

A comprehensive study to evaluate the safety and efficacy of Nd: YAG laser capsulotomy in the management of posterior capsular opacification in a rural environment

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Abstract

Objective: To evaluate the safety and the efficacy of Neodymium Yttrium Aluminium Garnet (Nd: YAG) laser capsulotomy in the management of posterior capsular opacification in a rural population.

Materials and Method: An interventional prospective study conducted for a period of eighteen months about the safety and efficacy of Nd: YAG laser capsulotomy in the management of posterior capsular opacification (PCO).

Results: Study demonstrates that the pearl type (59%) of PCO is commonest, grade II PCO (52%) is commonest followed by grade III (39%). Post Nd: YAG laser capsulotomy, best corrected visual acuity (BCVA) of 6/9 was achieved in about 48% of the patients and 6/6 BCVA was achieved in about 22% of the patients.

Conclusion: It is an outpatient procedure. The procedure is a non-invasive, simple, efficient, safe and economical in the management of PCO with minimal complications.

Keywords: Laser posterior capsulotomy, Nd: YAG laser, Posterior capsular opacification

Introduction

Prevalence of blindness due to senile cataract is very high among Indian population more so in the rural populace as they are a neglected lot due to ignorance, poverty and non-availability / poor availability of facilities for cataract surgery. The Indian government introduced various schemes under National Programme for Control of Blindness (NPCB), which implements its programmes through the District Blindness Control Society (DBCS) to achieve maximum reduction in avoidable blindness in the district through optimal utilization of available resources within the district. This proved to be a boon to eradicate blindness due to cataract. However this success is short lived owing to the development of a condition called posterior capsular opacification, which is still the most common problem following cataract surgery. PCO causes symptoms very similar to cataract. Post cataract surgery the remaining anterior epithelial cells (A-cells) present in the capsular bag is responsible for the development of PCO. These cells are also known as lens epithelial cells (LEC's). Cataract surgery induces wound healing response and the leftover LEC's proliferate and migrate towards posterior capsule and undergoes lens fibre degeneration and epithelial to mesenchymal transition (EMT), this coupled with collagen deposition leads to PCO. Clinically two morphological types of PCO is seen, the Fibrosis type and Pearl type. Fibrosis type is caused by the proliferation and migration of LEC's which undergo epithelial to mesenchymal transition (EMT), resulting in fibrous metaplasia and leading to significant visual loss and producing folds and wrinkles in the posterior capsule. Pearl type PCO is caused by the LECs located

at the equatorial lens region (lens bow) causing regeneration of crystalline-expressing lenticular fibres and forming Elschnig pearls and Soemmering ring, responsible for most cases of PCO-related visual loss. With the advent of Nd: YAG laser the management of PCO became a safe, simple and outpatient procedure but it has its own complications. Our institution is situated in a rural area in the Mandya district, my present study is undertaken to assess and evaluate the safety and efficacy of Nd: YAG laser capsulotomy in the management of posterior capsular opacification among the rural population.

Materials and Methods

Ethical clearance was obtained from the institutional ethics committee and informed consent from the patients was taken, an interventional prospective observational study was conducted for a period of eighteen months in the department of Ophthalmology, Adichunchanagiri Institute of Medical Sciences, B G Nagara, Mandya district in Karnataka. Hundred eyes of various patients presenting with symptoms of PCO after cataract surgery were included in the study.

Inclusion criteria: Patients reporting to the OPD with symptoms and signs of PCO minimum three months post cataract surgery with PCIOL (posterior chamber intra ocular lens) implant having visual acuity less than 6/18 by Snellen's visual acuity, patients willing to give informed consent for the treatment and study, patients willing to come for regular follow up.

Exclusion criteria: Uncooperative patients, patients unable to keep head fixed during the procedure, patients below forty years of age, patients having corneal scars /

irregularities /edema, patients with active intraocular inflammation, infections, cystoid macular edema, pre-existing conditions including high myopia, glaucoma, uveitis, retinal pathologies, decentred or dislocated posterior intraocular lens.

