undilated pupil. With a direct ophthalmoscope, there is marked obscuration of fundus details that even the margins of optic nerve head are not clearly defined, because of PCO.

Tonometry

Preoperative baseline intraocular pressure was taken by Schiotz tonometer. It was recorded at least 1 hour before the procedure.

Methods

All patients with Grade 2 and Grade 3 PCO were subjected to Nd: YAG laser capsulotomy.

The procedure to be done and complications associated with it were described to all patients and informed written consent was taken.

All eyes were dilated with tropicamide 1% eye drops 1 hour prior to laser therapy and topical 4% Xylocaine was instilled to each eye under case series. 1% Apraclonidine eye drops was installed 1 hour before the procedure to blunt the effect of IOP rise.

All the capsulotomies were done using Zeiss Visulas YAG II ophthalmic YAG laser system. Since Nd: YAG laser beam is an invisible infrared ray (wavelength 1064 nm), the red semiconductor laser (wavelength 633 nm) is used as aiming

beam from YAG laser. The laser system was so designed that aiming beam becomes co-axial with YAG laser beam and target for alignment is where the 2 alignment spots converge into 1 spot. (Dual beam focusing system).

Technique

The principle of this technique is to create a central opening in the opacified posterior capsule followed by focusing of laser pulse beam with low energy using small duration.¹² (nanoseconds).

The initial treatment for PCO with Nd: YAG laser was done by Aron Rosa and Fankhauser which proved superior to surgical dissections avoiding disastrous complications like vitreous loss and endophthalmitis.

Nd: YAG laser capsulotomy has been very effective but can also be visually threatening like retinal oedema and detachment.¹³

This Nd: YAG laser is a neodymium doped Yttrium-Aluminium garnet crystal which works on photodisruption principle.

The photons emitted will be forced to travel back & forth inside a cavity with polished mirrors. When a photon touches an excited particle, it emits a photon with identical wavelength. The number of active photons increases on amplification.¹⁴

This laser throws a 50 μ diameter beam of 30 picosecond in 40 nanoseconds with infrared wavelength (1064 nm) with a maximum frequency of 4-5 cycles/second.

This laser energy ionises the posterior capsular tissue producing plasma which is not harmful to the eye.¹⁵

Figure 1. Carl Zeiss YAG Laser

The following followup protocol was used to observe for complications.

Examination was done-

- 4 hours after laser.
- 1 day after laser.
- 2 weeks after laser.
- 3 months after laser.
- 6 months after laser.

Pre-Laser Instructions

- Complete history & use of any medication.
- Best corrected visual acuity.
- IOP measurement.
- Slit-lamp examination to find out the type of PCO, wrinkles and tension lines in PC.

- Informed consent.
- Pupillary dilatation can be considered for thick PCO & in uncooperative cases.
- A drop of topical proparacaine hydrochloride has to be instilled before the start of the procedure.
- To focus, the two red spots become one spot to mark the intersection of the He-Ne-beam locating the focal point of lasing beam.
- The procedure is started with less energy 1 mJ monoburst and successively increased in steps till the tissue breakdown was achieved. If the tissue did not open the focal point was shifted slightly forward.

RESULTS

A total of 50 patients were studied. The age of patients varied between 42 and 80 years. There were 27 males and 23 females, on whom Nd: YAG laser posterior capsulotomy was done. A comprehensive preoperative ophthalmic evaluation including Snellen's visual acuity, slit-lamp examination, direct ophthalmoscopy, Schiotz tonometry and fundus examination (whenever possible) was done. An inverted U-shaped capsulotomy was done. The postoperative IOP was measured at 4 hrs. and 24 hrs. after the procedure. The postoperative visual acuity was recorded at 24 hrs. after the procedure.

During the course of present case series, the following observations were made:

The age of patients undergoing capsulotomy varied from 42 to 80 years with majority of patients in the age group of 60-70 years.

In our present study of 50 patients with PCO, all eyes were subjected to Nd: YAG laser posterior capsulotomy.

