Evaluation of Macular Thickness by Optical Coherence Tomography (OCT) before and after Neodymiun-Yittrium Aluminium-Garnet (ND- YAG) Laser Capsulotomy for Treatment of Posterior Capsular Opacification (PCO) after Cataract Surgery

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Abstract

Background: PCO occurs due to lens epithelial cell activity. Treatments, including Nd:YAG laser capsulotomy and PPCC, risk retinal complications like CME with an incidence rate of 0.1-2.35%. Optical Coherence Tomography (OCT) aids in CME diagnosis.

Objectives: To use Spectral Domain OCT to evaluate how Nd-YAG laser capsulotomy affects macular thickness in individuals who are pseudophakic.

Patients and methods: Prospective study at South Valley University Hospitals (Dec 2016 - Oct 2017) on 40 pseudophakic patients (aged 40–72) with significant PCO. Inclusion criteria: centered posterior chamber IOL, 6 months to 6 years post-cataract surgery, evaluable for Nd-YAG laser capsulotomy. Exclusion criteria: Dense PCO, ocular diseases, trauma, prior laser treatments, uveitis, or diabetes mellitus. Methods: medical history, examinations, OCT for macular thickness, and Nd-YAG laser capsulotomy. Follow-up: 3 months.

Results: No complications post Nd-YAG laser capsulotomy. Median capsulotomy energy: 2 mj, pulses: 9.5. Time post-surgery: avg. 2 years. Significant post-capsulotomy increase in central macular thickness ($p<0.0001$).

Conclusion: Nd:YAG capsulotomy maintains normal macular thickness, affirming its safety in PCO management.

Keywords: Macular Thickness; OCT; Laser Capsulotomy; Posterior Capsular Opacification; Cataract Surgery.

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Introduction

Posterior capsular opacification (PCO) often develops after cataract surgery because to the fast growth and movement of remaining lens epithelial cells (LECs) onto the lens capsule **(Awasthi et al., 2009; Nibourg et al., 2015).** This process is accountable for the formation of posterior capsular opacification. **Kara et al. (2011)** suggested that the therapy of PCO may be achieved by using primary posterior continuous curvilinear capsulorhexis (PPCC) together with phacoemulsification and neodymium:Yttrium aluminium garnet, sometimes known as Nd:YAG, is a compound. Laser capsulotomy.

The use of Nd:YAG laser capsulotomy is a well acknowledged therapy for treating PCO. However, it is important to note that both Nd:YAG laser capsulotomy and PPCC have the risk of retinal issues due to the creation of an open posterior capsule. Several repercussions may emerge as a result of this condition, including cystoid macular edoema (CME), retinal fractures, and retinal detachment **(Burq and Taqui, 2008). Cystoid** macular edema (CME) is a key element that contributes to a decrease in vision, and it is predicted that between 0.1 and 2.35 percent of people who undergo cataract surgery may develop this condition. Two of the distinctive patterns that may be observed during fluorescein angiography are perifoveal petaloid staining and delayed leakage from the optic disk **(Zur and Loewenstein, 2017).** Both of these patterns are characterized by the presence of light. Following the completion of the surgery, this condition is characterized by the fact that it leads to a reduction in the visual acuity of the patient.

According to **Nolan et al. (2015),** OCT is a diagnostic technology that, in addition to being incredibly beneficial, is frequently employed by ophthalmologists for the goal of visually recording and documenting the architecture of the retina and optic nerve. This is done in order to accurately diagnose and treat a variety of eye conditions. OCT technology is a beneficial method for recognizing and managing cases of congenital myeloencephalopathy (CME) **(Zur and Loewenstein, 2017).** This is because OCT makes it possible to observe cystic patches in the outer nuclear layer.

This investigation aims to examine the impact of Nd-YAG laser capsulotomy on the thickness of macular tissue in individuals who have previously had cataract surgery. This assessment will be conducted using SD-OCT.

