Journal of Medicine in Scientific Research

Manuscript 1408

Subject Area: Ophthalmology

Effect of Nd:YAG laser capsulotomy for treatment of posterior capsular opacification (PCO) on central macular thickness (CMT) and ganglion cell complex (GCC) at Sohag Teaching Hospital

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ORIGINAL STUDY

Effect of Neodymium-doped Yttrium Aluminum Garnet laser capsulotomy for treatment of posterior capsular opacification on central macular thickness and ganglion cell complex at Sohag Teaching Hospital

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Abstract

Background: **After cataract surgery, a common consequence is posterior capsular opacification (PCO). Neodymium-doped Yttrium Aluminum Garnet (Nd:YAG) laser therapy is currently the most popular option for treating PCO since it is successful, fast, and noninvasive.**

Patients and methods: **One hundred consecutive patients who visited the Sohag Teaching Hospital's outpatient ophthalmology clinic and were eligible with PCO were included in the study. Central macular thickness (CMT), ganglion cell complex, and best corrected visual acuity (BCVA) were measured prior to YAG laser treatment. Following the surgery, follow-up evaluations were conducted 2 weeks, 1 month, and 3 months later.**

Results: **Comparing pre and post-Nd:YAG laser assessment results revealed statistically significant increases in mean BCVA at 2 weeks, 1 month, and 3 months post-Nd:YAG laser capsulotomy. Mean CMT showed a statistically significant increase at 2 weeks with a statistically significant decrease at 1 month and 3 months post-Nd:YAG laser.**

Conclusion: **The Nd:YAG laser capsulotomy technique is a noninvasive, outpatient PCO therapy option that greatly increases BCVA with negligible short-term negative effects on ganglion cell complex and CMT.**

Keywords: Central macular thickness, Neodymium-doped Yttrium Aluminum Garnet laser capsulotomy, Posterior capsular opacity

1. Introduction

Even with the latest advancements in cataract surgery, problems arise following the procedure, the most frequent one being posterior capsular opacification (PCO). Apart from the quantitative visual disruptions, PCO also causes a decrease in vision quality, which in turn leads to a decrease in contrast sensitivity, halo effect, and loss of binocular vision [1].

Neodymium-doped Yttrium Aluminum Garnet (Nd:YAG) laser capsulotomy is a common outpatient surgery that is rapid, noninvasive, and somewhat safe for treating PCO [2].

The purpose of this study was to ascertain how Nd:YAG laser capsulotomy affected the ganglion cell complex (GCC) and central macular thickness (CMT).

1.1. Aim

(1) To determine the effect of Nd:YAG laser capsulotomy on CMT and GCC.

2. Patients and methods

2.1. Study design

(1) Prospective, interventional study.

Received 16 July 2024; revised 5 September 2024; accepted 8 September 2024.
Available online 1 November 2024

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https://doi.org/10.59299/2537-0928.1408

(2) Study duration: patients were examined for full ophthalmological examination for 3 months follow-up after YAG capsulotomy.

2.2. Location

Data were collected from the outpatient ophthalmology clinic and Ophthalmology Department at Sohag Teaching Hospital from November 2023 to May 2024.

2.2.1. Inclusion criteria

(1) Patients with PCO, which does not interfere with OCT imaging but reduces best corrected visual acuity (BCVA).
(2) Patients with clear cornea, AC, vitreous.
(3) Patients who have noncomplicated cataract extraction surgery.

3. Exclusion criteria

(1) Diabetic patients.
(2) Glaucomatous patients.
(3) Patients with a history of traumatic cataracts and globe perforation.
(4) Patients with congenital or acquired retinal disorders.

3.1. Study population

(1) The sample size was calculated based on the primary objective of the study, assuming a mean difference of 50 μm in CMT before and after YAG capsulotomy, a SD of 50 μm, a power of 80 %, and a significance level of 0.05. Using these assumptions, the sample size required is 100 eyes, so this study was conducted on 100 eligible eyes with PCO in 100 consecutive patients attending the outpatient ophthalmology clinic at Sohag Teaching Hospital from November 2023 to May 2024.

3.2. Study procedures

(1) Pre-YAG laser assessment of BCVA, CMT, and GCC.
(2) Nd:YAG capsulotomy was done by (Ellex Ultra Q-reflex machine) using an Abraham capsulotomy contact lens with the following parameters (power from 1 to 2 mJ, posterior offset 100–200 μm, oblique illumination, single pulse mode, 200–400 laser shots), with postlaser treatment (Brimonidine Ed, Steroid Ed, AcetazolamideTab) for 1 week after YAG laser.
(3) Two weeks, 1 month, and 3 months after YAG laser capsulotomy evaluation of CMT, GCC, and visual acuity.

3.3. Ethical consideration

Ethical consideration was considered in each step of the study.

Approval of the Ethical Committee General Organization of Teaching Hospitals and Institutes (GOTHI) was taken. In addition, the objectives and steps of the study were explained to the participants before taking any information. Informed consent was obtained from all the patients participating in the study regarding the aim of the study and the nature of the planned investigation.

3.4. Statistical analysis

Data were collected, revised, coded, and tabulated. Version 20 of the Statistical Package for Social Science (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.) was used to analyze the data. When comparing results before and after Nd:YAG laser capsulotomy, paired *t* tests, and the SD were employed to provide quantitative data as the mean. The allowable margin of error was set at 5 %, while the confidence interval was set at 95 %. Consequently, the *P* value was deemed significant at the less than 0.05 level.

4. Results

The study group consisted of 66 males and 34 females. Their ages ranged from 49 to 66 years, with a mean age of 58.05 ± 4.59 years (Table 1).

Pre-Nd:YAG laser assessment of CMT, GCC, and visual acuity are shown in Table 2.

When comparing pre-Nd:YAG laser assessment results to post-Nd:YAG laser assessment results, statistically significant increases in mean BCVA assessment results were found at 2 weeks, 1 month, and 3 months post-Nd:YAG laser compared to its pre-Nd:YAG laser mean value. Mean CMT showed a statistically significant increase at 2 weeks and a

Table 1. Sociodemographic data of patients.

	n (%)
Sex	
Female	34 (34.0)
Male	66 (66.0)
Eye	
Left	56 (56.0)
Right	44 (44.0)
Age	
Mean ± SD	58.05 ± 4.59
Range	49–66

Table 2. Pre-Neodymium-doped Yttrium Aluminum Garnet laser assessment results.

