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Evaluation of change in intraocular pressure and macular thickness after Nd: YAG laser posterior capsulotomy

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Abstract
Purpose: To evaluate the changes in intraocular pressure and macular thickness after Nd: Yag laser posterior capsulotomy.
Methodology: This prospective study included 91 eyes of 78 patients who were diagnosed as posterior capsule opacification (PCO), following uncomplicated cataract surgery. All the patients were examined preoperatively and 1 hour post-procedure, 1 week and 4 weeks after Nd: YAG capsulotomy. IOP and macular thickness of all the patients was measured by Goldmann applanation tonometry and optical coherence tomography (OCT), respectively before performing the procedure and at subsequent visits. Patients were divided into two groups based on energy used (Group I ≤50 mJ, Group II >50 mJ). None of the patients received prophylactic antiglaucoma medications either before or after the procedure.
Results: There were 42 males and 36 female patients included in the study. Mean age of the patients was 53.87 ± 10.24 years (45-80 years). Mean total energy levels were 38.64±13.92 mJ in Group I and 85.76±22.10 mJ in Group II. In Group I, IOP did not increase at 1 hour postoperatively (P=0.063) and was within normal limits at 1 week and 4 weeks. In Group II, IOP increased at 1 hour postoperatively (P<0.001) and did not return to preoperative levels at 1-week follow-up (P=0.003). Likewise, macular thickness increased at 1 hour in group II (P<0.001). In Group I, macular thickness was normal at 1 week follow up whereas in Group II, it remained significantly high at 1-week follow-up (P=0.006). There was no case with serious rise in IOP or cystoid macular edema. However, at subsequent follow-up intervals, the difference between the IOP and macular thickness between two groups was not significant statistically.
Conclusion: Nd-YAG laser capsulotomy causes rise in IOP and macular thickness which can sustain up to a substantial period. The amount of energy used in Nd: YAG laser posterior capsulotomy is significantly correlated to rise in IOP and increased macular thickness.

Keywords: IOP, macular thickness, Nd: YAG laser, PCO

Introduction

Posterior capsule opacification is one of the most common complications of cataract surgery, which occurs in approximately 1 in 100 patients [1, 2]. Posterior capsule opacification mainly stems from the proliferation of remaining lens epithelial cells and their migration into the optic axis between the intraocular lens and posterior capsule. The treatment of choice for posterior capsule opacification has been Nd: YAG laser capsulotomy since the early 1980s [3, 4]. Decreased visual acuity, impaired contrast sensitivity, glare disability, and monocular diplopia are the usual visual complications secondary to posterior capsule opacification (PCO), which often require further treatment [5, 6]. Currently, the standard treatment for PCO is Nd: YAG laser posterior capsulotomy, which has a success rate of more than 95% [7].

Laser capsulotomy uses a quick-pulsed Nd: YAG laser to apply a series of focal ablations in the posterior capsule and create a small circular opening in the visual axis. Although safe and effective, the reported complications of Nd: YAG laser posterior capsulotomy include retinal detachment [1, 9, 10], cystoid macular edema (CME) [1, 11], and rise in IOP [12, 13].

Explanations for the rise in intraocular pressure following Nd:YAG laser capsulotomy include the deposition of debris in the trabecular meshwork, trabeculitis as a consequence of the radiating “shock waves”, neurovascular mechanisms, pupillary block and inflammatory swelling of the ciliary body or iris root associated with angle closure [14]. Macular edema after Nd-YAG laser might be caused by movement and damage in the vitreous cavity and release of inflammatory mediators due to the damage of blood-aqueous barrier [2]. Ari *et al.* underlined that the severity and duration of increased IOP and macular thickness are less when a total energy level less than 80mJ is used [15].

Optical coherence tomography is a powerful tool when compared to slit-lamp bio-microscopy and fundus fluorescein angiography for the detection of even subtle macular pathologies. In our study, the aim was to measure the foveal thickness of patients with posterior capsule opacification with SD-OCT preoperatively and in consecutive postoperative visits along with intraocular pressure changes pre- and post-operatively.

Methodology

This prospective study was conducted at the ophthalmology departments of two tertiary care institutes in North India for a duration of 1 year from Jan 2019 to Dec 2019. The study group comprised 91 eyes of 78 patients who were diagnosed with posterior capsular opacification. Only those cases that had undergone uncomplicated manual small incision cataract surgery or phacoemulsification with posterior chamber intraocular lens (PCIOL) in the bag implantation surgery were included in the study. Multiple surgeons performed the surgeries. Patients with complications during cataract surgery or during the postoperative period, diagnosed cases of glaucoma and steroid responders, those with corneal opacities, retinal diseases, uveitis, optic neuropathy, and those who had undergone any other ophthalmic surgeries prior to Nd:YAG laser posterior capsulotomy treatment were also excluded from the study. The minimum period between the cataract surgery and Nd: YAG capsulotomy was 3 months.

