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Effects of ND YAG Laser Capsulotomy on Intra ocular Pressure and Macular Thickness.

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ABSTRACT

Background: AIM- This study was aimed to find the changes in macular thickness and intra-ocular pressure overtime after ND-YAG laser capsulotomy. **Methods:** 100 pts fulfilling the inclusion criteria were included in the study and underwent a detailed ophthalmic examination. Pts IOP and macular thickness was measured by goldmann applanation tonometery and ocular coherence tomography (OCT) respectively before performing the procedure. Each patient was called for follow up on day 1, 1 week, 4 weeks, 8 weeks and 12 weeks. During all the follow up visits complete eye examination, IOP measurement, and macular thickness measurement were noted. **Results:** For this study, a total of 100 eyes of 100 patients (54 males, 46 females) aged 18to 80 years (mean age 51.98±14.01 years) fulfilling the inclusion and exclusion criteria were enrolled in the study.IOP was significantly higher at all the follow-up intervals among those in whom >40 mJ energy was used as compared to those in whom <40 mJ energy was used Mean change in macular thickness was found to be significantly higher at day 1 and week 1 among those in whom >40 mJ energy was used as compared to those in whom <40mJ energy was used. However, at subsequent follow-up intervals, the difference was not significant statistically. **Conclusion:** Nd-YAG laser capsulotomy results in increased IOP and macular thickness which sustains upto a substantial period.Rise in IOP following Nd:YAG laser posterior capsulotomy is correlated with the amount of energy used.Change in macular thickness following Nd:YAG laser posterior capsulotomy is weakly/mildly correlated with the amount of energy used during the initial follow-up, however, subsequently it does not show a correlation with amount of energy used.

Keywords: Posterior capsulr opacity (PCO), ND YAG laser capsulotomy, intra ocular pressure (IOP), macular thickness.

INTRODUCTION

Blindness is one of the major health hazards in developing countries. Worldwide, there are nearly 180 million people who are visually disabled, of whom nearly 45 million are blind. About 80% of them are living in developing countries. However, among them 80% of blindness is potentially preventable or treatable. In India, among the top causes of blindness; cataract stands in first position, closely followed by glaucoma.

One of the most frequent delayed complications of cataract surgery with IOL implantation is posterior capsule opacification (PCO).[1] ND-YAG (Neodynium-Yttrium-Aluminium-Garnet - Nd: Y3Al5O12) laser capsulotomy is a noninvasive alternative to surgical procedures. ND-YAG laser capsulotomy is a method using emitted energy from ND YAG crystal, which is bombarded by Neodymium particles. The aim of ND-YAG laser capsulotomy is to remove the posterior capsular opacification by making an opening in the posterior capsule in the center. It has an effect called noninvasive trauma with photochemical and ionising effect. The result is opening in the centre of posterior capsule with diameter of about 4mm. The acoustic energy from the capsule is transmitted to the retina through adhered vitreous cortex.

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Elevated IOP is the most common, although usually transient, complication following Nd:YAG laser capsulotomy. It is associated with an increased amount of aqueous particles following ND –YAG laser capsulotomy. IOP elevations greater than 10 mmHg have been observed in 15% to 67% of eyes. IOP typically begins to rise immediately after the laser capsulotomy, peaks at 3 to 4 hours, decreases but may remain elevated for 24 hours, and usually returns to baseline after 1 week. Rarely, IOP remains persistently elevated, causing visual field loss requiring glaucoma surgery.[2]

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.[3]

Energy from YAG laser capsulotomy can damage retinal tissue by thermal photocoagulation and especially has influence on central part of retina by changing foveal minimal thickness (FMT).[4,5] However, in a study done by Altiparmak et al,

reported no significant changes of foveal thickness on long term follow up after ND-YAG capsulotomy.[5]

As there are conflicting results of effects on IOP and macular thickness after ND-YAG laser capsulotomy, we would like to undertake this study.

Aim

To evaluate the effect of ND-YAG laser capsulotomy on macular thickness and Intra-Ocular Pressure.

Objective

1. To evaluate the changes in macular thickness after ND-YAG laser capsulotomy.
2. To evaluate the changes in intraocular pressure after ND-YAG laser capsulotomy.

MATERIALS AND METHODS

This prospective longitudinal study was performed in the Department of Ophthalmology, Teerthankar Mahaveer Medical College. A minimum of 100 patients visiting the Out Patient Department between January 2017- December 2017, fulfilling the inclusion criteria were included in the study.

The follow up of the enrolled patients was at 1 day, 1 week, 4 weeks, 8 weeks and 12 weeks.

