Original Article

AN ESTIMATION OF ND: YAG LASER CAPSULOTOMY ENERGY LEVEL FOR TREATING THE POSTERIOR CAPSULE OPACIFICATION

Humera Zafar and Hamid Mahmood

Objective: The objective of this study is to estimate the Nd: YAG laser capsulotomy energy level in milli joules (mJ) required to produce a clear visual axis in patients with posterior capsule opacification (PCO) in the Pakistani population.

Material and Methods: 138 eyes of the patients who were operated for cataract by routine extracapsular cataract extraction ECCE or Phaco emulisification with intraocular lens implant were included in the study. All had posterior capsule opacification and were treated with Nd;YAG capsulotomy in the Department of Ophthalmology, Sir Ganga Ram Hospital Hospital, Lahore from 1st January to 31st December 2011.

Results: Out of 138 eyes who were treated for PCO with Nd: yag laser the maximum energy required was in the range of 1.2 4.0 mJ in 92.1% of the eyes and the no of shots were < 40 in 88.5 % of the patients eye which is considered to be a safe range thereby minimizing the complications rate.

Conclusion: The Nd: YAG laser treatment is an effective technique to improve the hindered vision by PCO. It is not free from complications, so it is advised to be conscious of the extra damage to ocular tissues following Nd: YAG laser capsulotomy. It is also suggested that energy level should be kept to a minimum level to avoid severe complications.

Keywords: Posterior capsule opacification, visual axis, Nd:YAG laser capsulotomy, energy level

Introduction

Posterior capsule opacification (PCO) is the most common visually disabling consequence of modern cataract surgery and has important medical, social and economic implications.[1] Expectations of patients receiving modern cataract surgery are becoming similar to patients with refractive surgery; they expect almost perfect result, often emetropia. The reported incidence of PCO varies widely. Analysis of multiple reports has found the visually significant PCO rate overall to be approximately 28% at 5 years.[2] PCO reduces visual acuity, contrast sensitivity and causes uniocular diplopia. It also decreases field of view in therapeutic and diagnostic procedures.[3-5]

Sundelin and Sjostrand have defined visually significant PCO as a decrease in post-operative best corrected visual acuity by two Snellen lines.[6] At present, the most effective treatment of PCO is Nd:YAG laser capsulotomy. The procedure involves clearing of the visual axis by creating a central opening in the opacified posterior capsule[7] by focusing a Nd:YAG laser pulse, with energy of few millijoules and duration of a few nanoseconds, just behind the posterior capsule.

The literature search reviled that a number of studies had been done on the complications of the Nd: yag laser capsulotomy post treatment but estimated energy levels which are safe for the patients has a very limited publication. This study was designed to estimate the safe range of energy level to treat the visual disabling PCO in our setup.

Materials and Methods

A total of 138 patients who were operated for cataract by routine ECCE or phaco emulisification with intraocular lens implant presenting to Department of Ophthalmology, Sir Ganga Ram Hospital Hospital, Lahore from January 2011 to December 2011 , with posterior capsule opacification. A convenient sampling technique was used. All patients with posterior capsule opacification after cataract surgery , with more than six months post op were included in the study. Exclusion criteria were a history of previous intraocular surgery or laser treatment, diabetes mellitus requiring medical control, glaucoma, previous uveitis, or any posterior segment pathology and patient with the corneal opacity were excluded from the study .

The extent of PCO requiring laser capsulotomy was determined clinically. After thorough history, all patients were evaluated clinically. A record of VA (Snellen's) was maintained , along with slit lamp examination, applanation tonometry (Goldman's) was carried out. Fundoscopy was performed to rule out any retinal problem hampering the visual disability. The type and extent of PCO was carefully noted after mild pupillary dilation. Topical anesthetic was instilled in the ye to be treated. Abraham yag capsulotomy lens was used with a coupling agent.