All patients underwent a complete ocular examination on all visits, including BCVA, refraction (autorefraction followed by subjective refraction), slit lamp biomicroscopy, IOP measurement (Goldmann Applanation Tonometry) and OCT (Carl Zeiss Meditech Cirrus HD-OCT Model – 500) evaluation of macular thickness. Before capsulotomy and OCT measurement, full mydriasis was obtained with topical tropicamide 1% and phenylephrine hydrochloride 2.5%. Before capsulotomy, topical anesthesia was achieved using proparacaine 0.5% eye drops and a contact laser lens with lubricating gel was used. The aiming beam was focused on the posterior capsule and capsulotomy was performed with the minimum necessary laser shots. ND-YAG laser capsulotomy was performed using Carl Zeiss Meditech LSL YAG III IP20. At the end of the procedure 1 drop of brimonidine 0.2% was instilled into the conjunctival sac and were prescribed topical prednisolone acetate 1% four times a day.

Statistical analysis was done using Statistical Package for the Social Sciences (SPSS), version 21. Continuous variables were expressed as mean ± standard deviation. The repeated OCT and intraocular pressure measurements were analyzed using the paired samples t test. The impact of total laser energy and the changes in OCT measurements was compared using the Pearson correlation test. P values of less than 0.05 were considered significant.

Results

The aim of the present study was to evaluate the effect of ND-YAG laser capsulotomy on macular thickness and intra-ocular pressure. Total number of patients included in the study were 78 patients (42 males and 36 female). Sixty-five patients received treatment in unilateral eyes and 13 patients in both eyes. Mean age of the patients was 53.87 ± 10.24 years (45-80 years). Mean total energy levels were 38.64±13.92 mJ in Group I and 85.76±22.10mJ in Group II. In majority of the patients total energy levels used were ≤50 mJ. Mean age and gender were not significantly different between the two groups (P=0.474, 0.343, respectively).

Table 1 shows the total amount of energy used in Nd: YAG laser posterior capsulotomy in each group and compares IOP and macular thickness measurements between the two groups preoperatively, at 1 hour postoperatively, 1 week and 4 weeks postoperatively. The total amount of energy used during Nd: YAG laser capsulotomy was significantly higher in Group II (P<0.001). There was no significant difference between the groups by means of IOP and macular thickness at 1 hour postoperatively (p=0.244, p=0.229), 1 week (p=0.450, p=0.713) and 4 weeks postoperatively (p=0.145, p=0.613).

Table 2 compares the amount of change in IOP and macular thickness between the two energy groups at 1 hour postoperatively and 1 week postoperatively from the preoperative level. Higher energy use was associated with significantly higher rise in IOP and macular thickness at 1 hour (P<0.001). This effect was not seen at 1 week (P=0.062) for both IOP and macular thickness.

In both groups, I and II, IOP increased 1 hour postoperatively (P=0.023 and <0.001, respectively). IOP declined to preoperative levels at 1 month in Group I and II. Though the IOP at 1 month decreased significantly from 1-hour value, it remained significantly higher than the preoperative value in Group II (P=0.003). The maximum IOP spike was observed at 1 hour in both the groups. There were seven patients with an IOP increment of 5 mmHg at 1 hour out of which five were from Group II and one from Group I. None of these patients had an IOP >19 mmHg at 1 hour.

Table 1: Total amount of energy used in Nd: YAG laser posterior capsulotomy in Groups I and II and comparison of IOP and macular thickness between the groups at preoperative evaluation and at 1 hour postoperatively, 1 week and 4 weeks follow-up.

	Group I (n = 60)	Group II (n = 31)	p
Total energy (mJ)	38.64±13.92	85.76±22.10	<0.001
IOP (mmHg)			
Pretreatment	15.31±2.63	14.61±2.48	0.087
1-hour post-treatment	16.98±2.28	17.72±2.63	0.244
1-week post treatment	14.20±1.96	16.30±2.02	0.450
4 weeks post treatment	13.94±2.14	16.85±2.54	0.145
Macular Thickness	(µm)		
Pretreatment	228.51±14.51	232.85±12.63	0.320
1-hour post-treatment	238.26±13.70	245.52±12.36	0.229
1-week post treatment	224.82±14.90	224.20±13.26	0.713
4 weeks post treatment	227.82±12.90	233.20±12.26	0.613

Table 2: Comparison of amount of change in IOP and macular thickness between the two energy groups at 1 hour and 1 week postoperatively.

