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Intraocular Pressure Change After Low Energy and High Energy ND:YAG Laser Posterior Capsulotomy

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Author`s Contribution

[1,4]Substantial contributions to the conception or design of the work; or the acquisition, Drafting the work revising it critically for important intellectual contests, [3]Final approval of the version to be published, [2,5,6]Agreement to be accountable for all aspects of the work in ensuring that question related to the accuracy or integrity of any part of the work

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ABSTRACT

Objective: To determine the frequency of intraocular pressure (IOP) changes among patients undergoing YAG Laser Posterior Capsulotomy and to compare IOP changes based on the level of YAG laser energy and the number of shots applied.

Methodology: A descriptive cross-sectional study was conducted at the Department of Ophthalmology, Fauji Foundation Hospital Rawalpindi, from December 2021 to November 2022. A total of 200 pseudophakic eyes with posterior capsular opacification. Baseline intraocular pressure (IOP) was measured using Goldman Applanation Tonometry (GAT). Patients were categorized into groups based on the laser energy used and the number of shots. IOP measurements were taken at 1 and 4 hours after the procedure, and the results were compared.

Results: In the low-energy group, the mean pre-procedure IOP was 13.44 ± 2.91 mmHg. After 1 and 4 hours, the IOP values were 14.86 ± 3.36 mmHg and 12.97 ± 3.16 mmHg, respectively. In the high-energy group, the mean pre-procedure IOP was 14.31 ± 3.16 mmHg, and it increased to 19.42 ± 6.55 mmHg and 17.51 ± 5.19 mmHg after 1 and 4 hours of the procedure, respectively. In group 1 (less than 20 shots), the mean IOP at 1 and 4 hours post-procedure was 13.88 mmHg and 12.97 mmHg, respectively. In group 2 (greater than 20 shots), the mean IOP values were 21.63 mmHg and 18.31 mmHg, respectively. The increase in IOP was significantly higher in the group with higher laser energy and a greater number of shots at both 1 and 4 hours (p=0.000).

Conclusion: In conclusion, our study found that a significant rise in IOP is observed when higher energy and a greater number of shots are used in YAG laser capsulotomy.

Keywords: Pseudophakia, intraocular pressure change, ND:YAG laser energy,

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Introduction

Cataract is a leading cause of blindness in developing countries. Among the over 2.2 billion visually impaired individuals worldwide, 94 million suffer from cataracts, a preventable and treatable condition.[1] Often attributed to the aging of the crystalline lens, cataract has been a key focus in the global effort to eradicate preventable blindness by the year 2020.[2]

Extracapsular cataract extraction and phacoemulsification are the two most commonly performed cataract surgeries in most eye hospitals. Phacoemulsification cataract surgery, developed over 50 years ago, represents the current gold standard. Approximately a decade ago, femtosecond laser-assisted cataract surgery (FLACS) became commercially available in developed countries.[3] Both procedures have shown similar safety outcomes and visual rehabilitation results.[3]

One of the most frequent long-term postoperative consequences of cataract surgery, leading to secondary vision loss, is posterior capsule opacification (PCO)[4], often referred to as "second cataract".[5] The prevalence of PCO ranges from 20% to 60% in adults and can be even higher, potentially reaching 95%, in children and

adolescents due to their higher proliferative and regenerative capacities.[6] The incidence of PCO varies from 7% to 31% within the first two years after surgery.[7] In children and young adults, PCO is expected in 100% of eyes within one year.[8] PCO can result in visual disturbances, glare, reduced contrast sensitivity, decreased visual acuity, and monocular diplopia.[9]

However, this complication has become less common due to procedural improvements and the use of various types of intraocular lenses (IOLs). Studies have shown that hydrophobic acrylic IOLs require more time to develop PCO symptoms due to their better adherence to the posterior capsular bag, making them superior at PCO prevention.[10-12] Some research has also explored the medical prevention of PCO using cyclosporine A. Nevertheless, access to the latest anti-PCO medications is limited to less than 1% of cataract surgery patients in developing countries.[13] Despite these efforts, PCO formation remains unavoidable and continues to be a common complication in developing nations.[14]

The current standard therapy for PCO is Neodymium: Yttrium Aluminum Garnet (Nd:YAG) posterior capsulotomy.[14] While it is the only available treatment for posterior capsule opacification, it is not without complications. In addition to the financial burden, other complications include raised intraocular pressure (IOP), IOL pitting, uveitis, cystoid macular edema, corneal haze, and retinal detachment (0.87% after 5 months).[15]

The most prevalent complication following YAG capsulotomy is raised IOP ([7) (16]). Various theories suggest mechanisms for the rise in IOP. These include capsular debris and vitreous particles obstructing the trabecular meshwork, leading to reduced outflow, as well as trabeculitis due to shock waves, pupillary block, and inflammation of the ciliary body.[9]

This study aims to evaluate the increase in IOP following Nd:YAG posterior capsulotomy and the impact of energy settings and the number of laser shots on this change.