The red 4 point Diode laser beam was used for accurate aiming and focusing of the invisible therapeutic beam using Lightmed Yag Laser machine. The parameters of laser system were adjusted accordingly to the need of patients depending upon the type and extent of PCO. As capsulotomy was done for optical purpose its size was restricted to 2 3 mm in diameter using spiral technique. After laser capsulotomy, the patients were rest given for 1 hour. Post laser evaluation was carried out. Topical fluorometholone (FML eye drops) was advised four times daily. The intraocular pressure (IOP) was measured after one hour of the procedure, in cases where it was raised then topical beta-blocker was advised and monitored accordingly. A record of energy required to produce the optimum capsulotomy size and the number of pulse shots was maintained. The data was analysed with IBM SPSS version 20.

Results

A total no of 138 patients were included in the study who were treated at Sir Ganga Ram Hospital, Lahore from 1 January to 31 December 2011 with the posterior capsule opacification by the Nd: yag laser capsulotomy technique.The age range was 20 90 years with a mean of 57.16 SD ± 13.20 (Table 1), out of which 83 were male and 55 were female patients (Table 2), with a predilection for left eye 73 (52.5%) and right eye 66 (47.5 %).(Table 3). The visual acuity as recorded by Snellen's chart was PL (perception of light) in 2 (1.4%), HM (hand movement) in 7 (5.0%), CF (counting fingers) in 34 (24.5%), 6/60 vision in 39 (32.2%), 6/36 in 18 (12.9%), 6/24 in 12 (8.6), 6/18 in 12 (8.6), 6/12 in 14 (10.8 %) patients (Table 4). The energy utilized to clear the visual axis by the Nd; YAG laser was measured in milliJoules with a mean of 2.50 SD± 1.66 and range of 1.2 9.0 mJ was used (Table 5). The range of pulse shots was 2 100 with a mean of 25.01 SD ± 24.38 (Table 6). The two extreme ages i.e the 20 year old patient with visual acuity 6/24 required 1.6mJ and 21 shots to clear the visual axis, whereas the 90 years o

Table-1: Age distribution n=138.

Age in Years	Number	Percentage
20 - 30	07	5.7
31 - 40	10	7.2
51 - 50	36	25.9
51 - 60	38	27.4
61 - 70	36	25.9
71 - 80	10	7.2
81 - 00	01	0.7
Total	138	100

Mean 57.16 SD ± 13.20 / Range 20 90 years

Table-2: Sex distribution n=138.

Gender	Number	Percentage
Female	55	39.6
Male	83	60.4
51 - 50	138	100

Table-3: Eye n=138.

Gender	Number	Percentage
Right	66	47.5
Left	72	52.5
Total	138	100

Table-4: Visual Acuity n=138.

Visual Acuity	Number	Percentage
PL	02	1.4
HM	07	5.0
CF	34	24.5
6/60	39	32.2
6/36	18	12.9
6/24	12	8.6
6/18	12	8.6
6/12	15	10.8
Total	138	100

Table-5: Nd: YAG laser Energy in mJ n=138.

Energy in mJ	Number	Percentage
1.2 - 2.0	63	46.1
2.1 - 3.0	50	35.9
3.1 - 4.0	14	10.1
4.1 - 5.0	4	2.8
5.1 - 6.0	3	2.2
61 - 7.0	0	0
7.1 - 8.0	4	0
8.1 - 9.0	4	2.9
Total	138	100

Table-6: Number of shots n=138.

Pulse shots	Number	Percentage
1 - 20	75	54.2
21 - 40	49	34.3
41 - 60	11	7.8
61 - 80	01	0.9
81 - 100	02	1.8
Total	138	100

Mean 25.01 SD ± 24.38 / Range 2 100 pulse shots

Discussion

Opacification of the capsule is described most commonly in terms of lens epithelial cell growth that forms pearls or fibrosis. However, there are many other mechanisms through which the posterior capsule may be affected.[8] Lens remnants may become trapped, imbibe water, and appear fluffy white. Mechanical distortion of the bag through folds or tears may cause irregularities in posterior capsule transparency. Proteins and white blood cells from posterior inflammation may deposit on the posterior capsule, as may red blood cells and pigmented cells from surgical trauma i.e during Extra capsular cataract extraction or phacoemulsification.[8] Opacification of the posterior capsule can lead to clinically significant reduction in visual acuity, impaired contrast sensitivity, glare disability, and monocular diplopia which is very annoying for patient hindering their clear vision.[9,10] Since the introduction of refined techniques of extracapsular cataract extraction and popularity of the phacoemulsification, opacification of the posterior capsule has become the commonest cause of postoperative reduction in vision following cataract removal.[11]