Inclusion Criteria

1. Patients who have undergone cataract surgery with IOL implantation, atleast 3 months prior to the study and who had clinically observable posterior capsule opacification (PCO) encroaching over the visual axis and was decreasing the visual acuity as observed by the dilated slit lamp examination.
2. The patients above the age of 18 yrs who had given the written informed consent.

Exclusion Criteria

Patients with history of glaucoma, corneal or retinal disease, uveitis, previous laser treatments, ocular trauma, or surgery during the follow-up period were excluded.

Method

A detailed history including duration of refractive error or any past ophthalmic complaints was obtained.The patients selected underwent a complete ocular examination including Best corrected Visual acuity by Snellen's chart, Slit lamp examination (Undilated and Dilated), Dilated fundus examination with tropicamide 0.8% and Phenylephrine 5% was done.

For each patient, a base line IOP measurement by Goldman applanation tonometry was noted. For this, Cornea was anaesthetized. Before touching the cornea with biprism, sodium fluorescein dye was instilled in the eye and cobalt blue filter was switched on. When the observer viewed from the slit lamp uniocularly, two semicircles were seen. The knob of the tonometer was adjusted so that inner margins of both the semicircle meet and start pulsating. This was the end point where the reading was taken.

For each patient, a base line macular thickness measurement by Spectral OCT was noted using Carl Zeiss Meditech Cirrus HD-OCT Model – 500. The scan with good signal strength was taken as the final reading for analysis.

ND-YAG laser capsulotomy was performed using Carl Zeiss Meditech LSL YAG III IP20.

Procedure: A Q-switched Nd: YAG laser system, with wavelength of 1064 nm and pulse length of <4 ns (2-3 ns) was employed for this study. Nd-YAG laser capsulotomy was performed using an Abraham lens with hydroxyl propyl methylcellulose as the coupling agent. Before starting the procedure, one drop of 4% xylocaine and one drop of brimonidine 0.2% was instilled into the conjunctival cul-de sac. The pupils were fully dilated and the aim was to create a capsulotomy of about 4 mm in size. A central cruciate pattern in an upward-downward direction was be used.[6] The aiming beam was focused on the posterior capsule with posterior offset. The optical center of the IOL was matched with the center of the opening. The starting initial energy level (0.3-1.0 mJ), number of pulses used to create capsulotomy and summated laser energy were noted in each case. At the end of the procedure 1 drop of brimonidine 0.2% was instilled into the conjunctival cul-de sac.

All patients undergoing ND-YAG laser capsulotomy were prescribed topical ketorolac tromethamine 0.4% (Acular LS) 4 times a day for a period of 2 weeks. Each patient was called for follow up on day 1, 1 week, 4 weeks, 8 weeks and 12 weeks.

During all the follow up visits complete eye examination, IOP measurement, and macular thickness measurement was noted.

Stastical Analysis

The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 21.0 statistical Analysis Software

RESULTS

The present study was carried out with an aim to find the effect of ND-YAG laser capsulotomy on macular thickness and Intra-Ocular Pressure. Forthis purpose, a total of 100 eyes of 100 patients (54 males, 46 females) aged 18to 80 years (mean age 51.98±14.01 years) fulfilling the inclusion and exclusion criteria were enrolled in the study. Range of total energy levels used among patients enrolled in the study was 12-74 mJ, median 29.50mJ. Mean energy levels used were 32.61±13.66 mJ. In majority of the patients total energy levels used were ≤40 mJ.

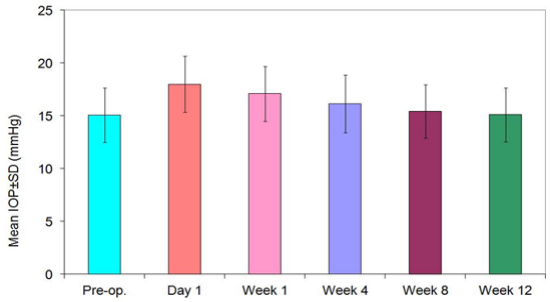

Figure 1: Intraocular Pressure (mm Hg) at different time intervals among study population

Above figure shows that mean preoperative IOP of patients recruited in the study was 15.09±2.57 mm Hg. However, at different post-operative periods, mean IOP values ranged from 15.11±2.56 mm Hg (Week 12) to 18.01±2.64 mmHg (Day 1). During different postoperative intervals, mean value was maximum at Day 1 (18.01±2.64 mmHg) followed by week 1(17.10±.61 mmHg), week 4 (16.15±2.71 mmHg), week 8 (15.42±2.52 mmHg) and week 12 (15.11±2.56 mmhg) respectively.

