ORIGINAL ARTICLE

The Changes of Anterior Chamber Depth, Refraction and Macular Thickness After YAG Laser Capsulotomy in Pseudophakic Eyes

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Abstract

Background: ***When it comes to long-term complications, phacoemulsification cataract surgery is most commonly associated with posterior capsule opacification (PCO). Common visual consequences of PCO include blurred vision, decreased contrast sensitivity, difficulty with glare perception, and diplopia in one eye. These issues typically necessitate additional treatment.***

Aim and objectives: ***To assess how YAG laser capsulotomy affects macular thickness, refraction, and anterior chamber depth.***

Subjects and methods: ***From September 2022 through September 2023, thirty (30) eyes of thirty patients were used in this prospective observational study. The patients were enrolled at the outpatient clinic with PCO at the Ophthalmology Department, Faculty of Medicine, Al-Azhar University.***

Results: ***While there was no statistically significant difference between the pre- and post-YAG intraocular pressure (IOP) and spherical equivalent, there was an extremely significant difference in best corrected visual acuity ($p<0.001$) between the two. Following a month of Nd: YAG capsulotomy, visual acuity significantly improved. When comparing the average ACD before and after YAG laser capsulotomy, there was no statistically significant difference ($p>0.05$).***

Conclusion: ***Despite improvement in visual acuity after YAG laser capsulotomy at one-month post-capsulotomy, no significant change in refractive error or ACD was found in this study. Macular edema was observed temporarily, which returned to normal levels within a few weeks.***

Keywords: YAG Laser Capsulotomy; Pseudophakic eyes; Macular thickness

1. Introduction

Lens fiber production, epithelial-mesenchymal transition, collagen deposition, and remnant lens epithelial cell proliferation and migration are the primary causes of posterior capsular opacification (PCO). Cytokines, growth factors like vascular endothelial growth factor (VEFG), and proteins found in the extracellular matrix all play a role in these processes.[1]

By applying a sequence of targeted ablations in the posterior capsule and creating a small circular opening in the visual axis, a laser capsulotomy can be performed using a quick-pulsed neodymium-doped yttrium aluminum garnet (Nd: YAG) laser. Nd: YAG laser posterior capsulotomy is a safe and successful procedure; nonetheless, there have been reports of vision-related problems such as cystoid macular edema (CME), retinal detachment, and others.[2]

Causes of localized endophthalmitis worsening include iris hemorrhage, corneal edema, intraocular lens (IOL) subluxation, macular hole, vitreous hemorrhage, and macular hemorrhage.[3]

Because the implant moves around during the surgery, the patient's refraction may change, and the lens's effective power in the eye may fluctuate as well.[4]

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Inflammatory swelling of the ciliary body or iris root due to angle-closure, neurovascular mechanisms, pupillary block, debris deposition in the trabecular meshwork, and trabeculitis caused by the radiating "shock waves" are all potential causes of an increase in intraocular pressure following an Nd: YAG laser capsulotomy.[5]

Macular thickness may be accurately and reliably measured using optical coherence tomography (OCT). As a result, it makes it easier to spot macular edema, the hallmark of maculopathy. Edema can affect the whole macular region or only one portion at a time. As time goes on, it often grows from a localized lesion to a more widespread one.[6]

This study set out to assess how YAG laser capsulotomy affected macular thickness, refraction, and anterior chamber depth.

2. Patients and methods

From September 2022 through September 2023, thirty (30) eyes of thirty patients were used in this prospective observational study. The patients were enrolled at the outpatient clinic with PCO at the Ophthalmology Department, Faculty of Medicine, Al-Azhar University.

Inclusion criteria:

Individuals must be of legal age to undergo bag implantation surgery, have a history of simple phacoemulsification with a posterior chamber intraocular lens (PC-IOL), be willing and able to cooperate throughout the procedure, have a clear cornea and clear media (with the exception of PCO), and be able to provide their own informed consent.

Exclusion criteria:

Past procedures involving the eye Patients with a history of intravitreal injection, ocular trauma, cataract surgery complications, glaucoma, steroid responders, corneal diseases (e.g., ulcers, opacities, dystrophy, ectasia, etc.), diseases of the posterior segment (e.g., diabetic retinopathy, retinal diseases, macular edema, retinal tear, retinal detachment, optic neuropathy, uveitis), any active periocular or ocular infection or inflammation at screening or baseline, and patients with systemic autoimmune diseases (e.g., rheumatic diseases, behcet, systemic lupus erythematosus, and rheumatic diseases).