Visual acuity for distant and near were recorded pre and post procedure using Snellen's chart. Complete ophthalmic and systemic history was noted. Detailed ophthalmic examination was done using slit lamp, intraocular pressure was measured using the rebound tonometer and Goldman applanation tonometer, fundus examination was done using the direct and indirect ophthalmoscope and the fundus pictures were documented using the Zeiss fundus camera. PCO was graded using the Madurai PCO grading scale. Patient who were having grade-II and grade-III PCO were treated with Nd-YAG laser capsulotomy. Before dilatation, a single marker shot was made in the capsule, near the middle of the pupil, when pupil was dilated this gave us the true visual axis of the patient. The eye with PCO was dilated with 0.8% tropicamide and phenylephrine hydrochloride 5% eye drops one hour prior to the laser treatment and anesthetized with propacaine hydrochloride 0.5% eye drops. Capsulotomy was effected using Zeiss VISULAS YAG III photodisruption laser. Initial laser energy in a single pulse mode was kept at 0.8 mj and was gradually increased till the desired effect was obtained. Cruciate openings were made beginning at 12 o' clock periphery and progressing towards 6 o' clock position. 4 to 5 mm opening was made in the PCO. Post laser anti-glaucoma eye drops were advised for patients who showed rise in the intraocular pressure (IOP) and 0.1% nepafenac eye drops four times daily for a week was advised. IOP was measured after 1 hour, 4 hours and after 24 hours. The patient was followed up after 1st week, 2nd week and 4th week, third month and sixth month.

Results

Since patients in the study group comprised of age more than forty years, majority of the patients belong to 61 to 70 years (64%) group followed by 51 to 60 years (26%), the remaining 10% belonged to age group between 40 to 50 years. Majority of the patients (62%) were males and females (38%). Right eye (61%) was involved more than left eye (39%). The onset of symptoms of PCO post cataract surgery appeared in (46%) patients within one to three years, followed by three to five years (23%), six months to one year (21%), less than six month (07%) and more than five years following cataract surgery (03%) of patients. We would like to state here that since our hospital is situated in a rural area most of the cases we encountered were camp patients operated under the NPCB programme and majority of the patients had undergone small incision cataract surgery with implantation of rigid IOL. In our study pearl type of PCO was commonest (59%) and fibrous type was (41%). Our study shows grade II PCO

(52%) was most common followed by (39%) grade III. Majority of patients (57%) required pulse energy between 1.0 -1.5 mJs. Most (46% of the eyes) the YAG -Capsulotomy was effectively performed by using < 20 mJs, for about (38%) of capsulotomies 51- 80 mJs was used and only one case demanded > 80 mJs. The pre YAG capsulotomy IOP was found to be 10-14 mm hg in majority (61%) of patients, highest IOP being 20-24 mm hg (03%) of patients In our study 4% developed IOP > 20 mm of hg post procedure, these cases were treated with Timolol maleate 0.5% topical eye drops twice daily for a week and was observed up to six months to rule out residual effects of the raised intraocular pressure. About three patients had superficial corneal burns and were treated with topical steroid-antibiotic eye drops and lubricating eye drops. 27% of the developed Iritis, when the total energy used for capsulotomy was about 51- 80 mJ, these cases were treated with topical steroid eye drops and homatropine 2% eye drops. 12% of cases had intra ocular lens related complications like pitting / decentration, which did not produce any change in the vision and hence no particular treatment was offered. CME was detected only in one percent of cases, which was treated with topical prednisolone acetate eye drops 1%. We did not come across complications like hyphema, retinal damage or endophthalmitis. Pre procedure (40%) of the patients had visual acuity of counting fingers and (34%) of the patients had visual acuity 6/ 60 and (10%) of patients had 6/24 visual acuity, the lowest visual acuity being hand movements in about (3%). Post procedure the best corrected visual acuity (BCVA) was 6/9 in about 48% of the patients and about 22% had 6/6 of best corrected visual acuity and only 1% had 6/60 owing to cystoid macular edema.