	Range	Mean ± SD
BCVA	0.02–0.33	0.14 ± 0.09
CMT	195–303	250.46 ± 27.51
Superior GCC count	46–185	96.53 ± 22.89
Inferior GCC count	40–200	93.65 ± 22.10
Average GCC count	43–172	95.10 ± 20.36

BCVA, best corrected visual acuity; CMT, central macular thickness; GCC, ganglion cell complex.

statistically significant decrease at 3 months post-Nd:YAG laser compared to its pre-Nd:YAG laser mean value. Both superior and average GCC count showed statistically significant decreases at 3 months post-Nd:YAG laser compared to their pre-Nd:YAG laser mean values. Meanwhile, the changes in superior and average GCC count at 2 weeks and 1 month, as well as changes in inferior GCC at 2 weeks, 1 month, and 3 months, were not statistically significant (Tables 4–6).

Table 3. Post-Neodymium-doped Yttrium Aluminum Garnet laser assessment results at 2 weeks, 1 month, and 3 months.

	2 weeks		1 month		3 months	
	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
BCVA	0.1–0.66	0.29 ± 0.13	0.1–1	0.42 ± 0.16	0.25–1	0.51 ± 0.17
CMT	198–347	258.66 ± 32.85	191–305	247.71 ± 24.58	192–275	237.28 ± 15.55
Superior GCC count	54–125	93.40 ± 14.80	55–119	93.13 ± 13.09	51–106	91.16 ± 12.02
Inferior GCC count	56–178	94.28 ± 17.23	56–130	93.66 ± 14.44	54–112	91.88 ± 11.41
Average GCC count	55–148	93.83 ± 15.46	55–121	93.16 ± 13.52	53–108	91.21 ± 11.35

BCVA, best corrected visual acuity; CMT, central macular thickness; GCC, ganglion cell complex.

Table 4. Pre-Neodymium-doped Yttrium Aluminum Garnet laser assessment results compared to 2 weeks post-Neodymium-doped Yttrium Aluminum Garnet laser assessment results.

	Pre-Nd:YAG laser		2 weeks post-Nd:YAG		Paired *t*-test	
	Mean	SD	Mean	SD	*t*	*P* value
BCVA	0.14	0.09	0.29	0.13	−16.842	0.001
CMT	250.46	27.51	258.66	32.85	−3.549	0.001
Superior GCC count	96.53	22.89	93.40	14.80	1.658	0.100
Inferior GCC count	93.65	22.10	94.28	17.23	−0.317	0.752
Average GCC count	95.10	20.36	93.83	15.46	0.766	0.446

BCVA, best corrected visual acuity; CMT, central macular thickness; GCC, ganglion cell complex.

Table 5. Pre-Neodymium-doped Yttrium Aluminum Garnet laser assessment results compared to 1-month post-Neodymium-doped Yttrium Aluminum Garnet laser assessment results.

	Pre-Nd:YAG laser		1 month post-Nd:YAG		Paired *t*-test	
	Mean	SD	Mean	SD	*t*	*P* value
BCVA	0.14	0.09	0.42	0.16	−18.733	0.001
CMT	250.46	27.51	247.71	24.58	1.525	0.130
Superior GCC count	96.53	22.89	93.13	13.09	1.799	0.075
Inferior GCC count	93.65	22.10	93.66	14.44	−0.005	0.996
Average GCC count	95.10	20.36	93.16	13.52	1.191	0.237

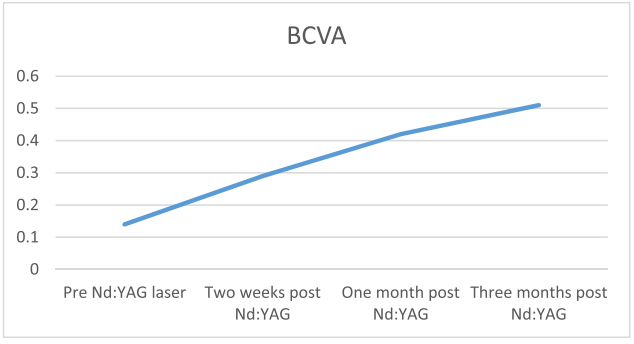
BCVA, best corrected visual acuity; CMT, central macular thickness; GCC, ganglion cell complex.

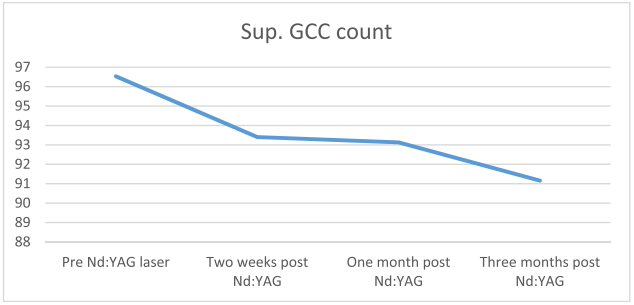
Table 6. Pre-Neodymium-doped Yttrium Aluminum Garnet laser assessment results compared to 3 months post-Neodymium-doped Yttrium Aluminum Garnet laser assessment results.

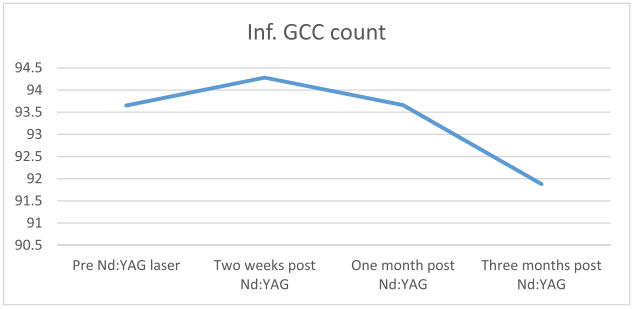
	Pre-Nd:YAG laser		3 months post-Nd:YAG		Paired *t*-test	
	Mean	SD	Mean	SD	*t*	*P* value
BCVA	0.14	0.09	0.51	0.17	−22.632	0.001
CMT	250.46	27.51	237.28	15.55	6.589	0.001
Superior GCC count	96.53	22.89	91.16	12.02	2.961	0.004
Inferior GCC count	93.65	22.10	91.88	11.41	0.971	0.334
Average GCC count	95.10	20.36	91.21	11.35	2.539	0.013

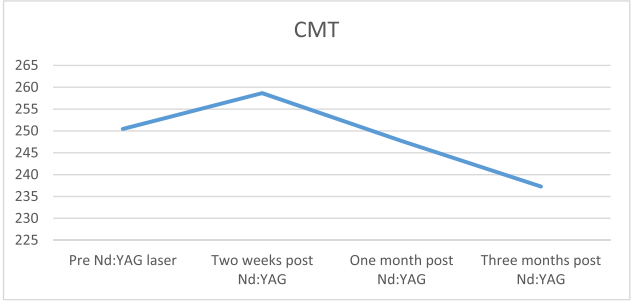
BCVA, best corrected visual acuity; CMT, central macular thickness; GCC, ganglion cell complex.