Methodology:

The following information was gathered from each patient: demographics (name, age, sex, residence, and occupation), medical history (including any history of eye complaints, ocular diseases, or medications), the patient's initial complaint, time since cataract surgery, and the degree to which opacification had progressed.

Ophthalmic Examination:

Evaluation of best-corrected and uncorrected visual acuity using Snellen's chart: best-corrected and uncorrected, with results expressed as decimal or LogMAR values. Topcon RC-5000 autorefractometer, Japan, for obvious refraction. By adding the sphere and half of the cylindrical power, we were able to determine the spherical equivalent (SE) values. To rule out problems with the cornea or lens, a slit lamp biomicroscopy (Nidek, 22631, 2013, Nidek, Japan) examination of the front part of the eye is performed. Prior to the procedure, the intraocular pressure was measured using an applanation tonometer (Keeler, UK) in order to rule out the possibility of an increase in IOP. Direct and indirect ophthalmoscopy, as well as a fundus examination using a 78 or 90 D lens on a slit lamp.

Macular thickness measurements were taken using DRICOT Triton Plus Topcon, a spectral domain Optical Coherence Tomography system. For the purpose of determining anterior chamber depth (ACD), the IOL-Master 500 was utilized.

Figure 1. DRICOT Triton Plus Topcon.

Figure 2. IOL-Master 500.

Operative Technique:

Tropicamide 1% is administered for pupillary dilatation for 1 hour before the procedure. Topical anesthesia (Benoxinate hydrochloride) is administered to the operating eye.

For the Nd: YAG laser capsulotomy, the IRIDEX IQ532 system was utilized. A small quantity of energy, between one and four millijoules, is used, with an increase as we move towards the periphery. Stabilize your eyes, enhance the optics of your laser beam, and concentrate with ease with the help of the Central Abraham contact lens.

Lastly, following the treatment, a one-week course of anti-glaucoma medication was provided,

along with a mixture of antibiotic and steroid eye drops (ciprofloxacin 0.3%+ dexamethasone 0.1%).

Figure 3. IRIDEX IQ532 YAG.

Postoperative Examination and Follow-up:

The patient was examined one hour postoperatively and followed up for one week, one month and 3 months postoperatively. In each visit, refraction, UCVA, BCVA, IOP, and ACD were measured and recorded. OCT was done after one and 3 months.

Ethical considerations:

The protocol was approved by the Local Research Committee, the Studies Committee, and the Research Ethics Committee before the study could be undertaken. All patients provided written informed consent.

Statistical Analysis:

SPSS, a statistical package for social science software, version 21, was used to process and analyze pre-coded data. For quantitative factors, the data were summarized using standard deviation, median, and interquartile range. Qualitative variables were represented using numbers and percentages. The Chi-square test was utilized to compare qualitative factors, while an independent t-test was employed to compare quantitative data between the two groups. For quantitative variables that fell into more than two normally distributed categories, we utilized a one-way analysis of variance test. For quantitative variables that did not follow a normal distribution, we employed nonparametric Kruskal-Wallis and Mann-Whitney tests. When required, further statistical tests were employed. Statistical significance is established when the p-value is less than or equal to 0.05.

Descriptive statistics:

The arithmetic mean is a measure of central tendency that acts as an average over all data. The chi-square 2 test uses the standard deviation to quantify the dispersion of the data around the mean. This test determines if there is a statistically significant difference between the expected and observed frequencies of an occurrence by comparing them to the null hypothesis. It compares more than two proportions. A 5% level Student's t-test (t) was used as the significance threshold for all the tests listed above. The probability (P-value) was found to be: a P-value more than 0.05 indicates non-significant results, a P-value less than 0.05 indicates significant results, and a P-value less than 0.01 indicates very significant results.

3. Results

Table 1. Age and sex distribution of the studied patients.

	MALES		FEMALES		SIGNIFICANCE	
GENDER	No.	%	No.	%	χ2	P
TOTAL (N=30)	16	53.3	14	46.7	0.724	0.158
	Min	Max	Mean	±SD		
AGE (YEARS)	51	79	63.89	7.02		

x2 = Chi square, *p = highly significant, SD: standard deviation.

Thirteen female patients (46.7%) and sixteen male patients (53.3%) who had phacoemulsification had pseudophakic eyes in this study. Their mean ± SD was 63.89±7.02 years, and their ages varied from 51 to 79 years. The following table provides an illustration of this. Prior to and one month following the operation, they conducted SD-OCT, (table 1; figure 4).