Table 1: Madurai PCO Grading Scale

Level of Severity	On examination
No PCO	No evidence of Posterior Capsule Opacification (PCO) seen before and after pupillary dilation to a minimum of 6 mm. With a direct ophthalmoscope a clear view of the optic disc, blood vessels and the nerve fibre layer is obtained.
Grade I	No central PCO is seen. PCO is seen only with the pupil dilated to a minimum of 6 mm. With a direct ophthalmoscope a clear view of the optic disc, blood vessels and the nerve fibre layer is obtained.
Grade II	PCO is present in the central visual axis, detectable in an undilated pupil. With a direct ophthalmoscope there is a mild obscuration of

Table 2: Laser energy used for capsulotomy

Energy used in mJ	No of Eyes	Percentage
0.5-1.0	05	05
1.0-1.5	57	57
1.5-2.0	37	37
>2.0	01	01
Total	100	100

Table 3: Total laser energy used

Total Energy Used In MJS	No of Eyes	Percentage
< 20	46	46
21-50	15	15
51 -80	38	38
>80	01	01
Total	100	100

Table 4: Complications post Nd-YAG laser capsulotomy

Complications	No of Patients
Corneal injury/ burns	03
Iritis	27
Hyphema	0
IOL related:	12
Pitting.....09	
Cracks.....none	
Decentration.....03	
CME	01
Retinal damage	0
Endophthalmitis	0
Rise in IOP	04

Table 5: Variation in IOP post Nd-YAG laser capsulotomy

IOP mmhg	Pre Nd:YAG		Post Nd:YAG Capsulotomy					
			After 1 Hour		After 4 Hours		After 24 Hours (Next Day)	
	No of eyes	%	No Of Eyes	%	No Of Eyes	%	No Of Eyes	%
<10	09	09	12	12	10	10	10	10
10-14	61	61	63	63	64	64	65	65
15-19	27	27	18	18	20	20	21	21
20-24	03	03	04	04	03	03	01	01
>25	00	00	03	03	03	03	03	03
Total	100	100	100	100	100	100	100	100

Table 6: Comparison of visual acuity pre and post Nd-YAG laser capsulotomy

VA	Pre YAG		Post YAG	
	No of Patients	Percentage	No of Patients	Percentage
Hand movements	03	03	0	0
CF	40	40	0	0
6/60	34	34	01	01
6/36	12	12	04	04
6/24	10	10	06	06
6/18	01	01	09	09
6/12	0	0	10	10
6/9	0	0	48	48
6/6	0	0	22	22
Total	100	100	100	100

Discussion

Even though PCO following cataract surgery is more common in children and younger adults,⁽¹⁻⁴⁾ our study included patients above 40 years of age because of relatively atypical behaviour of the PCO in the children and younger adults.⁽⁵⁾ In our study 62% were males and 38% were females, our study included the rural population, showing that the female population had less inclination towards the follow up after cataract surgery either due to ignorance or due to socio economic factor, similar findings was found in other studies.^(6,7) The early incidence of PCO after cataract in our study was probably due to the usage of rigid PMMA IOL, studies have shown that foldable intraocular lens have lower PCO rate compared to rigid IOL.⁽⁸⁾ In our study, the PCO was mostly Elschnig's pearl type (59%), the rest were fibrous type (41%). grade 2 was the commonest (52%), in comparison with various other studies.⁽⁹⁻¹¹⁾ In our study majority of the patients (57%) required pulse energy between 1.0 mJ to 1.5 mJ. The total energy requirement for

effective capsulotomy was less than 20 mJ in 46% of patients, 51- 80 mJ in 38% patients, 21 -50 mJ in 15% of patients, only in one case (1%) it required more than 80 mJ. Various other studies have shown the usage of total energy ranging from 10.4 mJ even up to 566 mJ.^(12,13)