Sex	No. of Cases	Percentage
Males	27	54.0
Females	23	46.0
Total	50	100.0

Table 1. Gender Distribution of Patients

A total of 50 patients were treated, of which 27 were male and 23 were female as shown in Table 1. Majority of the people were from a low socioeconomic background.

The youngest age among the female patients was 42 years and oldest was 76 years. Similarly, in male patients, youngest male was of 42 years, and oldest was 80 years. Maximum no. of patients affected were in the age group between 61-70 years. Their number was 22. They constituted more than 40% of total cases.

Eye	No. of eyes	Percentage
Right eye	25	50.0
Left eye	25	50.0
Total	50	100.0

Table 2. Eye Distribution of Patients

A total of 50 patients were treated. Out of the 50 eyes that were studied, 25 were Right eyes and 25 were Left eyes as shown in Table 2.

Level of Energy (mj)	No. of Patients	Percentage
1.2 - 1.5	10	20.0
1.6 - 1.8	12	24.0
1.9 - 2.1	11	22.0
2.2 - 2.4	9	18.0
2.5 - 2.7	4	8.0
2.8 - 3.1	4	8.0
Total	50	100.0

Table 3. Energy Setting

Most of the capsulotomies were done at the level of energy between 1.6 mJ to 2.4 mJ as shown in Table 3. It consisted of 32 eyes. 10 capsulotomies were done at the level of 1.2 mJ to 1.5 mJ, while 8 capsulotomies were done at the level of 2.5 mJ to 3.1 mJ. The minimum amount of energy used was 1.2 mJ and maximum amount of energy used was 3.1 mJ.

In our case series, thirty-nine patients required total energy between 30 mJ and 90 mJ. Out of them, thirty-one required below 60 mJ, A total of 2 patients required more than 90 mJ, and 1 patient required more than 120 mJ. The maximum amount of energy used was 124 mJ and minimum was 14.4 mJ.

In our case series, preoperatively 38 patients had best corrected visual acuity of counting fingers to 6/24. Only 2 patients had BCVA of appreciating only hand movements and another 2 patients had BCVA of 6/12 and 8 patients had BCVA of 6/18.

Postoperatively, 36 patients had BCVA of 6/9 and 6/6. 5 patients had BCVA 6/12 and seven patients had BCVA of 6/18. Only one patient had BCVA $\leq$ 6/36, he developed cystoid macular oedema and with treatment his vision improved.

Improvement	No. of Patients	Percentage
>3 lines	25	50.0
> 2 lines	18	36.0
> 1 line	7	14.0
No improvement	0	0
Decrease	0	0
Total	50	100

Table 4. Distribution of Improvement of Vision in Snellen's Chart

Improvement of 3 lines or more was seen in 25 patients, 18 patients had an improvement of 2 lines and 7 patients had an improvement of 1 line.

IOP	No. of Patients	Percentage
< 14 mmHg	9	18.0
14-15.9 mmHg	21	42.0
16-17.9 mmHg	12	24.0
18-19.9 mmHg	6	12.0
20-21.9 mmHg	2	4.0
>22 mmHg	0	0
Total	50	100.0

Table 5. Distribution of Preoperative Intraocular Pressure

In our case series, thirty-three patients were in the range of 14 mmHg to 18 mmHg, and 6 were above 18 mmHg. 9 patients had IOP less than 14 mmHg preoperatively as shown

in table 5. The minimum IOP found in the group was 10.2 mmHg and maximum of 20.6 mmHg.

Distribution of postoperative intraocular pressure at 4 hours: 34 patients were in the range of 14-18 mmHg and 8 patients had intraocular pressure between 18 mmHg and 20 mmHg.

In our case series, thirty-four patients had intraocular pressure between 14-18 mmHg, 7 patients had pressure less than 14 mmHg, 7 patients had intraocular pressure between 18-20 mmHg, 2 patients had intraocular pressure greater than 20 mmHg after 4 hours of YAG Laser.

The patients were followed up for a period of 6 months. Out of 50 patients treated, 2 patients had acute rise of intraocular pressure. Both the patients were treated with antiglaucoma medications, their pressures returned to base line.