The Neodymium-YAG laser has become popular non-invasive technique of creating a posterior capsulotomy in both aphakic and pseudophakic eyes. Its safety and efficacy can be argued but it has established its place as a standard treatment for PCO replacing surgical capsulotomy.[12,15]

The procedure involves clearing of the visual axis by creating a central opening in the opacified posterior capsule by focusing a Nd:YAG laser pulse, with energy of few millijoules and duration of a few nanoseconds, just behind the posterior capsule. During a posterior capsulotomy, the laser breaks the capsule by creating a pressure wave on the anterior vitreal side of the capsule. The pressure wave is a result of a process created by infrared light of 1,064 nanometers (nm) amplified and focused so that electrons are ripped away from nuclei, forming energy plasma and corresponding shock wave. This plasma formation is known as optical breakdown. Commonly used Nd:YAG lasers are either Q-switched, mode-locked, or both, which allows for greater efficiency, lower power settings, and fewer side effects. As a consequence free radicals are produced during Nd:YAG laser capsulotomy, but these are unlikely to have any clinical effect.[16,17,18] Singh et al found that sex of the patient did not affect the predictability of posterior capsule opacification post-operatively.[19] Tetz et al analysed energy levels for Nd: YAG laser capsulotomy for PMMA IOL's and found that sulcus fixated IOL's required higher energy. Close proximity of IOL to posterior capsule in bag fixated lenses could account for pitting observed in bag fixation.[20] Till date, only a few studies have estimated the mean energy required for capsulotomy in various subtypes of posterior capsule opacification (Medline Search).Auffarth et al analysed energy levels for capsulotomy in a series of 172 patients and found that the average total energy used was 12.7 +/- 9.4 mJ.[20] Khanzada and co-workers evaluated the complications during and following Nd: YAG laser posterior capsulotomy and found that on an average 24 pulses were required in creating an opening in the posterior capsule. The mean initial energy level in their study was 3.2 mJ and the mean summated energy level was 48.8 mJ.[21]

In our study, the mean energy level was 2.50 ± 1.66 mJ with a minimum being 1.2 mJ and maximum level 15 mJ which is comparable with Auffarth et al[20] and Khanzada and co-workers[21] work.

Moreover , our results are also comparable to other

studies as 92.1% of the patients required a range of 1.2 4 mJ of energy to clear the visual axis which is considered to be safe for the patient and the no of shots were also in the range of < 40 shots in 88.5 % of the patients this is again in a safe range to miminize the possibilities of post laser complications like intraocular pressure elevation and glaucoma, cystoid macular oedema, endothelial cells reduction and damage, retinal tears and detachment and, most commonly, intraocular lens (IOL) damage, or so-called pitting.

Khanzada and co-workers experience shown that it is unnecessary to use higher energy level,[21] we therefore aimed to achieve satisfactory opening of the posterior capsule while keeping the initial energy setting and amount of total energy used as low as possible. The total energy level and retro focusing of aiming beam is the cause of less number of complications [22], so we can suggest that Nd: YAG laser capsulotomy is a safe and reliable procedure to improve the visual acuity in patients with posterior capsule opacification. This study has limitations. The sample was small and represents the results at a single centre only.

Conclusion

We suggest that laser energy be set at lowest possible level and laser beam focused slightly beyond posterior capsule. Despite the wide range of reported complications, Nd:YAG capsulotomy has become the preferred mode of treatment for PCO since its introduction over 20 years ago. It has proven to be an effective and safe alternative to surgical discission. More research is needed to determine the risks associated with modern laser machines, laser techniques, and with current trends in cataract surgery and intraocular lenses. However, knowledge of the research base in this field can help treating physicians to tailor their management to individual patients, optimizing visual results of Nd:YAG capsulotomy and keeping potential risks to a minimum.