	Group I (n = 60)	Group II (n = 31)	p
IOP change at 1 hour (mmHg)	0.46±1.48	2.12±1.68	<0.001
IOP change at 1 week (mmHg)	0.12±1.41	0.70±1.39	0.062
Macular thickness change at 1 hour (µm)	3.75±5.32	9.67±6.52	<0.001
Macular thickness change at 1 week (µm)	0.30±4.96	2.35±5.08	0.062

Mean macular thickness measurements at 1 hour postoperatively compared to preoperative values were significantly higher in both Groups I and II (P<0.001). In Group I and II, macular thickness decreased to preoperative levels at 4 weeks follow-up. We did not observe any case

with serious rise in IOP, anterior chamber reaction or CME. Topical antiglaucoma medications were not started in any of the patients undergoing Nd: YAG laser capsulotomy.

Table 3: Comparison of the change in IOP and macular thickness in Group I.

	Mean (SD)	p
IOP (mmHg)		
1 hour to pretreatment	0.56±1.58	0.013
1 week to pretreatment	0.30±1.54	0.530
4 weeks to pretreatment	0.22±1.41	0.511
Macular thickness (µm)		
1 hour to pretreatment	4.75±4.32	<0.001
1 week to pretreatment	1.21±3.98	0.415
4 weeks to pretreatment	0.40±4.96	0.549

Table 4: Comparison of the change in IOP and macular thickness in Group II.

	Mean (SD)	p
IOP (mmHg)		
1 hour to pretreatment	3.12±1.68	<0.001
1 week to pretreatment	2.58±1.54	0.021
4 weeks to pretreatment	0.80±1.39	0.004
Macular thickness (µm)		
1 hour to pretreatment	9.87±5.52	<0.001
1 week to pretreatment	7.25±5.21	0.001
4 weeks to pretreatment	2.44±4.08	0.006

Discussion

The reported incidence of PCO is 20.7% at 2 years and 28.5% at 5 years after cataract surgery [16]. PCO is the most frequent cause of diminished visual acuity after extra capsular cataract surgery [14]. Nd: YAG laser capsulotomy is the main treatment option for posterior capsule opacification [7]. Steinert *et al.* diagnosed cystoid macular edema after Nd: YAG laser capsulotomy using fundus examination and determined its rate as 1.23% (11 cystoid macular edema cases in a series of 897 eyes). The cystoid macular edema developed in the first 3 postoperative months in 5 eyes and in all eyes in the first postoperative year [1].

The most common complication of Nd: YAG laser posterior capsulotomy is increased IOP. In the absence of antiglaucoma or anti-inflammatory prophylaxis, 59–67% of patients showed IOP increment of at least 10 mm Hg following Nd:YAG laser capsulotomy [17, 18]. In our study, patients in whom less energy was used did show IOP rise at 1 hour postoperative but returned to preoperative levels by 1 week. However, IOP of patients in group II (energy >50mJ) returned to preoperative levels after 1 week. Ge *et al.* found that rise in IOP was more pronounced in patients with glaucoma in those who experienced a higher rise of IOP within hour of capsulotomy [19]. However, Shani *et al.* could not find any elevation of IOP and postulated that healthy pseudophakic eyes do not generally show elevation of IOP after Nd: YAG laser capsulotomy [20]. Ari *et al.* also did not find any persistent rise in IOP [15].

With respect to change in macular thickness, in our study, as compared to preoperative, mean change in macular thickness in group I and group II was 4.75±4.32, 1.21±3.98, 0.40±4.96 and 9.87±5.52, 7.25±5.21, 2.44±4.08 at 1 hour, 1 week and 4 week, respectively Statistically, the change was significant at 1 hour postoperative in group I and significant at all follow ups in group II. Giocanti *et al.* in their study found a mean increase of 6.4 µm (3.1%) at 1 week and a decline of 1.8 µm (-0.88%) at 1-month interval but at 3 month they the increase was 3.2 µm (1.6%), thus showing a fluctuating trend with peak increase at 3 months. In their study, at different follow up periods, the change in macular thickness, as compared to baseline was not significant [21]. Ari *et al.* observed significant increase in macular thickness following Nd: YAG capsulotomy and that the increment was higher in patients who received higher energy [15]. Karahan *et al.* found significant increment in central macular thickness after Nd: YAG capsulotomy at 1 week which decreased to preoperative levels at 4 weeks irrespective of the capsulotomy size [22].

Conclusion

After Nd: YAG laser capsulotomy, increase in IOP and macular thickness is quite common, whose severity and duration changes regarding with the amount of total energy used. OCT plays an important role in measuring macular thickness. The more the amount of energy used in Nd: YAG capsulotomy, more are the chances of rise in IOP and macular thickness.

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