Patients and methods

This prospective study was conducted using the following code: SVU/MED/OPH026/1/24/2/811, and it was carried out in the Department of Ophthalmology at South Valley University Hospitals during the months of December 2016 and October 2017. The medical school ethics committee at South Valley University gave its approval for it. Participants in the study exhibited clinically significant posterior capsular opacification (PCO), and the study included forty eyes from forty pseudophakic patients ranging in age from forty to seventy-two years old. All patients who had previously had cataract surgery with IOL implantation and had a post-surgical duration ranging from six months to six years underwent the therapy. Patients who had a centered posterior chamber intraocular lens (IOL) and were able to undergo evaluation three months following the intervention using Nd-YAG laser posterior capsulotomy were the only group of patients who were eligible for participation in the study. The group of patients who were studied did not include individuals who had major PCO, diseases of

the cornea or retina, uveitis, prior laser treatments, ocular trauma, surgery, or other causes of macular edema such as diabetes mellitus. Patients who had these conditions were excluded from the evaluation.

Methods

A. Medical History and Examination: Prior to Nd-YAG laser capsulotomy, demographic data including age, sex, eye (right or left), and medical history were collected. Slit-lamp biomicroscopy, fundus examination, and visual acuity assessments were performed. Eligible eyes with PCO requiring Nd:YAG laser capsulotomy and prior cataract surgery (extracapsular or phacoemulsification) were evaluated **(Aslam and Patton, 2004; Wakamatsu et al., 2011).**

B. OCT Macular Thickness Evaluation: The SPECTRALIS OCT, manufactured by Heidelberg Engineering GmbH in Heidelberg, Germany, was used to measure the thickness of the central fovea before and three months after the Nd-YAG capsulotomy treatment.

C. Nd-YAG Laser Posterior Capsulotomy: Patients with pseudophakia and PCO who had undergone cataract surgery were candidates for Nd-YAG laser posterior capsulotomy at least six months after the surgical procedure. During the surgery, the pupil was dilated with eye drops containing Tropicamide 1% E.D., corneal anesthetic was administered with Benoxinate hydrochloride 0.4% E.D., and the Abraham capsulotomy lens was sealed with 2% HydroxypropylMethylCellulose. Using a Nd-YAG laser (Visulas YAG II Zeiss Nd:YAG, Carl Zeiss Meditec, Dublin, AC, USA), skilled surgeons conducted capsulotomy. The number and energy of laser shots were measured during the procedure. Following the surgical procedure, patients were given an alpha-adrenergic agonist (Briminodine Tartrate 0.2%) twice daily, as well as 0.3% tobramycin and 0.1% dexamethasone twice daily for a period of one week **(Lighthizer et al., 2023).**

D. Follow-up: After three months, all patients were reevaluated to compare preoperative and postoperative macular thickness using SD-OCT, assessing the effect of Nd-YAG laser capsulotomy on pseudophakic patients' macular thickness.

Statistical analysis

The statistical analysis was performed using SPSS version 24. The descriptive statistics were reported as the mean plus or minus the standard deviation, or as the median with the interquartile range, depending on the distribution of the variables. Percentages were used to represent categorical variables. The Wilcoxon Signed Rank test was used to compare continuous data, whereas the Chi-square test was used to evaluate categorical ones. The associations were evaluated using Spearman correlation. A significance level of $p < 0.05$ was deemed to have statistical significance. The main focus of the study was the measurement of foveal thickness before and after YAG posterior capsulotomy. This measurement showed a strong and statistically significant relationship ($p < 0.0001$) with central macular thickness. Despite a little rise in central macular thickness after the treatment, it stayed within the normal range over the 3-month follow-up period.

Results

The eyes of 40 individuals were investigated from December 2016 to October 2017. The follow-up was 12–14 weeks. Overall, 40 patients completed the protocol's 3-month follow-up. The average follow-up was 12 weeks. No complications occurred during or after Nd-YAG laser posterior capsulotomy in all subjects. The 40 patients were 16 women (40%) and 24 men (60%).

The average age was 58.85 ± 7.80 years (range: 43-71 years). Treatment included 23 right eyes (57.5%) and 17 left

eyes (42.5%). To produce a 4 mm capsulotomy, the surgeon chose cross or circular.

Median applied energy was 2 (1.5-2.5) mj, and median YAG laser pulses were 9.5 (7-10). Patients averaged 2 (2-3) years between cataract surgery and Nd-YAG capsulotomy, ranging from 0.5 to 6 years. The 40 patients were monitored for 3 months on average following capsulotomy (**Table.1**).