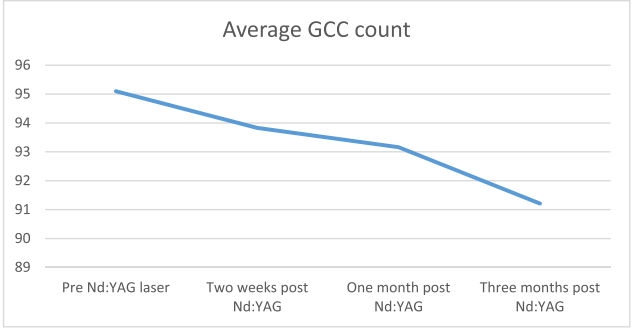
Post-Nd:YAG laser assessment results are shown in Tables 3–6.



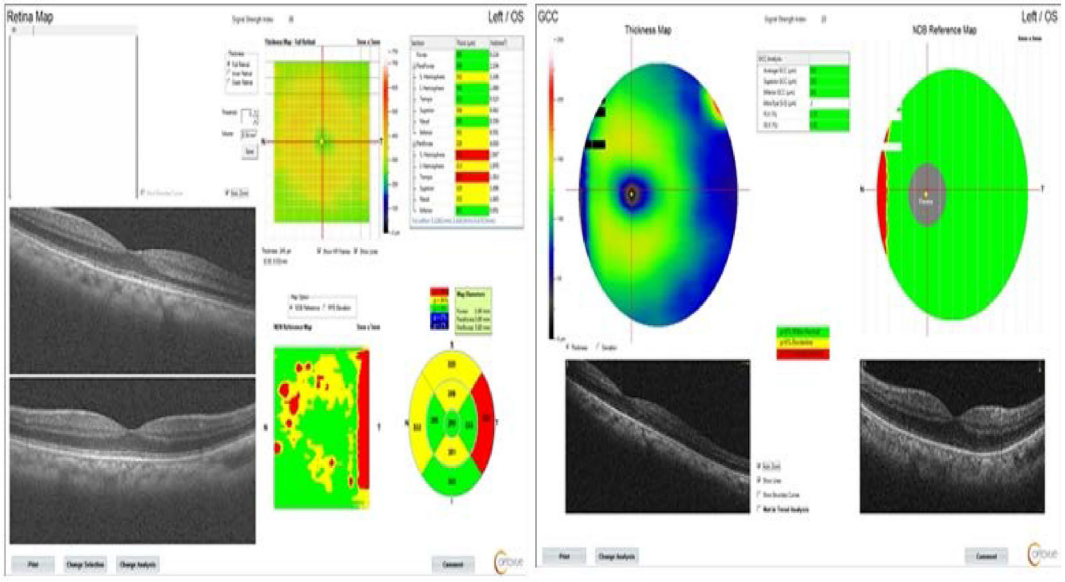




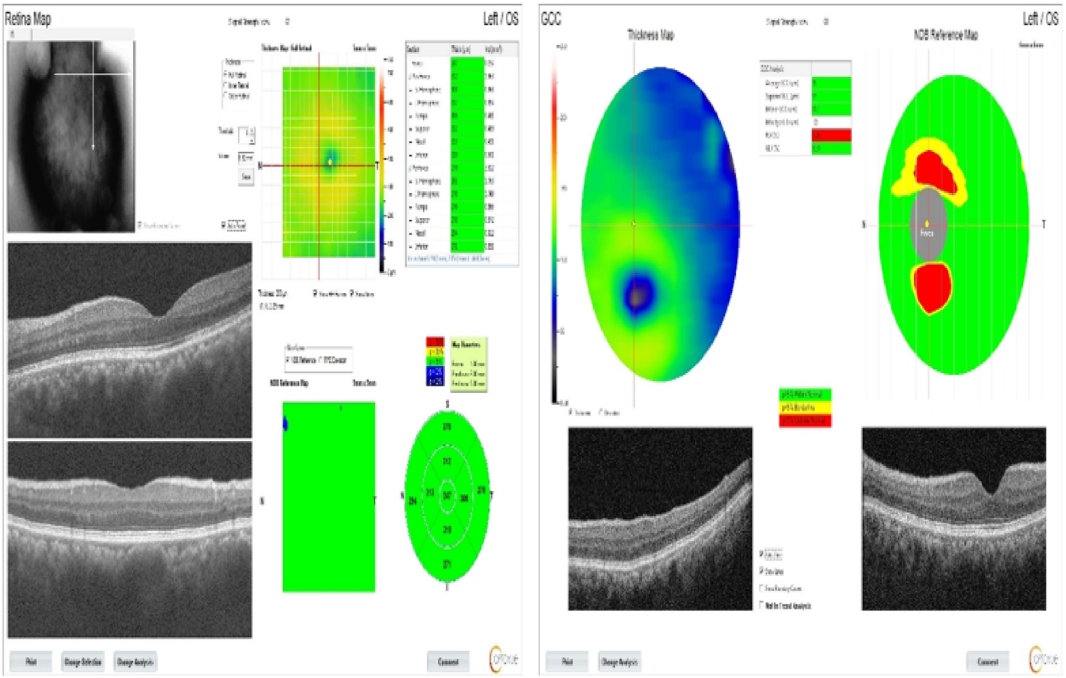




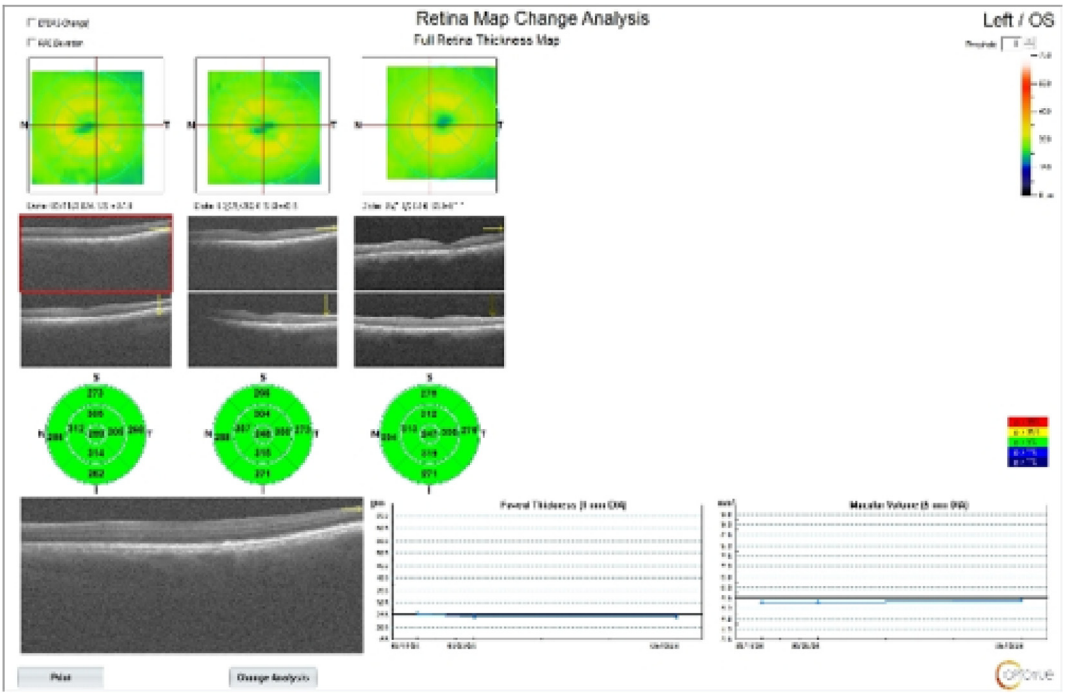
Case 1: OCT (CMT, GCC) pre-Nd:YAG laser.