At different post-operative follow-up intervals, change in IOP ranged from -2 to 7 mmHg. Mean change ranged from 0.02±0.38 mm Hg (0.13% rise at week 12) to 2.92±1.38 mm Hg (19.35% rise). Mean change from baseline was 2.92±1.38 mmHg (19.35% rise), 2.01±1.22 mmHg (13.32% rise), 1.06±1.22 mmHg (7.02% rise), 0.33+0.78 mmHg (2.19% rise) and 0.02+0.38 mmHg (0.13% rise) at day 1, week 1, week 4, week 8 and week 12 intervals. At all the follow up intervals except week 12, the mean change from baseline was significant statistically too (p<0.001).

Table 1: Change in Pre-operative IOP at different follow up visits (n=100) (Paired "t" test)

Follow up visit	Range of change	Mean Ch.	S.D.	% Change	"t"	"p"
Day 1	0 to 7	2.92	1.38	19.35	21.23	<0.001
Week 1	0 to 6	2.01	1.22	13.32	16.50	<0.001
Week 4	-2 to 5	1.06	1.22	7.02	8.74	<0.001
Week 8	-1 to 4	0.33	0.78	2.19	4.24	<0.001
Week 12	-1 to 2	0.02	0.38	0.13	0.53	0.596

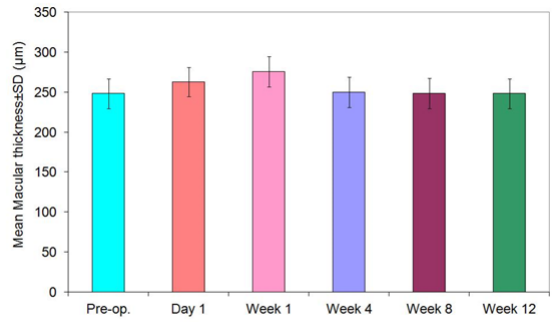

Figure 2: Macular thickness (µm) at different time intervals among study population.

Table 2: Change in Pre-operative Macular thickness at different follow up visits (n=100) (Paired „t" test).

Follow up visit	Range of change	Mean Ch.	S.D.	% Change	"t"	"p"
Day 1	-4 to 29	14.66	7.35	5.91	19.96	<0.001
Week 1	-4 to 47	27.47	9.69	11.07	28.35	<0.001
Week 4	-2 to 6	1.75	1.73	0.71	10.14	<0.001
Week 8	-2 to 3	0.46	0.96	0.19	4.80	<0.001
Week 12	-3 to 2	0.10	0.56	0.04	1.79	0.077

During the evaluation period, macular thickness ranged from 212 to 304 µm at different time intervals. Mean macular thickness was 248.16±18.74 preoperatively and was observed to be 262.82±18.06, 275.63±19.11, 249.91±19.20, 248.62±18.88 and 248.26±18.76 µm respectively at day 1, week 1, week 4, week 8 and week 12 post-operative intervals.

At different post-operative follow-up intervals, change in IOP ranged from -2 to 7 mmHg. Mean change ranged from 0.02±0.38 mm Hg (0.13% rise at week 12) to 2.92±1.38 mm Hg (19.35% rise). Mean change from baseline was 2.92±1.38 mmHg (19.35% rise), 2.01±1.22 mmHg (13.32% rise), 1.06±1.22 mmHg (7.02% rise), 0.33+0.78 mmHg (2.19% rise) and 0.02+0.38 mmHg (0.13% rise) at day 1, week 1, week 4, week 8 and week 12 intervals. At all the follow up intervals except week 12, the mean change from baseline was significant statistically too (p<0.001).

Among cases in whom <40 mJ energy was used, mean change in IOP ranged from -0.03±0.23 mmHg (Week 12) to 2.44±0.99 mmHg (Day 1) whereas among those in whom 40-80 mJ energy was used, mean change in IOP ranged from 0.18+0.66 (Week 12) to 4.64+1.18 mmHg (Day 1). At all the time intervals, mean change in IOP was significantly higher among those in whom 40-80 mJ energy was used as compared to those in whom <40 mJ energy was used (p<0.05). A significant correlation was observed between amount of energy used and change in IOP at day 1, week 1, week 4, week 8 and week 12 intervals. The strength of this correlation was observed to be strong at day 1, week 1 and week 4 intervals. At week 8 and week 12 intervals, this strength was moderate and mild respectively.

Table 3: Association between Amount of Energy and Change in Intraocular Pressure (mm Hg) (Student „t" test).