Table 1. Clinical patients' characteristics (n=40)

Parameters	Mean± SD/ Median (25^{th}-75^{th}) or percentage	Range
History:		
Age (Years)	58.85± 7.80	43-71
Sex (%)		
• Male	24 (60%)	
• Female	16 (40%)	
Eye (%)		
• Right eye	23 (57.5%)	
• Left eye	17 (42.5%)	
YAG laser intervention:		
Average YAG laser energy (mJ)	2 (1.5-2.5)	1.2-3
Average YAG laser pulses	9.5 (7-10)	7-13
Average time between Cataract surgery and YAG capsulotomy (years)	2 (2-3)	0.5-6
Average follow up period (weeks)	12 (12-14)	12-16

The treated eye's central macular thickness was measured before and three months after the treatment. Significant P value (<0.0001) indicates increased foveal thickness following Nd-YAG laser capsulotomy. (**Table.2**).

Table 2. Central macular thickness patients' characteristics (n=40).

Parameters	Median (25^{th}-75^{th})	Range	P Value
Central macular thickness before YAG (mm)	249 (232.75- 268)	221-280	*** <0.0001**
Central macular thickness after YAG (mm)	258 (243- 273.25)	228-285	

Comparison was done by use of related samples Wilcoxon Signed Rank test.
* P value < 0.05 was considered significant.

Case presentations(Fig.1-5)