Even though some studies show that raise in the intraocular pressure as the most common complication after the procedure,⁽¹⁴⁾ in our study we encountered iritis (27%) as the most common complication. In our study about 1% of patients were found to have >20 mm hg and about 3% of patients had >25 mm hg even after 24 hrs. All these cases were managed with topical anti-glaucoma medications. Some studies have found that elevation of IOP post procedure was found in about 0.6% to 1% patients,^(15,16) while other studies could not find any elevation of IOP post procedure.⁽¹⁷⁻¹⁹⁾ Different explanations have been given for the rise in IOP following Nd: YAG laser which include the deposition of debris in the trabecular meshwork^(20,21) pupillary block,^(22,23) and inflammatory swelling of the ciliary body or iris root associated with angle closure.⁽²⁴⁾ A study showed that patients who required more than 200 mj risked the rise in intraocular pressure.⁽²⁵⁾ one study showed that in patients with no prior history of glaucoma, the use of prophylactic anti glaucoma medications was not indicated, since the IOP elevation within the first 24 hours appeared to be a self-limited process in most cases⁽²⁶⁾ and one study showed that a short-term IOP elevation after capsulotomy was more common in glaucomatous than in non-glaucomatous eyes.⁽²⁷⁾ In our study we encountered (12%) intraocular lens (IOL) complications such as IOL pitting (09%) and decentration of IOL (03%). Various studies shows that about (6.8% to 19.8%) IOL related complications occur post procedure.⁽²⁸⁻³⁰⁾ We encountered 03% of superficial corneal burns and was treated with topical steroid eye drops. In our study CME was detected in only 01% of the study group. CME has been reported to develop in 0.55-2.5% of eyes following Nd: YAG laser posterior capsulotomy.⁽³¹⁾ Possible mechanism of CME is still unclear but it is suggested that in response to Nd-YAG laser the prostaglandin released from anterior segment reaches the retina through the vitreous, altering the permeability of paramacular capillaries to develop CME,⁽³²⁾ Continuous iris irritation by displaced vitreous in AC around the pupil margin may promote CME,⁽³³⁾ and vitreous instability secondary to Hyaluronic acid and prostaglandin diffusion through the compromised posterior capsule.⁽³⁴⁾ Studies have shown that delay in Nd: YAG laser capsulotomy by 90 days after cataract surgery allows full recovery of the blood aqueous barrier and can reduce the rate of cystoids macular edema.⁽³⁵⁾ Visual acuity improvement successfully achieved in 89% of cases (VA > 6/18), the rest being borderline (10%) and poor vision < 6/60 improvement was seen in about 01%, in comparison with several other studies which have shown that 82.9% to 96% had improvement in the vision after Nd-YAG laser capsulotomy.⁽³⁶⁻⁴²⁾ Totally about 11% of the cases were having borderline

to poor vision due to development of iritis or cystoid macular edema, which were treated with topical anti-inflammatory drugs for about 1-3 weeks achieving a reasonably good vision.

Conclusion

The procedure is non-invasive, simple, instantaneous, efficient, safe and economical. The patient accepts the same as an outpatient procedure, though it is not without some complications.