Department of Ophthalmology,
Sir Ganga Ram Hospital Hospital, Lahore

www.esculapio.pk

References

1. Hollick EJ, Spalton DJ, Ursell PG et al.The effect of PMMA, Silicone and polyacrylic IOL's on PCO, 3 years after cataract surgery. Ophthalmology.1998 ;106 :49-55.
2. Schaumberg DA, Dana MR, Christen WG, Glynn RJ. A systematic overview of the incidence of posterior capsule opacification. Ophthalmology. 1998;105: 1213-21.
3. Apple DJ, Solomon KD, Tetz M R et al .Posterior Capsule Opacifi- cation. Survey Ophthalmology. 1992; 37: 73-116.
4. Tan JC, Spalton DJ et al. Comparison of methods to assess visual impairment from glare and light scattering, with posterior capsule Opacification. J Cat RefrSurg. 1998; 24:1626-31.
5. Paulson LE, Sjostrand J. Contrast sensitivity in the presence of a glare light. Theoretical concepts and pr- eliminary clinical studies. Invest O- phthalmol Vis Sci.1980; 19:401- 6.
6. Sundelin K, Sjostrand J. Posterior capsule Ooacification, 5 years after ECCE. J Cat Ref Surgery.1999: 24; 1632- 35.
7. Apple DJ, Peng Q, Visessook N, et al. Eradication of posterior capsule opacification: documentation of a marked decrease in Nd:YAG laser posterior capsulotomy rates noted in an analysis of 5416 pseudophakic human eyes obtained postmortem. Ophth-almology 2001;108:505-18.
8. Murrill CA, Stanfield DL, Van Brocklin MD. Capsulotomy.Optom Clin.1995; 4:6983.
9. Claesson M, Klaren L, Beckman C, Sjostrand J: Glare and contrast sensitivity before and after Nd:YAG laser capsulotomy. Acta Ophthalmol (Copenh). 1994; 72:2732.
10. Sunderraj P, Villada JR, Joyce PW, Watson A: Glare testing in pseudophakes with posterior capsule opacification. Eye.1992; 6:4113.
11. Aslam TM, Devlin H, Dhillon B. Use of Nd: YAG laser Capsulotomy. Survey Ophthalmol. 2003; 48: 594-612.
12. Knolle GE Jr. Knife versus neodymium: YAG laser posterior capsulotomy: A one year follow up. J Am Intraocular Implant Soc. 1985; 11: 44855.
13. Riggins J, Pedrotti LS, keates RH. Evaluation of the neodymium: YAG laser for treatment of ocular opacities.Ophthalmic Surg. 1983; 14: 657-82.
14. Stark WJ, Warthen D, Holladay JT, et al. Neodymium: YAG laser. An FDA report. Ophthalmology 1985; 92: 20912.
15. Terry AC, Stark WJ, Maumenee AF, et al. Neodymium-YAG laser for posterior capsulotomy. Am J Ophthalmol. 1983; 96:716-20
16. Timberlake GT, Gemperli AW, Larive CK: Free radical production by Nd:YAG laser photodisruption. Ophthalmic

Surg Lasers.1997; 28:5829.
17. Steinert RF, Puliafito CA . The Nd:YAG LASER in Ophthalmology. Principles, clinical application and photo disruption. WB Saunders, Philadelphia.1983.
18. Belcher CD III, Mainster MA . Current status of Nd: YAG LASER in photo disruption in Ophthalmology. Ann. Ophthalmology part I, II, III (editorial) .1985;15:997-9 ,1097-99.
19. Singh S, Pal V, Dhull CS . A comparative study of PCO in eyes with ECCE. North Zone J Opthalmol.2000; 12: 12-15.
20. Auffarth GU, Nimsgern C, Tetz MR, Volcker et al. Analysis of energy levels for Nd: YAG LASER capsulotomy for secondary cataract. Ophthalmology: 2000; 97(1): 1-4.
21. Khanzada MA, Jatoi MS, Narsani KA, Dabir AS and co-workers . Is the Nd: YAG LASER a safe procedure for posterior capsulotomy? Pak J Ophthalmol.2008;.24 (2): 73-7.
22. Jain S, Chandravanshi SL, Jain G, Tirkey E, Jain SC. Effect of ND: YAG Laser Capsulotomy in pseudophakic eyes with special reference to IOP changes. JEMDS. 2014; 3 (55): 12627-35.