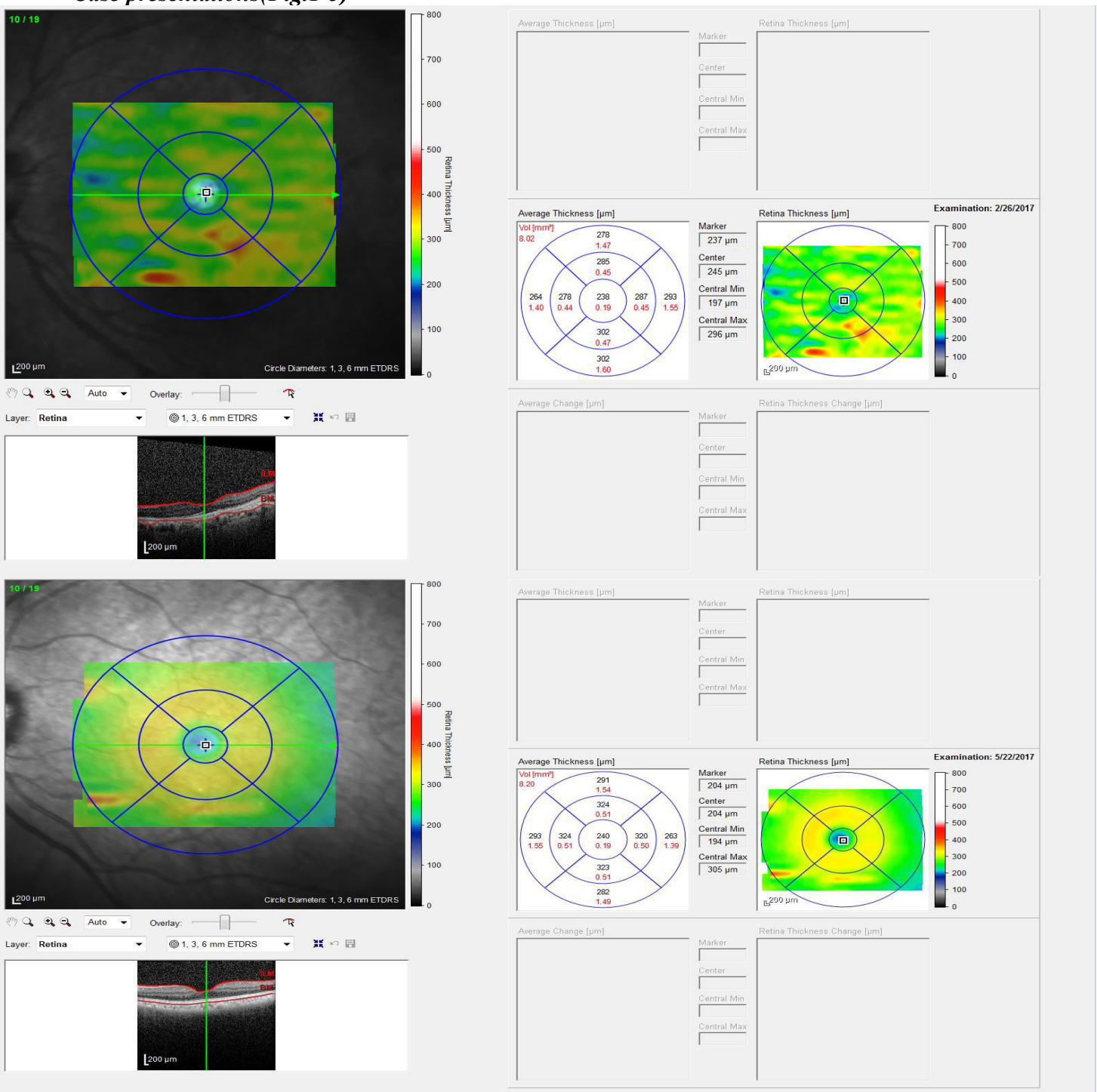

Fig.1. A 55-year-old female case had a Central macular thickness of 238 mm before YAG and 240 mm after YAG.