References

1. Fagadau WR, Maumence AE, Stark WJ Jr, et al. Posterior chamber intraocular lenses at the wilmer institute: a comparative analysis of complications and visual results. *Br J Ophthalmol.* 1984;68:13-8.
2. Emery JM, Wilhelmus KA, Rosenberg S. Complications of phacoemulsification. *Ophthalmology.* 1978;85:141-50.
3. Pearce JL. Modern simple extracapsular surgery. *Trans Ophthalmol Soc UK.* 1979;99:176-82.
4. Kraff MC, Sanders DR, Lieberman HL. Intraocular pressure and the corneal endothelium after neodymium-YAG laser posterior capsulotomy. Relative effects of aphakia and pseudophakia. *Arch Ophthalmol.* 1985;103:511-4.
5. Khan MY, Jan S, Khan MN, Khan S, Kundi N. Visual outcome after Nd-YAG capsulotomy in posterior capsule opacification. *Pak J Ophthalmol* 2006;22:87-91.
6. Billote C, Berdeaux G. Adverse clinical consequence of Neodymium-YAG laser treatment of posterior capsule opacification. *J Cataract Refract Surg* 2004;30:2064-2971.
7. Tayyab AA, Sahi TN, Ajmal M, et al. Frequency of PCO following PMMA vs silicone posterior chamber IOL Pak J Ophthalmology. 2004;20:96-9.
8. Schauumberg DA, Dana MR, Christen WG, et al. A systemic overview of the incidence of posterior capsule opacification. *Ophthalmology.* 1998;105:1213-21.
9. Sellman *et al.* (*J Cataract Refract Surg* 1988;14(1):68-72).
10. Baratz KH, Cook BE, Hodge DO. Probability of Nd:YAG laser capsulotomy after cataract surgery in Olmsted County, Minnesota. *Am J Ophthalmol.* 2001;131:161-166.
11. Moreno-Montanes *et al.* (*Invest Ophthalmol Vis Sci* 2005;46(11):3999-4006).
12. Khan MY, Jan S, Khan MN, Khan S, Kundi N. Visual outcome after Nd-YAG capsulotomy in posterior capsule opacification. *Pak J Ophthalmol* 2006;22:87-91.
13. Khanzada MA, Jatoti SM, Narsani AK, Dabir SA, Gul S. Is the Nd-YAG laser a safe procedure for capsulotomy? *Pak J Ophthalmol* 2008;24(2):73-78.
14. Stark JW, Worthen D, Holladay JT, Murray G. Neodymium: YAG lasers: an FDA report. *Ophthalmology.* 1985;92:209- 212.
15. R. H. Keates, R. F. Steinert, C. A. Puliafito, and S. K. Maxwell, "Long-term follow-up of Nd: YAG laser posterior capsulotomy," *The American Intra-Ocular Implant Society Journal*, vol. 10, no. 2, pp. 164-168, 1984.
16. W. J. Stark, D. Worthen, J. T. Holladay, and G. Murray, "Neodymium: YAG lasers: an FDA report," *Ophthalmology*, vol. 92, no. 2, pp. 209-212, 1985.
17. L. Shani, R. David, Z. Tessler, S. Rosen, M. Schneek, and Y. Yassar, "Intraocular pressure after neodymium: YAG