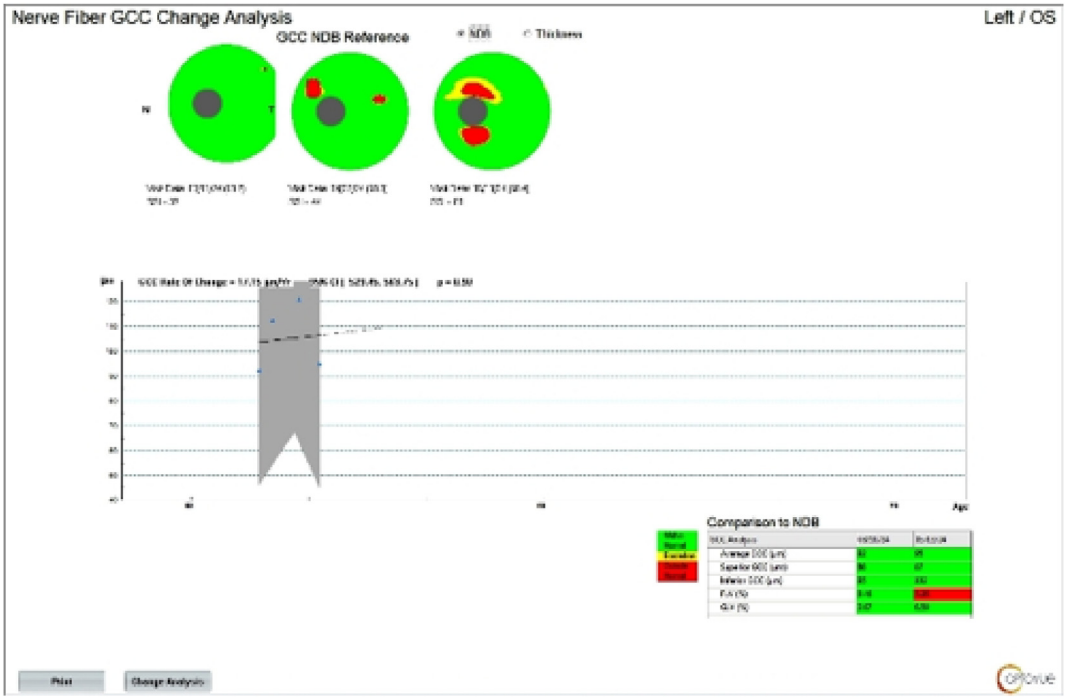


OCT (CMT, GCC) 3 months post-Nd:YAG laser.

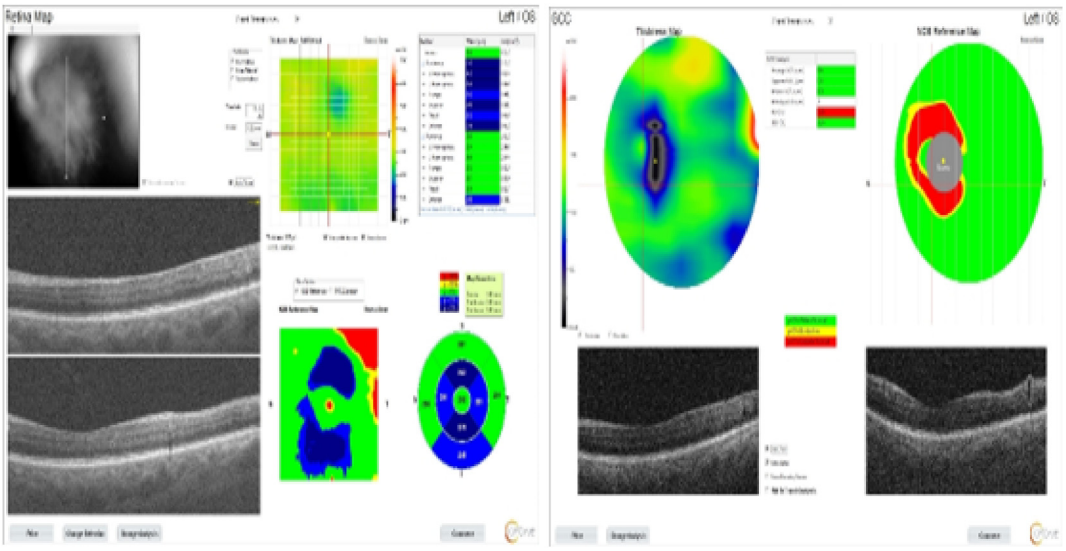


Serial OCT (CMT, GCC).