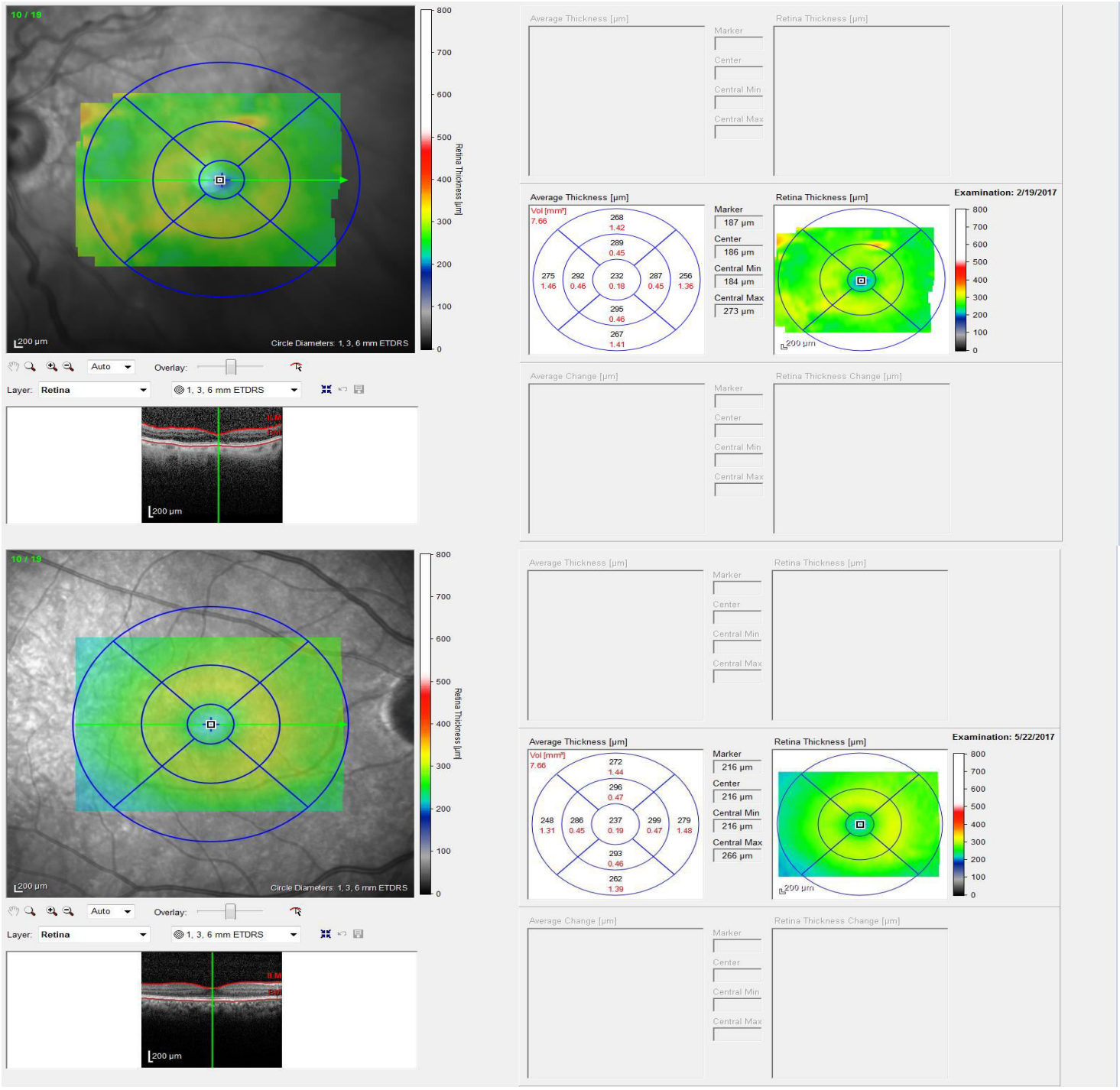

Fig.2 A 64-year-old female case had a Central macular thickness of 232 mm before YAG and 237 mm after YAG.

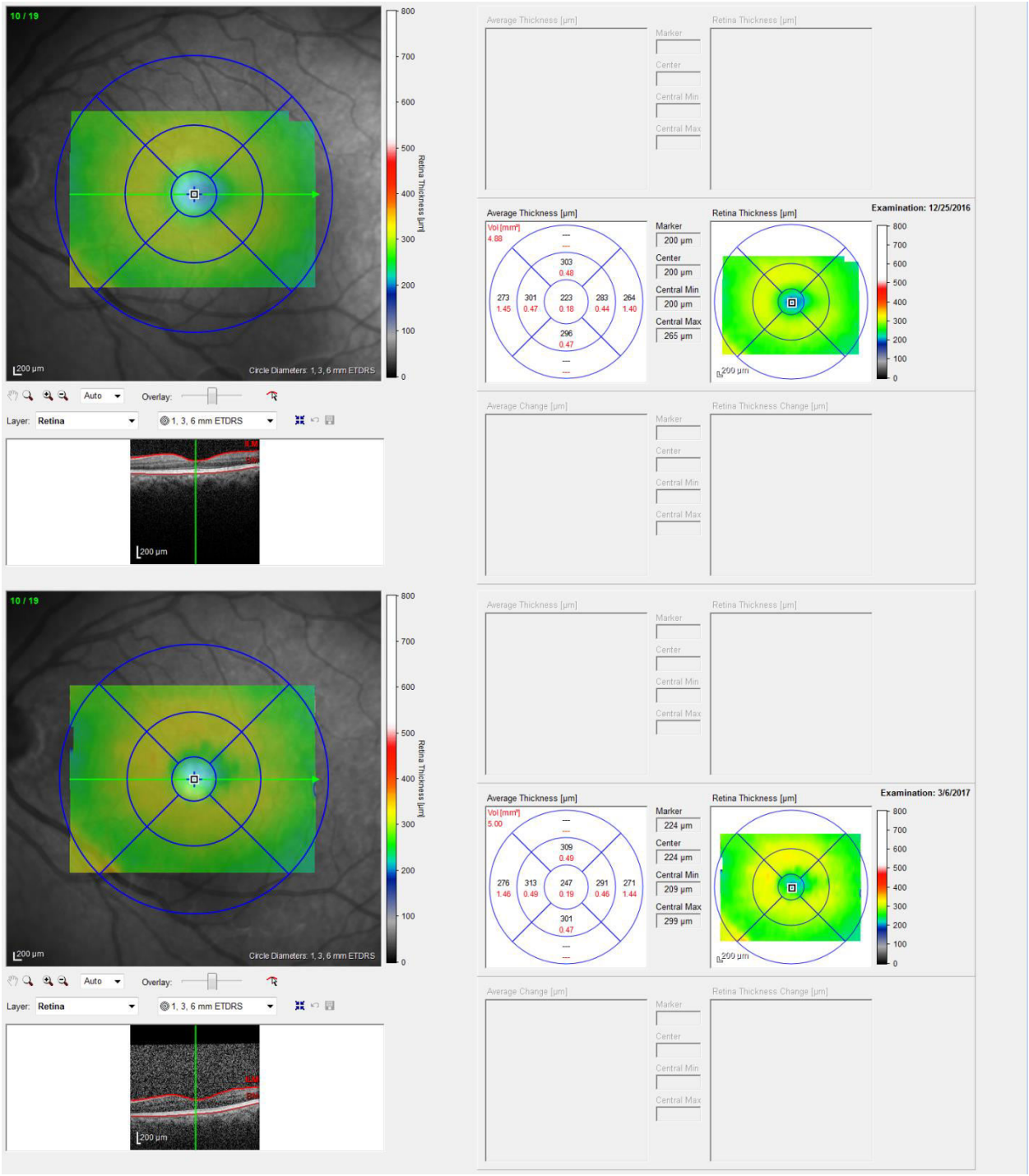

Fig.3. A 69-year-old male case had a Central macular thickness of 223 mm before YAG and 247 mm after YAG.