SN	Follow up period	≤40 mJ (n=78)		40-80 mJ (n=22)		Significance of difference	
		Mean	S.D.	Mean	S.D.	„t"	„p"
1-	Day 1	2.44	0.99	4.64	1.18	-8.837	<0.001
2-	Week1	1.58	0.81	3.55	1.18	-8.998	<0.001
3-	Week 4	0.64	0.88	2.55	1.06	-8.552	<0.001
4-	Week 8	0.08	0.50	1.23	0.92	-7.714	<0.001
5-	Week 12	-0.03	0.23	0.18	0.66	-2.340	0.021

Table 4: Association between Amount of Energy and Change in Macular Thickness (µm) (Student „t" test).

SN	Follow up period	≤40 mJ (n=78)		40-80 mJ (n=22)		Significance of difference	
		Mean	S.D.	Mean	S.D.	„t"	„p"
1-	Day 1	13.77	7.62	17.82	5.31	-2.334	0.022
2-	Week 1	25.76	9.79	33.55	6.42	-3.516	0.001
3-	Week 4	1.72	1.82	1.86	1.39	0.348	0.728
4-	Week 8	0.49	0.92	0.36	1.05	0.532	0.596
5-	Week 12	0.13	0.57	0.00	0.53	0.949	0.345

Among those in whom <40 mJ energy was used, mean change in macular thickness ranged from 0.13±0.57 µm (Week 12) to 25.76±9.79 µm (Week 1) whereas the same ranged from 0.00±0.53 (Week 4) to 33.55+6.42 µm (Week 1) among those in whom 40-80 mJ energy was used. At day 1 and week 1, mean increase in macular thickness was significantly higher among those in whom 40-80 mJ energy was used as compared to those in whom <40 mJ energy ($p<0.05$) was used. However, at subsequent intervals there was no significant difference between two groups ($p>0.05$) A significant correlation between change in macular thickness and energy use was observed for day 1 and week 1 observations when this correlation was found to be weak and mild positive. However, on subsequent intervals, the correlation was weak and was not found to be significant statistically ($p>0.05$)

DISCUSSION

Posterior chamber opacification (PCO) is a common complication following cataract surgery and posterior chamber capsulotomy using Nd:YAG laser is a popular modality to treat PCO. There are reports that claim that owing to energy used during the Nd:YAG laser capsulotomy the intraocular pressure rises and results in macular edema owing to which macular thickness is increased. There is still no consensus regarding the amount of energy that optimizes this resultant IOP rise and causes macular edema. With this background the present study was carried out with an aim to evaluate the effect of Nd:YAG laser capsulotomy for PCO after cataract surgery and complications like rise in intraocular pressure and macular thickness. In present study, the energy required for laser posterior chamber capsulotomy ranged from 12 to 74 mJ with a mean value of 32.61±13.66 mJ. Energy levels generally are dependent on the grade of PCO. In a study Channell and Beckman (1984),[7] reported use of as high as 250.7 mJ average in seven of 33 laser capsulotomy procedures performed by them. Richter et al. (1985),[8] have reported use of <200 mJ of total laser energy to be relatively safer. Ari et al. (2012),[9] reported a mean of 58±18 mJ and 117±36 mJ respectively among two groups of patients receiving 14 to 80 mJ and 84 to 200 mJ of energy respectivelyIn their study, Barnes et al. (2004),[10] reported IOP rise in only 4.2% cases. Shaikh et al. (2010),[11] in their study reported post Nd:YAG laser IOP rise in only 11.5% patients on same day, in 4.8% patients after 1 week and 1.6% patients after 4 weeks of procedure. Thus showing a declining trend of IOP rise with passage of time as observed in present study. With respect to change in macular thickness, in present study, as compared to baseline mean change in macular thickness was 14.66±7.35 (5.91%), 27.47±9.69 (11.07%), 1.75±1.73 (0.71%), 0.46±0.96 (0.19%) and 0.10±0.56 (0.04) µm respectively at post-operative day 1, week 1, week 4, week 8 and week 12 intervals. Statistically, the change was significant from day 1 to week 8 intervals. Thus, the maximum increase in macular thickness was observed at week 1 (11.07%). Compared to this Giocanti et al. (2009),[12] 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. In present study, we did not observe such fluctuating trends, rather observed an inclining trend till week 1 and thereafter a declining trend that continued till the end of study.

Limitations

Since this was a time bound study, we had limited ourselves to a sample size of 100 eyes. A study with a larger sample size would have higher validity in defining the correlation between laser energy, macular edema and /or IOP.

CONCLUSION

Nd-YAG laser capsulotomy results in increased IOP and macular thickness which sustains upto a substantial period.Rise in IOP following Nd:YAG laser posterior capsulotomy is correlated with the amount of energy used.Change in macular thickness following Nd:YAG laser posterior capsulotomy is weakly/mildly correlated with the amount of energy used during the initial follow-up, however, subsequently it does not show a correlation with amount of energy used.

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