IOL pitting was observed in 4 patients. This pitting was not visually significant and did not produce any glare or image degradation.

3 patients developed iritis, which was treated with topical steroids and cycloplegics. Iritis resolved subsequently without causing any significant longterm reduction of vision.

1 patient developed CME, with treatment it resolved without any deteriorating effect on vision.

Figure 2. Distribution of Complications

DISCUSSION

The occurrence of complication is due to size of PCO opening and the total energy level delivered. The common causes for raised IOP was deposition of debris in trabeculum, pupillary block and inflammation of iris and ciliary body with angle closure.¹³ Keates et al found iritis in 0.4% and vitritis in 0.7% after a 6-month postoperative period. Anterior chamber flare is seen post laser treatment.¹³ Hassan et al found 19.8% IOL pitting in a case series. The retrofocusing of laser beam will reduce the IOL damage.¹³ Hussain MM reported CME in 0.8% in eyes treated with Nd: YAG laser.¹⁶ YAG laser produces vitreous liquefaction.¹⁶ Levy et al reports displaced IOL after laser treatment.¹³ Pupillary block glaucoma, macular hole, retinal haemorrhage, low grade endophthalmitis.

This procedure has its own merits and demerits. It is non-invasive but can carry the list of some complications.¹³ The time period between cataract extraction and performing Nd: YAG laser capsulotomy was 2.49 years by Hasan et al and 24 months by Kundi and Younas. The predominant type of PCO was capsular fibrosis which differs from Hasan et al who reported Elschnig's pearls to be the predominant type in pseudophakic eyes.

Hasan et al noted that improvement of visual acuity after Nd: YAG laser capsulotomy on Snellen's chart was 1-3 lines in 42 and 4-6 lines in 31 out of 86 patients. A similar case series showed improvement of visual acuity, more Snellen's lines in 56 out of 63 eyes. Latif and Aasi using Nd: YAG laser showed overall 87.5% improvement in the visual acuity of an average 3 lines on Snellen's chart. Nd: YAG laser use has been accepted as a standard technique for treating PCO resulting in rapid visual improvement.

Straylight is correlated with the severity of the PCO and that corrected distance visual acuity (CDVA) and straylight values improved significantly after Nd: YAG laser capsulotomy.¹⁷ Straylight is a sensitive, additional indicator for capsulotomy referral, especially in less severe cases of PCO.¹⁸ Nd: YAG laser posterior capsulotomy did not significantly change anterior chamber depth and spherical equivalent.¹⁹

The acrylic hydrophobic IOL showed better results when related to the incidence and intensity of one piece acrylic hydrophilic IOL.²⁰

In patients who underwent, phaco surgery and combined vitrectomy, Nd: YAG capsulotomy was found to be safe and effective.²¹

CONCLUSION

The case series of Nd: YAG laser in the treatment of posterior capsular opacification after cataract surgery conducted on 50 eyes in the Department of Ophthalmology, RMMCH, Chidambaram concludes that the improvement in visual acuity is excellent after Nd: YAG laser capsulotomy. It is relatively non-invasive and can be performed as an OPD procedure.

Since PCO is a visually disabling condition reducing ability of patient to carry out the activities of daily living, Nd: YAG laser capsulotomy with its remarkable outcome on visual acuity and with least complications acts as a boon to such patients limiting the need for undergoing a second operative procedure. It thereby reduces the cost that could have been imposed by operating room usage and inpatient care.

Although this procedure is safe, it is associated with complications like transient intraocular pressure rise, pitting of the intraocular lenses, mild iritis which are not vision threatening and they are transient. Therefore, this treatment modality is cost effective and safe.