Methodology

A descriptive cross-sectional study was carried out in the Department of Ophthalmology at Fauji Foundation Hospital between December 2021 and November 2022, following approval from the ethical committee. The study included 200 eyes of patients with pseudophakia for over 3 months, experiencing posterior capsular opacification severe enough to cause visual disturbances, and with normal intraocular pressure (IOP). Patients were enrolled upon obtaining written informed consent. A comprehensive examination, encompassing best corrected visual acuity (BCVA), slit lamp examination, and dilated fundus examination using an indirect ophthalmoscope, was conducted. Preliminary baseline intra-ocular pressure (IOP) was measured using Goldman Applanation Tonometry (GAT). To achieve pupil dilation, each eye received one drop of 1% tropicamide eye drops, instilled three times at ten-minute intervals.

Topical anesthesia was administered through 0.5% proparacaine hydrochloride eye drops five minutes prior to the procedure. The Nd YAG laser (Zeiss VISULAS YAG III) was employed to create an adequate opening in the posterior capsule to clear the visual axis. An Abraham capsulotomy lens was utilized in all patients to enhance procedural precision. Patients were categorized into groups based on the energy used, with a cutoff value of 3.5mJ distinguishing between low-energy and high-energy groups. The number of shots required to achieve the desired capsulotomy size was also recorded, and the data was subsequently split into two groups: one with less than 20 shots and the other with more than 20 shots. IOP measurements were taken at 1 and 4 hours post-procedure using GAT across all groups. All patients were prescribed flourometholone 0.1% eye drops, to be administered four times a day for one week post-procedure, and they were scheduled for follow-up after two weeks.

Data analysis was performed using SPSS version 22. For quantitative variables such as age, IOP (both pre and post-procedure), and total energy utilized, the mean and standard deviations were calculated. The association between the rise in IOP and various variables was assessed using a paired t-test, with a significance level set at a p-value less than 0.05.

Results

A total of 200 pseudophakic patients with posterior capsular opacities were enrolled in the study out of which 106 were males (53% of the total) and 94 were females (47%).

The means of age, pre-laser IOP, post-laser IOP after 01 hour and 4 hours, the mean value of YAG energy used, the time elapsed between the cataract surgery and YAG laser procedure and the mean of number of shots given during YAG are shown in table I.

In the low energy group, mean IOP calculated was 13.44 ± 2.91 mmHg pre-procedure, and 14.86 ± 3.36 and 12.97 ± 3.16 mmHg after 1 and after 4 hours of procedure

respectively. The mean YAG laser energy used was 2.73 ± 0.29 mJ.

Mean pre-procedure IOP in the high energy group was 14.31 ± 3.16 mmHg. While it was 19.42 ± 6.55 and 17.51 ± 5.19 mmHg after 1 and 4 hours of procedure. The mean energy used in this group was 4.11 ± 0.65 mJ. This is depicted in the table II. As evidenced, the rise in IOP was significantly higher for the higher laser energy group at both 1 and 4 hours (p=0.000).

Table I: Mean values of Demographic data.

Parameter	Mean	Max	Min
Age of Patient (Years)	63.41 ± 7.38	78	50
Time Elapsed Post Cataract Surgery (Years)	3.24 ± 1.12	6	1
YAG Laser Energy (mJ)	3.38 ± 0.87	5.7	2.0
Number of Shots Applied	18.43 ± 6.14	35	10
Pre-YAG IOP (mmHg)	13.88 ± 3.07	20	9
Post-YAG IOP at 1 Hour (mmHg)	17.10 ± 5.64	40	8
Post-YAG IOP at 4 Hours (mmHg)	15.19 ± 4.84	30	5

Table II: Comparison of IOP spike in low energy and high energy YAG laser groups.

Parameters	Low YAG Energy (Less than 3.5 mJ)	High YAG Energy (3.5 mJ and above)	P Value
Pre YAG Laser IOP (mmHg)	13.44 ± 2.91	14.31 ± 3.16	0.072
Post YAG Laser IOP after 1 hour (mmHg)	14.86 ± 3.36	19.42 ± 6.55	0.000
Post YAG Laser IOP after 4 hours (mmHg)	12.97 ± 3.16	17.51 ± 5.19	0.000
YAG Laser Energy (mJ)	2.73 ± 0.29	4.11 ± 0.65	0.000

Similarly, results were calculated in both groups sorted according to the number of laser shots. The number of shots on average used was 14 in the first group. IOP calculated after 1 and 4 hours of procedure was 13.88 and 12.97 mmHg respectively. In group 2 number of shots on average was 24 and mean IOP calculated after 1 and 4 hours were 21.63 and 18.31 mmHg respectively. (Table III)

P value was calculated as 0.000 showing a statistically significant rise of IOP after 1 and 4 hours in the group with greater number of shots.