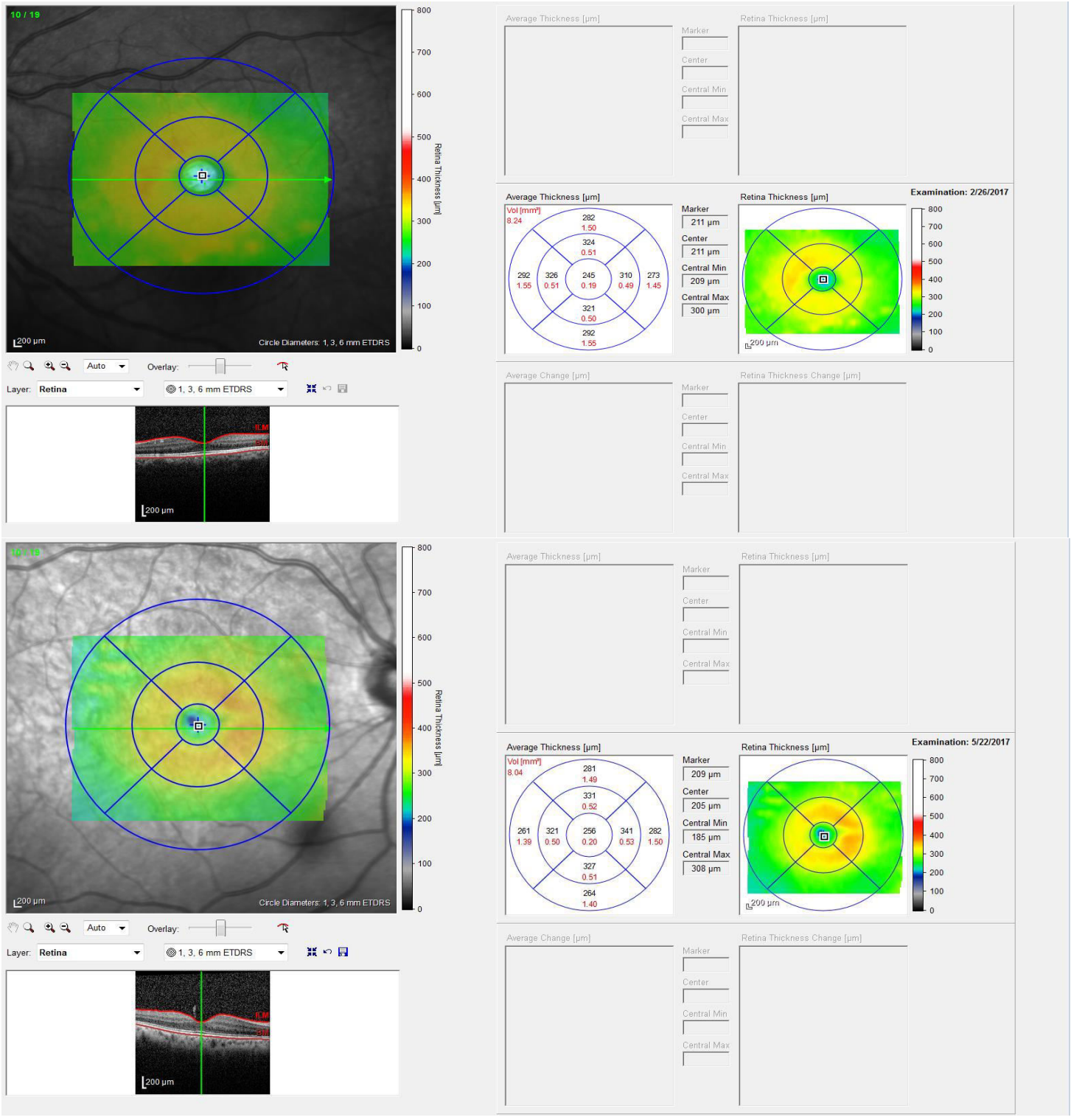

Fig.4. A 61-year-old female case had a Central macular thickness of 245 mm before YAG and 256 mm after YAG.