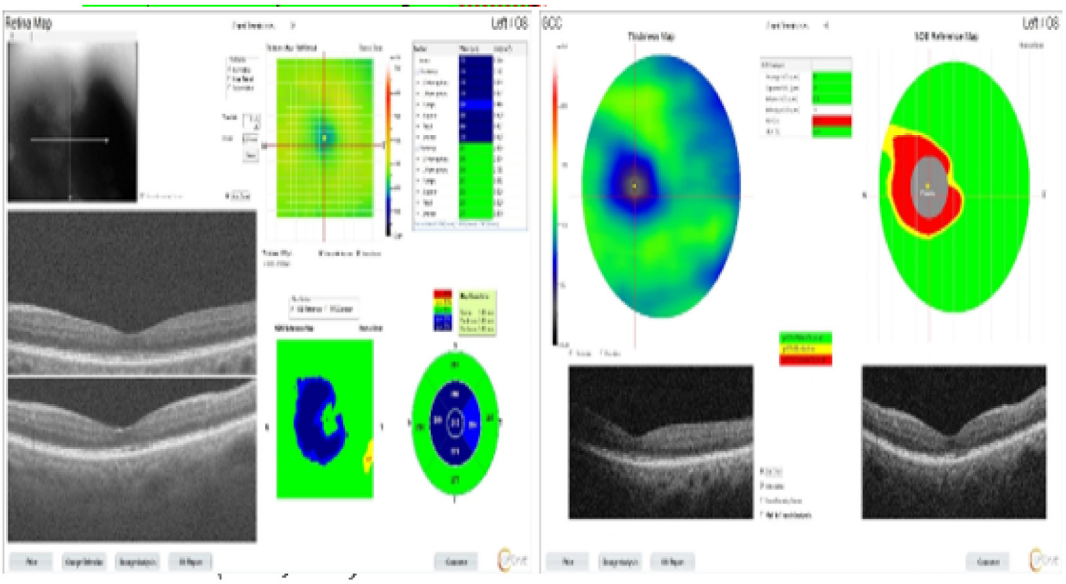




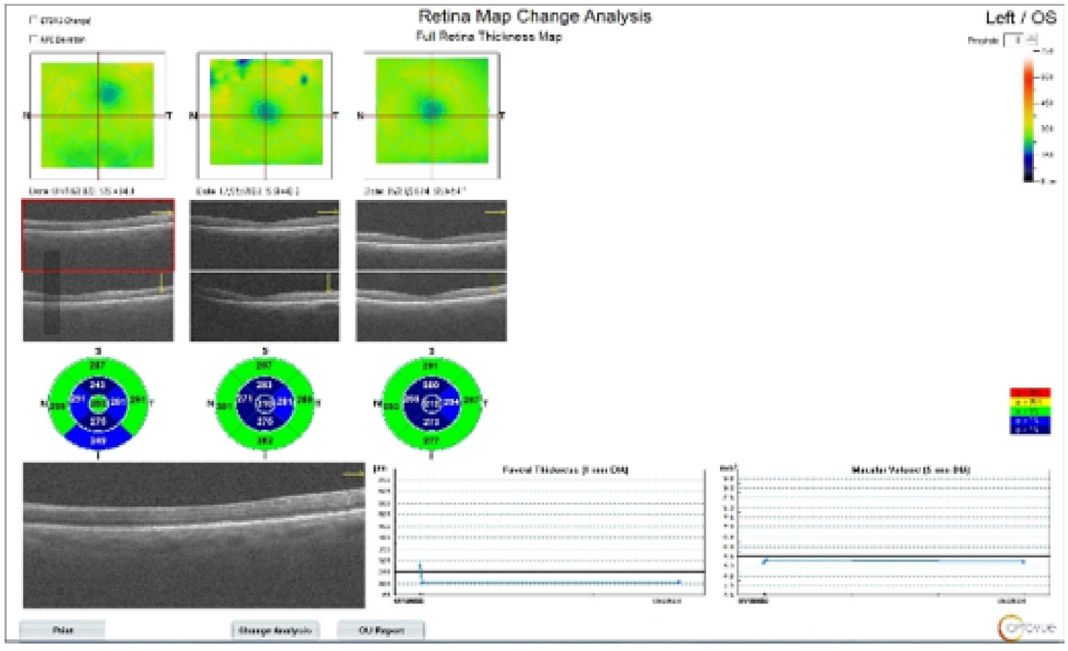
Case 2: OCT (CMT, GCC) pre-Nd:YAG laser.

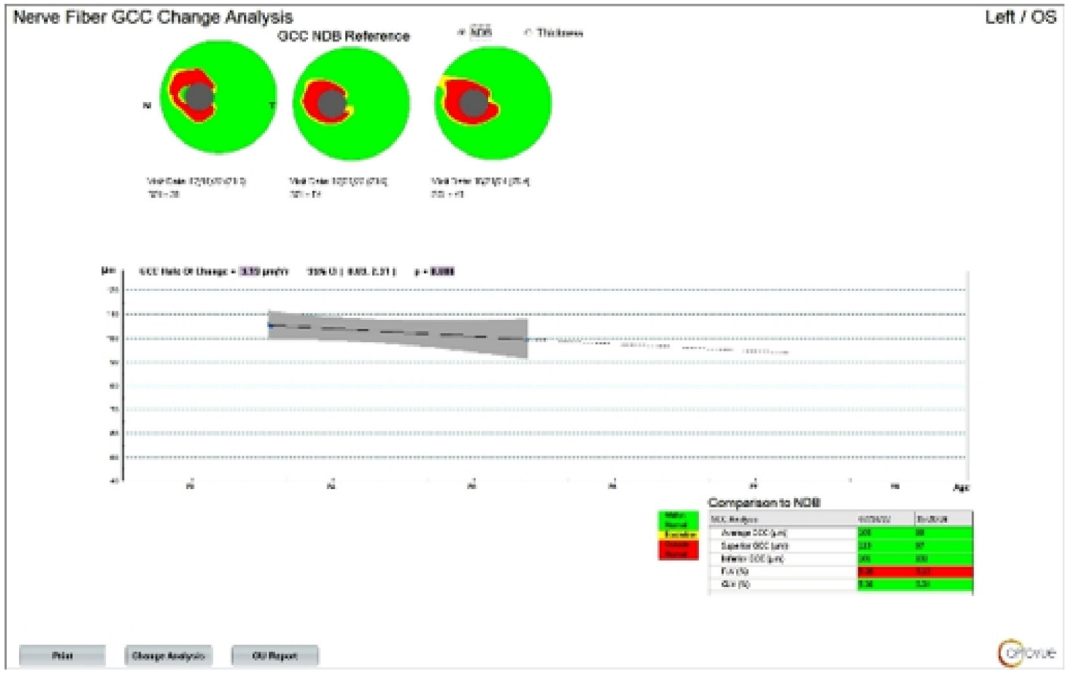


OCT (CMT, GCC) 3 months post-Nd:YAG laser.