Another important conclusion obtained by this study was that age of the patient and rise of IOP was found to be significant with the p-value of 0.000. However, gender did not impact the eye's response to YAG capsulotomy in terms of change in IOP (p=0.64 and 0.08). This is shown in table IV.

Table III: Comparison of IOP spike in two groups sorted according to the number of shots.

Parameter	No of Laser Shots (Less than 20)	No of Laser Shots (20 and above)	P Value
Pre YAG Laser IOP (mmHg)	12.86 ± 2.58	15.31 ± 3.16	0.000
Post YAG Laser IOP after 1 hour (mmHg)	13.88 ± 2.40	21.63 ± 5.80	0.000
Post YAG Laser IOP after 4 hours (mmHg)	12.97 ± 2.03	18.31 ± 5.83	0.000
Mean no. of Shots	14.03 ± 2.51	24.61 ± 3.88	0.000

Table IV: Impact on IOP change after Nd:YAG laser according to the age and gender of the patient.

Parameter	Mean	P Value
Age of Patient & Post YAG IOP after 1 hour	46.31	0.000
Age of Patient & Post YAG IOP after 4 hours	48.22	0.000
Gender & Post YAG IOP after 1 hour	0.38	0.64
Gender & Post YAG IOP after 4 hours	-1.20	0.08

Although all patients showed a rise of IOP after ND YAG laser, anti-glaucoma medication wasn't required by many patients. IOP calculated after 4 hours, although showed a rise, was still less than 21mmhg. Out of 200 patients, 12 patients who had primary open angle glaucoma showed an IOP rise of >25mmhg after 1 hour and 4 hours' post-procedure. They were added another anti-glaucoma medications (brimonidine 0.15%) and called for review in 7 days.

Discussion

According to recent research, the mean increase in intraocular pressure (IOP) is 3.83 ± 1.84 mmHg when low energy is used and 5.51 ± 1.58 mmHg when high energy is used, with a statistically significant p-value of <0.001.[17] These findings align with our results, which also indicate a substantial elevation in IOP following ND: YAG laser treatment. The peak of the IOP rise is typically observed within the first three hours after the procedure.[14]

Due to the known complication of this procedure, many ophthalmologists administer short-term anti-glaucoma medications, and some even prescribe them prophylactically. The most commonly used medications for this purpose are topical Apraclonidine and Timolol.[18]

In a study, prophylactic apraclonidine 0.5% was administered to all patients undergoing ND:YAG laser posterior capsulotomy, and only 1.1% experienced a mild increase in IOP after the procedure, with none exceeding 21 mmHg.[19]

Significant increases in IOP were observed in all of our patients within one hour and four hours following ND:YAG laser treatment. Keates et al. reported that 0.6% of their patients experienced elevated IOP, while Stark et al. reported a 1.0% IOP elevation after Nd:YAG capsulotomy. These findings support our research results.[20] Additionally, Ge et al. found that patients with glaucoma experienced a rapid IOP rise within an hour of capsulotomy and had more significant increases in IOP.[20]

We discovered a strong correlation between the spike in IOP and the number of shots administered during YAG laser treatment. A higher number of shots were directly associated with a greater increase in IOP. This corresponds with a previous study conducted by Eyyup et al., which demonstrated a significant rise in IOP, with a more pronounced increase associated with higher energy levels and an increased number of shots during ND:YAG laser treatment. The study also revealed that larger capsulotomies resulted in a greater IOP rise, regardless of the energy used.[20]

Shetty et al. found that the IOP rise in patients who received more than 40 shots was significant and required monitoring for persistent elevation. It was noted that only those patients requiring more than 40 shots during the procedure would need close monitoring, and in cases of persistent IOP increase, ocular hypotensive medication might be recommended.[7] This aligns with our study, which demonstrated greater IOP spikes in group 2 compared to group 1.

Conclusion

In conclusion, our observations reveal that patients who underwent posterior capsulotomy with a higher energy level and a greater number of shots exhibited elevated intraocular pressure (IOP). Furthermore, a significant increase in IOP was observed after the procedure, in comparison to pre-procedure IOP levels. Additionally, a noteworthy finding is the direct correlation between age and the post-ND YAG laser IOP rise. Gender and the duration between cataract surgery and ND YAG laser treatment, however, were not found to be significant factors in this study.

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