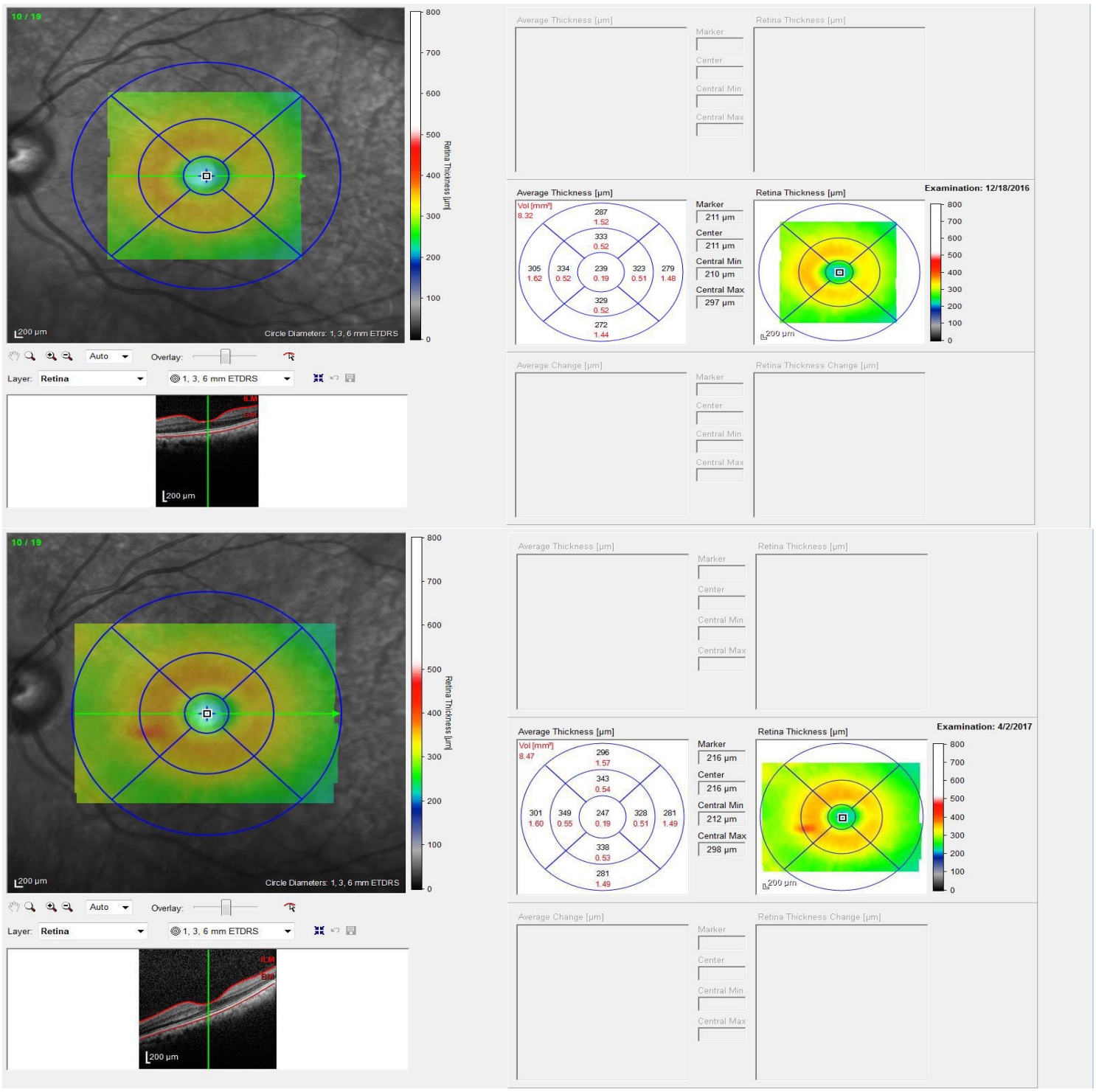

Fig.5 A 58-year-old male case had a Central macular thickness of 239 mm before YAG and 247 mm after YAG

Discussion

Our study found a significant association ($p \leq 0.0001$) between Nd-YAG posterior capsulotomy and central macular thickness over a three-month follow-up period. Although central macular thickness increased slightly after the procedure, it remained within normal limits.