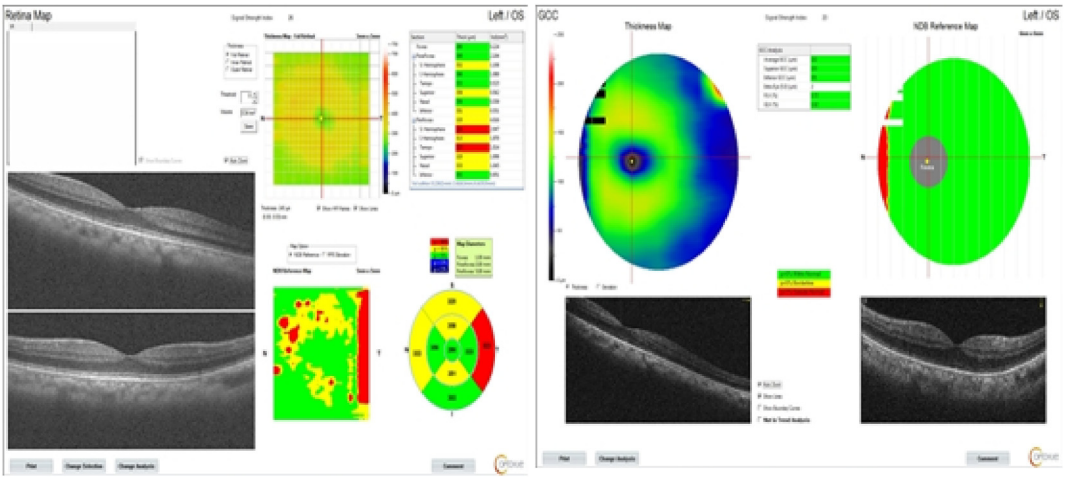


Serial OCT (CMT, GCC).

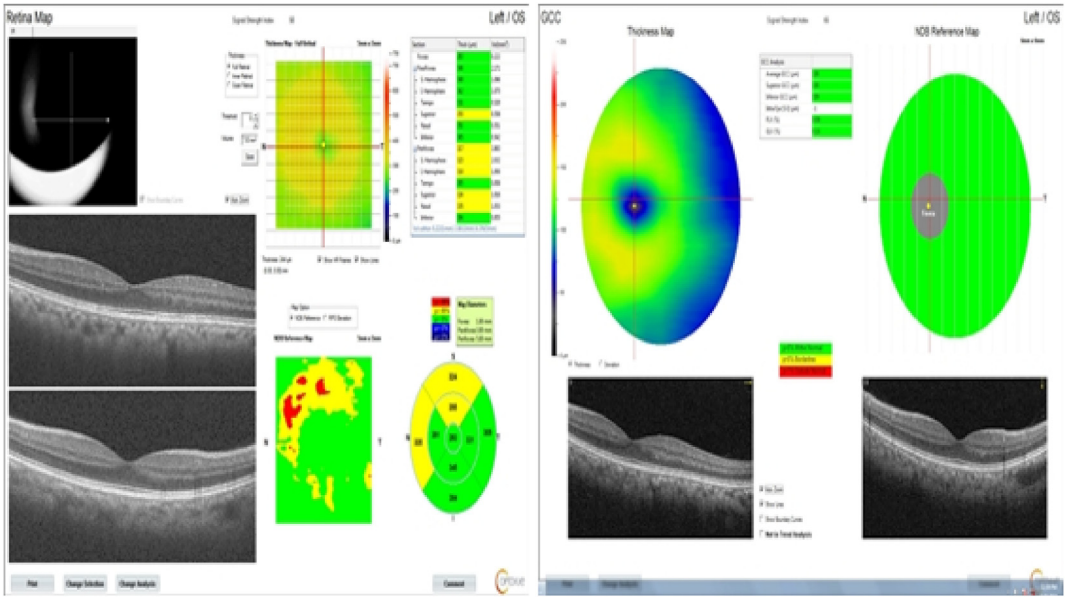




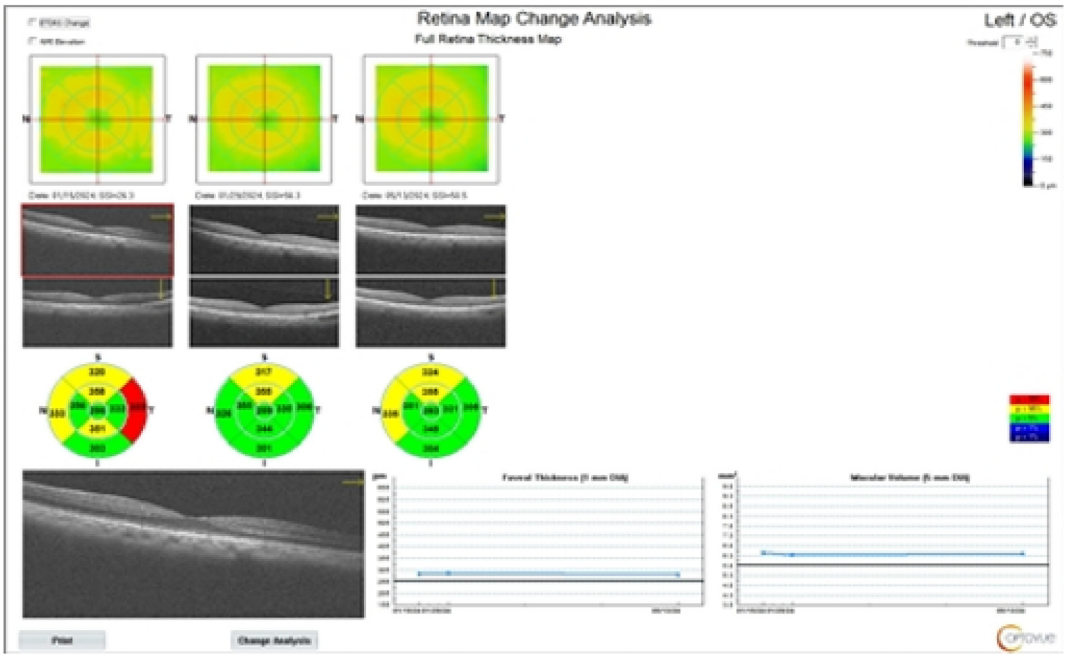
Case 3: OCT (CMT, GCC) pre-Nd:YAG laser.

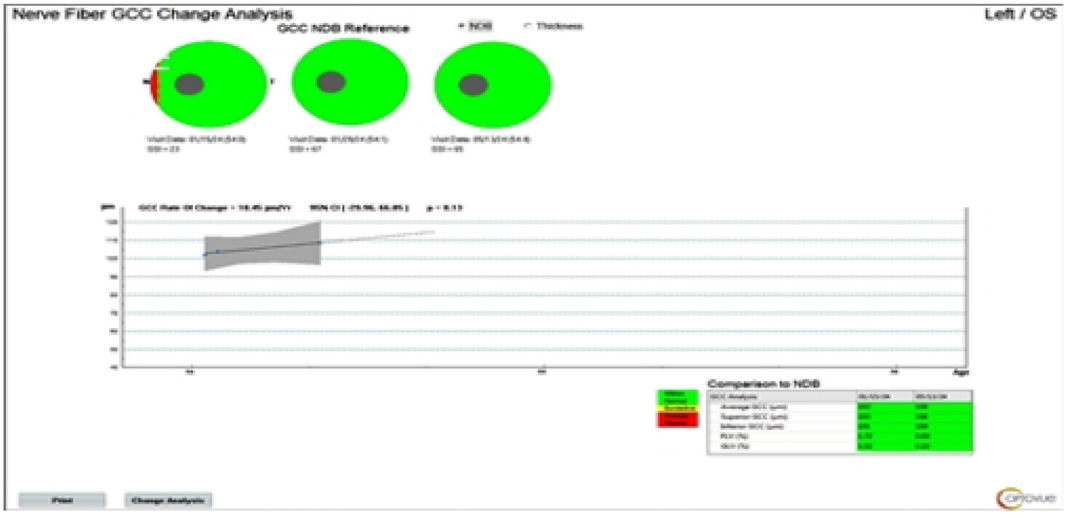


OCT (CMT, GCC) 3 months post-Nd:Yag laser:

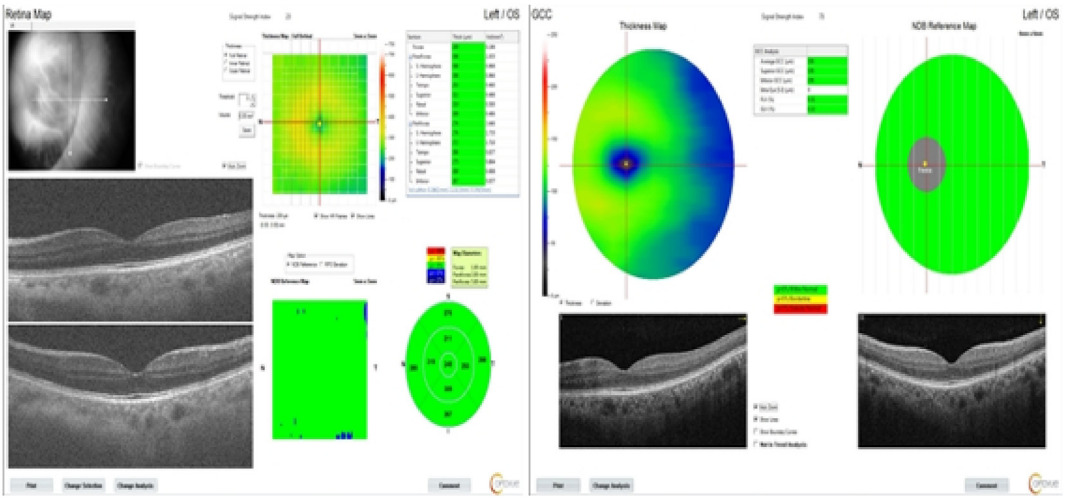


Serial OCT (CMT, GCC).

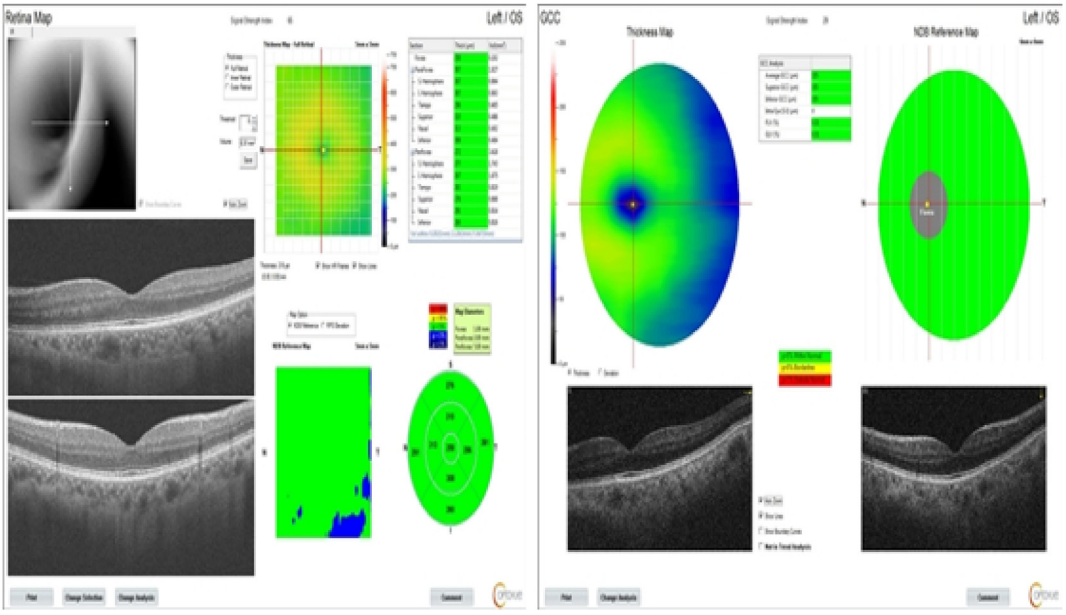




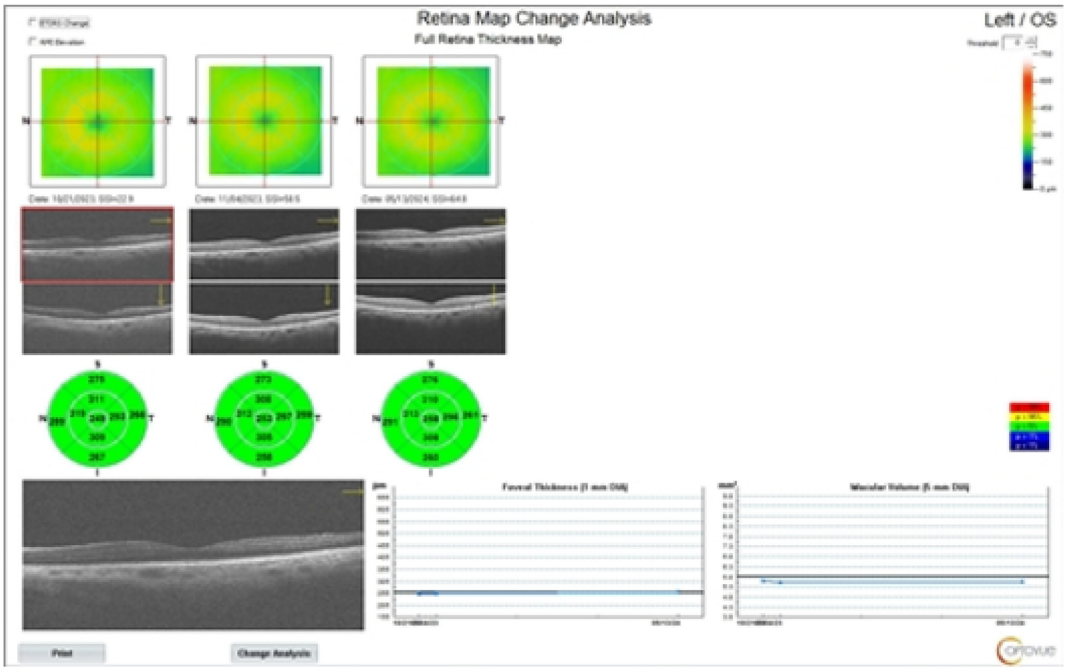
Case 4: OCT (CMT, GCC) pre-Nd:YAG laser.