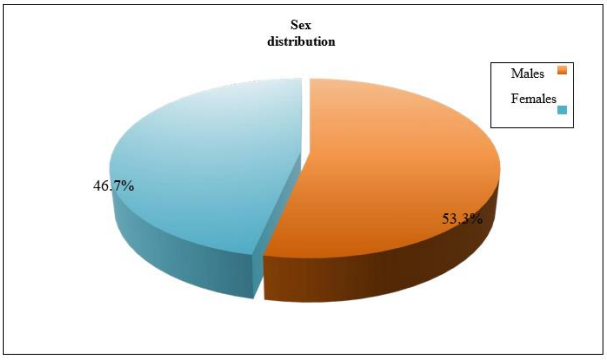

Figure 4. Sex distribution of the studied patients.

Table 2. Features of the eyes prior to and one month following Nd:YAG lase.

	PRE-YAG		POST-YAG		SIGNIFICANCE	
	Mean	±SD	Mean	±SD	t	P
IOP (MMHG)	14.82	1.26	13.91	1.72	0.261	0.257
BCVA (LOGMAR)	0.60	0.29	0.15	0.18	13.26	0.000*
SPHERICAL EQUIVALENT	-1.75	1.37	-1.18	1.25	0.355	0.184

Unpaired t-test (t), extremely significant (p<0.001). IOP stands for intraocular pressure, BCVA for best corrected visual acuity, and SD for standard deviation.

The mean Pre-YAG and Post-YAG IOP and spherical equivalent were statistically insignificant, while best corrected visual acuity was statistically highly significant in comparison between before and after YAG-laser capsulotomy (p<0.001). Vision was markedly improved after one month of Nd: YAG capsulotomy, (table 2; figures 5&6).

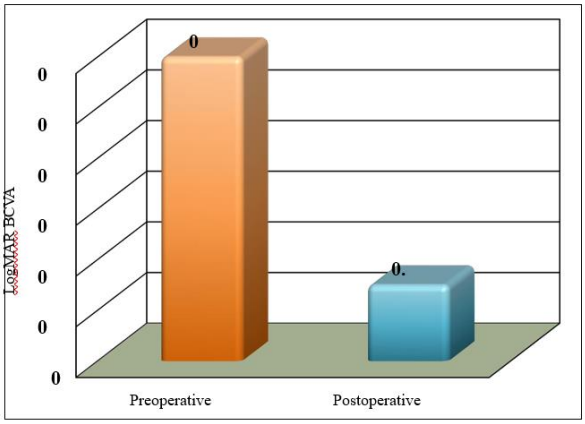

Figure 5. The mean pre-YAG and one-month post-YAG LogMAR BCVA.

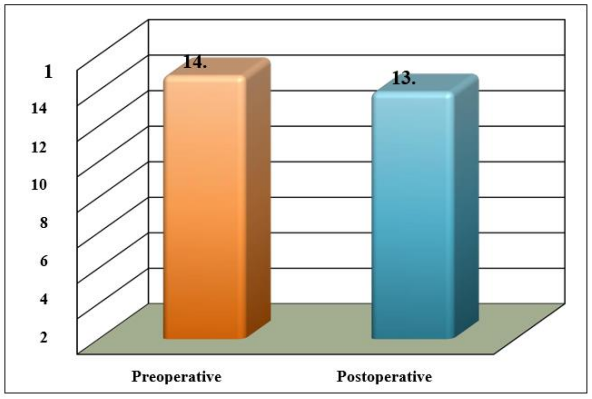

Figure 6. The mean IOP before and one month after YAG-Laser.

Table 3. Anterior chamber depth before and one month after Nd: YAG laser.

ACD (MM)	PRE-YAG	POST-YAG	T	P
MINIMUM	1.7	2.1		
MAXIMUM	3.6	3.9		
AVERAGE	2.747	3.047	0.298	0.191
±SD	0.571	0.521		

tp >0.05, unpaired t-test: not significant.

ACD stands for anterior chamber depth, and SD for standard deviation.

The mean Pre-YAG and Post-YAG ACD showed statistically insignificant difference (p >0.05) in comparison between pre- and post-YAG laser capsulotomy, (table 3; figure 7).