Similar to our study, **Ari et al. (2012),** who investigated the effects of varying energy levels of Nd:YAG laser posterior capsulotomy on the BCVA, IOP, and macular thickness in thirty eyes belonging to thirty patients who had posterior capsule opacification following phacoemulsification. Group I consisted of patients with a total energy consumption of less than 80 millijoules (mJ) during Nd:YAG laser capsulotomy, while group II included patients with a total energy consumption of more than 80 mJ. The retinal thickness of both groups was significantly greater than the preoperative values; however, group II had significantly higher readings one week and one month after surgery (P = 0.004 and.03, respectively).

Also, in agreement with our findings, **Gonzalez-Ocampo-Dorta et al. (2008),** who investigated the ways in which PCO influences the quality of macular OCT imaging and the thickness of the retina.

However, in contrast to our study, **Altiparmak et al. (2010)** assessed the foveal thickness after Nd:YAG laser capsulotomy. A total of 54 eyes with posterior capsule opacification underwent laser capsulotomy using a Nd:YAG wavelength. Foveal optical coherence tomography was conducted before and after surgery on days 1 and 7, as well as on months 1, 3, 6, and 12. The Altiparmak et al's, study found that there was no significant change in the thickness of the fovea over the first year after laser therapy.

Kara et al. (2011), investigated the impact of Nd:YAG laser capsulotomy and primary posterior continuous capsulorhexis (PPCC) with phacoemulsification on the thickness of the adult macular tissue using optical coherence tomography. The research included 32 eyes from 30 patients who had received Nd:YAG laser capsulotomy and 33 eyes from 33 patients who had undergone PPCC cataract surgery. There was no discernible variation in macular thickness across the groups when comparing measures taken before and after the surgery. The OCT results showed that both groups did not have any cystoid alterations after the surgery.

Using optical coherence tomography (OCT), **Giocanti-Aurégan et al. (2011)** evaluated the change in foveal thickness that occurred after Nd:YAG capsulotomy by examining thirty eyes from twenty-six different people was done. Before capsulotomy, the mean foveal thickness was 209 ± 26 µm. After the procedure, the thickness was 213 ± 23 µm. After one week, one month, and three months, the thickness was 204 ± 19 µm. There were no significant changes in the foveal thickness.

Utilizing OCT, **Wróblewska-Czajka et al. (2012)** found that there were no substantial alterations in retinal thickness after undergoing Nd: YAG capsulotomy. Additionally, **Ruiz-Casas et al. (2013)** discovered that there was no correlation between Nd:YAG capsulotomy and postoperative macular thickness on their study.

In a similar manner, **Yuvacı et al. (2015)** employed OCT to evaluate the choroid, retina, and corneal nerve fiber layer subsequent to a simple YAG laser capsulotomy. The choroidal and retinal structures of 28 eyes belonging to 28 patients were analyzed using optical coherence tomography (OCT) following standard examinations performed before and 24 hours, 72 hours, 2 weeks, 4 weeks, and 12 weeks after YAG laser capsulotomy. Following YAG capsulotomy, the thickness of the central macular region dropped from 272.14 ± 25.76 µm to 266.53 ± 26.47, 269.14 ± 27.20, 272.17 ± 26.97, 270.91 ± 26.79, and 273 ± 26.63 µm. However, there was no significant change in the thickness of the central macular region.

Yilmaz et al. (2017) investigated the changes that occurred in the intraocular pressure (IOP), CMT, and sub-foveal choroid thickness (SCT) in 42 eyes of 42 patients before and after Nd:YAG laser capsulotomy. The preoperative micrometer (CMT) measured 238.1 ± 27.6 μm (mean ± standard deviation), and the postoperative CMT measured 239.7 ± 29.8, 241.3 ± 28.7, 242.7 ± 27.2, 238.8 ± 23.7, and 238.3 ± 21.7 μm. There were no significant changes in the CMT measurements.

Conclusion

In conclusion, our study noted that macular thickness remained within normal range after Nd:YAG capsulotomy. This finding assures the safety of this procedure in management of PCO.

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