REFERENCES

- [1] Bari KN. Nd: YAG laser posterior capsulotomy and visual outcome. *Delta Med Col J* 2013;1(1):16-9.
- [2] Gore VS. The study of complications of ND: YAG laser capsulotomy. *Int J Bioinformatics Res* 2012;4(2): 265-8.
- [3] Pandey SK, Apple DJ, Werner L, et al. Posterior capsule opacification: a review of the aetiopathogenesis, experimental and clinical studies and factors for prevention. *Indian J Ophthalmol* 2004;52(2):99-112.
- [4] Boureau C, Lafuma A, Jeanbat V, et al. Cost of cataract surgery after implantation of three intraocular lenses. *Clin Ophthalmol* 2009;3:277-85.
- [5] Alipour F, Jabbarvand M, Khodaparast M, et al. Hinged capsulotomy—does it decrease floaters after Yttrium aluminum garnet laser capsulotomy? *Middle East Afr J Ophthalmol* 2015;22(3):352-5.
- [6] Ram J, Brar GS. Posterior capsule opacification: an overview. *DOS Times* 2006;12(4):285-9.
- [7] Vock L, Menapace R, Stifter E, et al. PCO and Nd: YAG laser capsulotomy rates with a round-edged silicone and a sharp-edged hydrophobic acrylic intraocular lens 10 years after surgery. *J Cataract Refract Surg* 2009;35(3):459-65.
- [8] Georgopoulos M, Findl O, Menapace R, et al. Influence of intraocular lens material on regenerative posterior capsule opacification after Nd: YAG laser capsulotomy. *J Cataract Refract Surg* 2003;29(8):1560-5.
- [9] Bai L, Zhang J, Ma T, et al. Comparison of posterior capsule opacification at 360-degree square edge hydrophilic and sharp edge hydrophobic acrylic intraocular lens in diabetic patients. *Int J Ophthalmol* 2015;8(4):725-9.
- [10] Bhargava R, Kumar P, Prakash A, et al. Estimation of mean Nd: Yag laser capsulotomy energy levels for membranous and fibrous posterior capsular opacification. *Nepal J Ophthalmol* 2012;4(1):108-13.
- [11] Bhargava R, Kumar P, Phogat H, et al. Nd: YAG laser capsulotomy energy levels for posterior capsule opacification. *J Ophthalmic Vis Res* 2015;10(1):37-42.
- [12] Hawlina G, Olup BD. Nd: YAG laser capsulotomy for treating posterior capsule opacification. *J Laser Health Academy* 2013;1:S34-5.
- [13] Karahan E, Duygu ER, Kaynak S. An overview of Nd: YAG laser capsulotomy. *Med Hypothesis Discov Innov Ophthalmol* 2014;3(2):45-50.
- [14] Francis A, L'Esperence. *Ophthalmic lasers: photocoagulation, photoradiation and surgery*. 2nd edn. Mosby 1983:79-83.
- [15] Katzen LE, Fleischman JA, Trokel SL. The YAG laser: an American experience. *J Am Intraocular Implant Soc* 1983;9(2):151-6.
- [16] Khanzada MA, Jatoti SM, Narsani AK, et al. Is the Nd: YAG laser a safe procedure for posterior capsulotomy. *Pak J Ophthalmol* 2008;24(2):73-8.
- [17] Yotsukura E, Torii H, Saiki M, et al. Effect of Nd: YAG laser capsulotomy on visual function in patients with posterior capsule opacification and good visual acuity. *J Cataract Refract Surg* 2016;42(3):399-404.
- [18] Van Bree MC, van den Berg TJ, Zijlmans BL, et al. Posterior capsule opacification severity, assessed with straylight measurement, as main indicator of early visual function deterioration. *Ophthalmology* 2013;120(1):20-33.
- [19] Khambhiphant B, Liumsiri Jarern C, Saehout P. The effect of Nd: YAG laser treatment of posterior capsule opacification on anterior chamber depth and refraction in pseudophakic eyes. *Clin Ophthalmol* 2015;9:557-61.
- [20] Schriebl SM, Menapace R, Stifter E, et al. Posterior capsule opacification and Nd: YAG laser capsulotomy rates with 2 microincision intraocular lenses: four-year results. *J Cataract Refract Surg* 2015;41(5):956-63.
- [21] Georgalas I, Petrou P, Kalantzis G, et al. Nd: YAG capsulotomy for posterior capsule opacification after combined clear corneal phacoemulsification and vitrectomy. *Ther Clin Risk Manag* 2009;5(1):133-7.