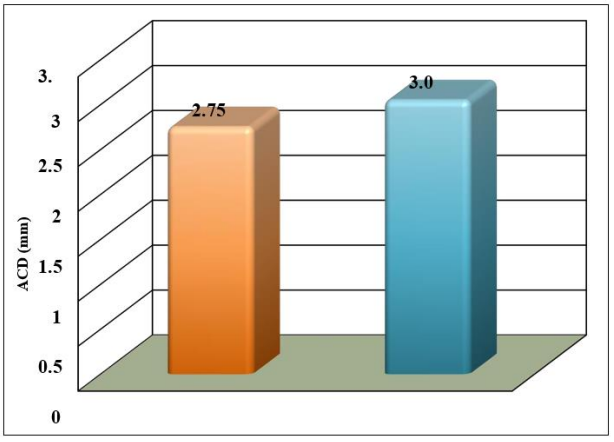

Figure 7. The mean ACD before and one month after YAG-Laser.

Table 4. Retinal thickness in 6 mm central circle (inner circle) by OCT pre- and post-Nd: YAG laser capsulotomy.

RETINAL THICKNESS (µM)	PRE-YAG		POST-YAG		SIGNIFICANCE	
	Mean	±SD	Mean	±SD	t	P
CMT	260.0	9.63	273.4	14.03	2.012	0.008*
SIQ	322.3	9.66	328.5	10.95	0.217	0.029*
IIQ	317.9	9.74	324.4	11.05	1.453	0.021*
NIQ	321.2	10.07	327.6	10.48	1.450	0.023*
TIQ	309.4	10.48	315.9	9.87	1.452	0.022*

t: unpaired t-test, *p <0.05: significant. SD: standard deviation, CMT: central macular thickness, SIQ: superior inner quadrant, IIQ: inferior inner quadrant, NIQ: nasal inner quadrant, TIQ: temporal inner quadrant.

The mean central retinal thickness and all retinal quadrants in the inner circle (6 mm diameter) showed significant difference (p<0.05) in comparison between pre-YAG and one-month post-YAG values. This indicated that central retinal thickness increased after one month of Nd:YAG laser capsulotomy, (table 4; figures 9&10).

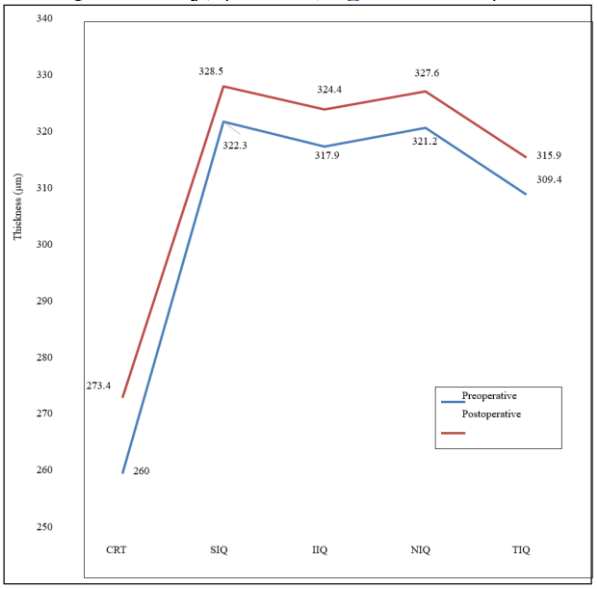

Figure 8. The mean central retinal thickness and inner circle quadrants thickness pre- and post-YAG laser capsulotomy.

Table 5. Retinal thickness in 9 mm central circle (outer circle) by OCT pre- and post-Nd:YAG.

RETINAL THICKNESS (µM)	PRE-YAG		POST-YAG		SIGNIFICANCE	
	Mean	±SD	Mean	±SD	t	P
SIQ	277.6	10.95	283.8	10.1	0.217	0.029*
IIQ	273.1	9.68	279.9	9.87	1.472	0.018*
NIQ	276.4	10.31	282.9	9.80	1.453	0.021*
TIQ	264.1	9.74	270.9	9.58	1.474	0.017*

t: unpaired t-test, *p <0.05: significant. SD: standard deviation, SIQ: superior inner quadrant,

IIQ: inferior inner quadrant, NIQ: nasal inner quadrant, TIQ: temporal inner quadrant.

The mean retinal quadrants in the outer circle (9 mm diameter) showed statistically significant difference (p<0.05) in comparison between pre-YAG and one-month post-YAG values. This indicated that outer circle thickness increased after one month of Nd:YAG laser capsulotomy, (table 5).