- laser treatments in the anterior segment," *Journal of Cataract and Refractive Surgery*, vol. 20, no. 4, pp. 455–458, 1994.
18. S. Ari, A. K. Cing'u, A. Sahin, Y. C. Inar, and I. C. ac, a, "The effects of Nd: YAG laser posterior capsulotomy on macular thickness, intraocular pressure, and visual acuity," *Ophthalmic Surg Lasers Imaging*, vol. 43, pp. 395–400, 2012.
 19. Bath PE, Hoffer KJ, Aron-Rosa D, Dang Y. Glare disability secondary to YAG laser intraocular lens damage. *J Cataract Refract Surg*. 1987;13:309-313.
 20. Kraff MC, Sanders DR, Lieberman HL. Intraocular pressure and the corneal endothelium after neodymium-YAG laser posterior capsulotomy. Relative effects of aphakia and pseudophakia. *Arch Ophthalmol*. 1985;103:511-4.
 21. Vine AK. Ocular hypertension following Nd-YAG Laser Capsulotomy: A potentially blinding complication. *Ophthalmic Surg*. 1984;15:283-4.
 22. Parker MD, Clofeine GS, Stocklin RD. Marked intraocular pressure rise following Nd-YAG laser capsulotomy. *Ophthalmic Surg*. 1984;15:103-4.
 23. Ruderman JM, Mitchell PG, Kraff M. Pupillary block following Nd-YAG laser capsulotomy. *Ophthalmic Surg*. 1983;14:418-9.
 24. MacEwen CJ, Dutton GN, Holding D. Angle closure following Neodymium-YAG (Nd-YAG) laser capsulotomy in the Aphakic Eye. *Br J Ophthalmol*. 1985;69:795-6.
 25. Richter CU, Arzeno G, Pappas HR, Steinert RF, Puliafito C, Epstein DL. Intraocular pressure elevation following Nd:YAG laser posterior capsulotomy. *Ophthalmology*. 1985;92:636-640.
 26. Slomovic AR, Parrish RK. Acute elevations of intraocular pressure following Nd: YAG laser posterior capsulotomy. *Ophthalmology*. 1985;92:973-976.
 27. Flohr MJ, Robin AL, Kelley JS. Early complications following Q-switched Neodymium: YAG laser posterior capsulotomy. *Ophthalmology*;1985;92:360-363.
 28. Wang J, Sun B, Yang X, Chen J. [Evaluation of visual function following neodymium: YAG laser posterior capsulotomy]. *Zhonghua Yan Ke Za Zhi*. 2002 Sep; 38(9):556–61. Chinese. PubMed PMID: 12410978.
 29. Pop I, Petroi C, Coroi M, Ban C, Roiu G, Stepan E, Nistoran S, Hanciu D. [Secondary cataract treatment with laser YAG-ND]. *Oftalmologia*. 2002;54(3):68–71. Romanian. PubMed PMID: 12723203.
 30. Hasan KS, Adhi MI, Aziz M, et al. Nd: YAG Laser Posterior Capsulotomy. *Pak J Ophthalmol*. 1996;12:3-7.
 31. R. H. Keates, R. F. Steinert, C. A. Puliafito, and S. K. Maxwell, "Long-term follow-up of Nd: YAG laser posterior capsulotomy," *The American Intra-Ocular Implant Society Journal*, vol. 10, no. 2, pp. 164–168, 1984.
 32. Kundi NK, Younas M. Nd-YAG laser posterior capsulotomy. *J Med Sciences*. 1998;8:90-4.
 33. Kraff MC, Sanders DR, Lieberman HL. Intraocular pressure and the corneal endothelium after neodymium-YAG laser posterior capsulotomy. Relative effects of aphakia and pseudophakia. *Arch Ophthalmol*. 1985;103:511-4.
 34. Winslow RL, Taylor BC. Retinal complications following YAG laser capsulotomy. *Ophthalmology*. 1985;92:785-789.
 35. Ruderman JM, Mitchell PG, Kraff M. Pupillary block following Nd-YAG laser capsulotomy. *Ophthalmic Surg*. 1983, 14: 418-9.
 36. Hossains MI, Hossains MA, Hossains MJ. Visual outcome after ND-YAD laser capsulotomy. *JAFMC Bangladesh* 2009;5(2):29-31.
 37. Tariq M, Aslam I, Patton N. Methods of assessment of patients for ND-YAG laser capsulotomy that correlate with final visual improvement. *BMC Ophthalmol* 2004;4:13.
 38. Skolnick KA, Perlman JI, Long DM, Kernan JM, Neodymium Y. Laser posterior capsulotomies performed by residents at a veterans administration hospital. *J Cataract Refract Surg* 2000;26:597-601.
 39. Mirza Shafiq AB, Ali MA. Yag laser capsulotomy: Review of 500 cases at civil hospital, Karachi. *Pak J Surg* 2009;25(1):41-3.
 40. Steinert RF, Keates RH, Steinert RF, Puliafito CA, Maxwell SK. Long-term follow-up of Nd: YAG laser posterior capsulotomy. *J Am Intraocul Implant Soc*. 1984 Spring; 10(2):164–8. PubMed PMID: 6547424.
 41. Stark WJ, Worthen D, Holladay JT, Murray G. Neodymium: YAG lasers. An FDA report. *Ophthalmology*. 1985 Feb; 92(2):209–12. PubMed PMID: 3982799.
 42. Polak M, Zarnowski T, Zagorski Z, Results of Nd: YAG laser capsulotomy in posterior capsule opacification. *Ophthalmology*. 2001;108:505–18.