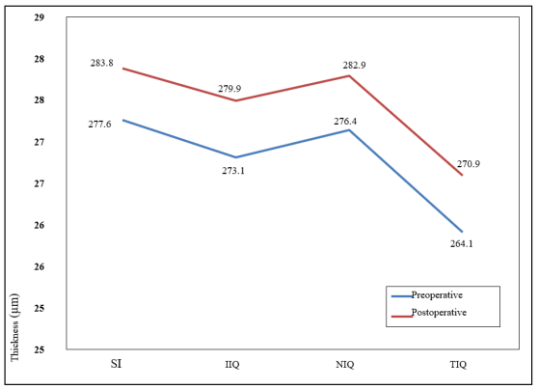

Figure 9. The mean central retinal thickness and outer circle quadrants thickness pre- and post-YAG laser capsulotomy.

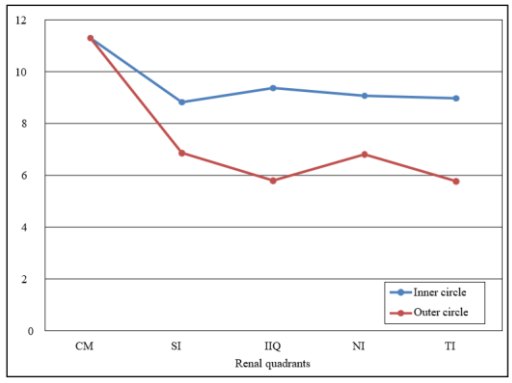

Figure 10. Change of retinal thickness from Pre-YAG to Post-YAG values.

The graph shows that the central macular thickness was the most affected by Nd:YAG laser with marked increase in thickness due to macular edema. This change in thickness became smaller as we are going peripherally and became less from inner to outer circles.

Case presentation:

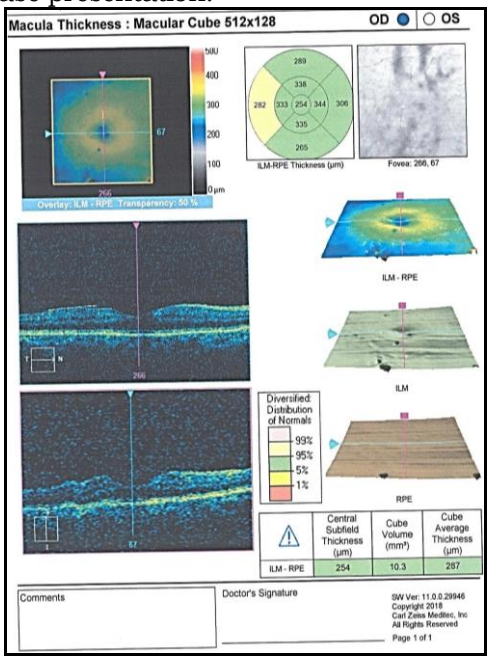

Figure 11. Case No. (1) showing OCT image before Nd:YAG.

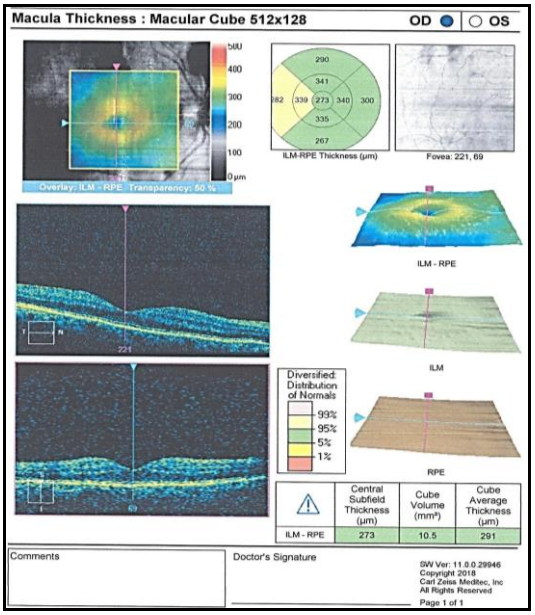

Figure 12. Case No. (1) showing OCT image after 1 month Nd:YAG.

4. Discussion

The current study found no statistically significant difference between the pre- and post-YAG intraocular pressure (IOP) and spherical equivalent, but there was a highly significant difference in best corrected visual acuity ($p<0.001$) between the two groups. After one month of Nd: YAG capsulotomy, vision improved significantly.

Similar to our results, Mohamed et al.[7] concluded that, at the one-month mark following Nd: YAG capsulotomy, visual acuity had significantly improved.

Multiple studies have shown that a capsulotomy can enhance visual acuity.[8]

We found that after Nd: YAG laser capsulotomy, all of the patients' eyesight significantly improved.

In agreement with our results, Moshirfar et al.,[8] compared the numbers from before surgery to those from one month and one year after surgery and found no change in the sphere or axis. Given the nature of the YAG treatment, it was not surprising that corrected distance visual acuity (CDVA) improved significantly from baseline at both time intervals. Curiously, cylinder values were found to be significantly lower one month and one year after surgery compared to preoperative values, with differences of 0.042±0.448 D and 0.101±0.455 D, respectively. If the cylinder is stratified, the distribution of cylindrical power is better after YAG capsulotomy than it was before the procedure, as seen by the postoperative values compared to the preoperative ones.

Patients may have a better understanding of the cylinder's mistake after YAG capsulotomy resolves

the core opacities and cleans the medium. After a YAG capsulotomy, patients report an improvement in their eyesight and an increased ability to perceive fine details. So, capsulotomy does not significantly alter the measured cylinder dimensions. The fact that SE and axis did not show any statistical significance at the one-month and one-year periods provides credence to this theory. At one month and one year after surgery, there may not be a clinically meaningful reduction in cylindrical power. It appears that neither the centroid nor the distribution has undergone any major changes at any time frame.[8]

The cylinder drop may not be clinically important, but they cannot say for sure because the p-value was statistically significant.

Numerous studies have failed to evaluate the cylinder on its own, much like ours. Just two of the six patients who did so saw a statistically significant change in their cylinders at their most recent follow-up appointment, and even those changes were smaller than before.[9]

Khambhiphant et al.,[5] discovered that the cylinder decreased one week after surgery, and by three months postoperatively, it had restored to its preoperative level. There was no statistically significant change in spherical equivalent in our investigation; thus, we hypothesized that this short-lived shift might not have any practical implications.

Consistent with earlier research, our study found no statistically significant change in IOP between pre- and post-procedure (P>0.05).[7]

A total of 101 eyes were examined by Holweger and Marefat[10] They also discovered no appreciable increase in intraocular pressure (IOP) after capsulotomy; hence, it was deemed unnecessary to regularly measure IOP at 1-3 hour and 1-day intervals following the procedure.

Our study found a statistically non-significant increase (p>0.05) in ACD between the mean intraoperative pressure (IOP) before and after YAG.

Our findings are consistent with the fact that ACD did not change after the Nd: YAG capsulotomy procedure. Ozkurt et al.,[11] discovered no significant change in ACD and SE following Nd:YAG capsulotomy.

On the other hand, our research, Mohamed et al.,[7] reported that there was a statistically significant variation (p<0.001) in the anterior chamber depth between the pre-laser value and the last follow-up period (3 months), with a steady reduction. The lenses utilized and the power of the lasers could be to blame for this. In addition, a correlation analysis was conducted between ACD and CMT, which revealed a robust positive relationship (r=0.5208, p<0.001).

When comparing the values from before YAG and one month after YAG, our study found a significant difference (p<0.05) in the mean central retinal thickness across all inner and outer retinal quadrants. A month following Nd: YAG laser capsulotomy, CMT rose, according to the results. Increases in central macular thickness caused by macular edema were the most noticeable effect of the Nd: YAG laser. This transient shift in thickness shrank from the inner to the outer rings and shrank much more as we moved toward the periphery.

Consistent with our findings, Mohamed et al.,[7] discovered a significantly higher central macular thickness following laser treatment, which subsequently decreased over the course of the follow-up period, with a statistically significant difference between the two times (p<0.001). They went on to say that high myopes patients had significantly thinner central macular and retinal layers than emmetropic eyes.

Limitations:

The statistical results could be impacted by the small sample size of only 30 patients. Additionally, we did not assess the results of the keratometry since we believe the Nd: YAG laser has minimal effect on corneal topography and tomography. No physiological mechanism is known to change corneal curvature, thus we reasoned that this analysis would be irrelevant. Moreover, there were no control groups to compare the outcomes of patients with and without PCO, which was another disadvantage.

4. Conclusion

This study did not find a significant change in refractive error or ACD, even though visual acuity improved one month after YAG laser capsulotomy. A transient increase in macular edema was noted, but it subsided within a few weeks.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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