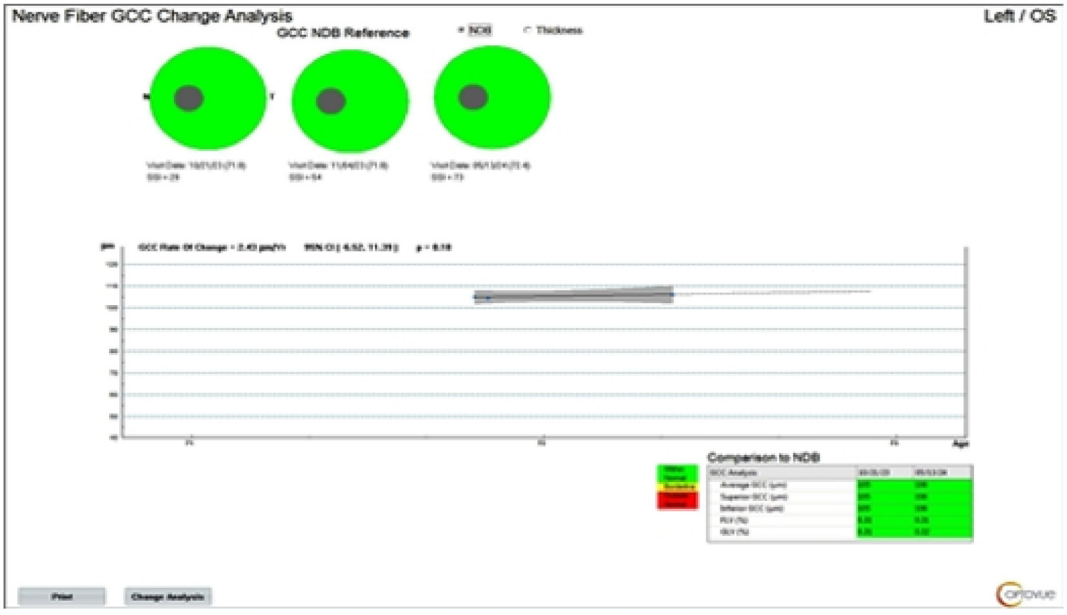


OCT (CMT, GCC) 3 months post-Nd:YAG laser.

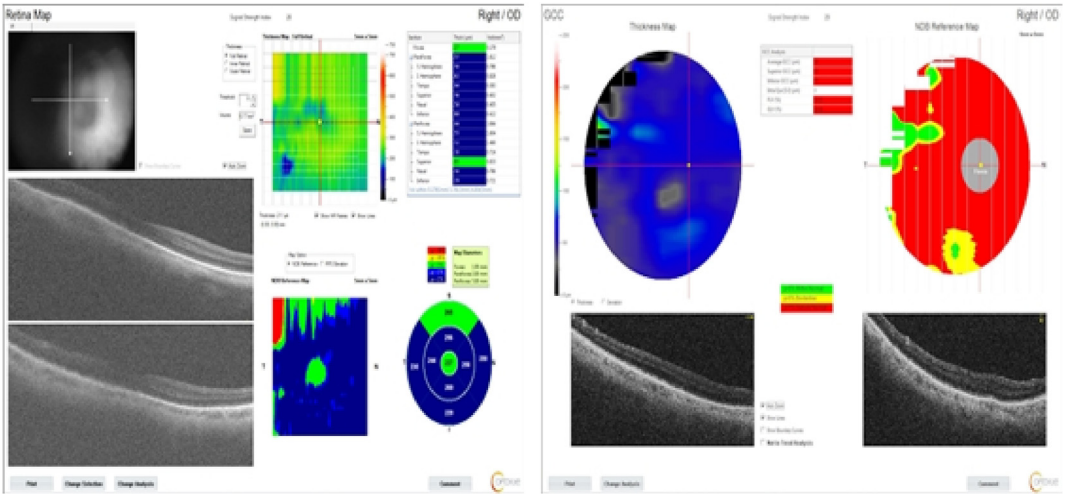


Serial OCT (CMT, GCC).

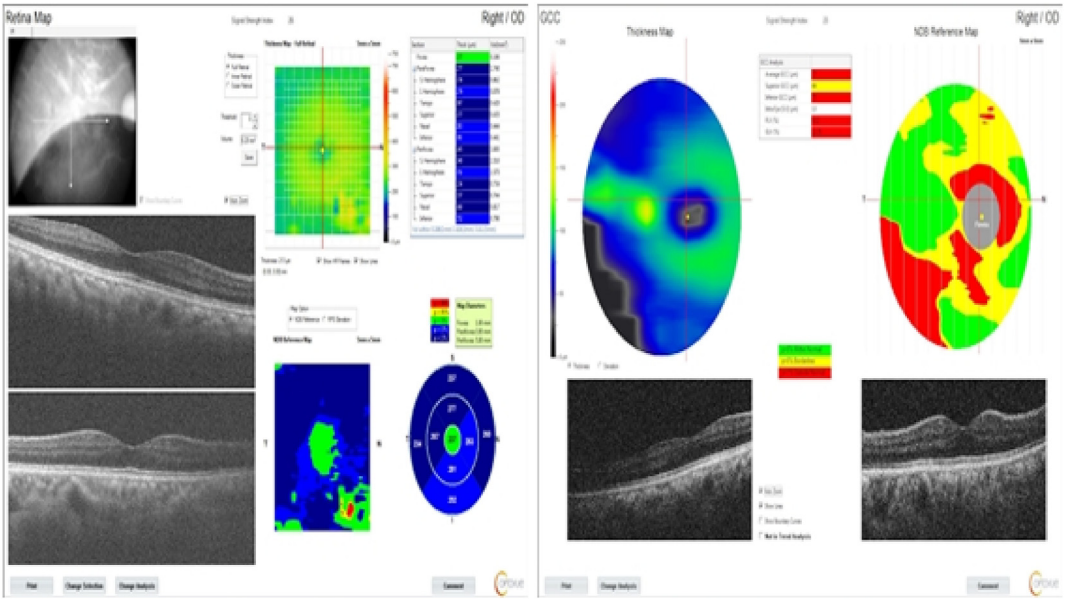




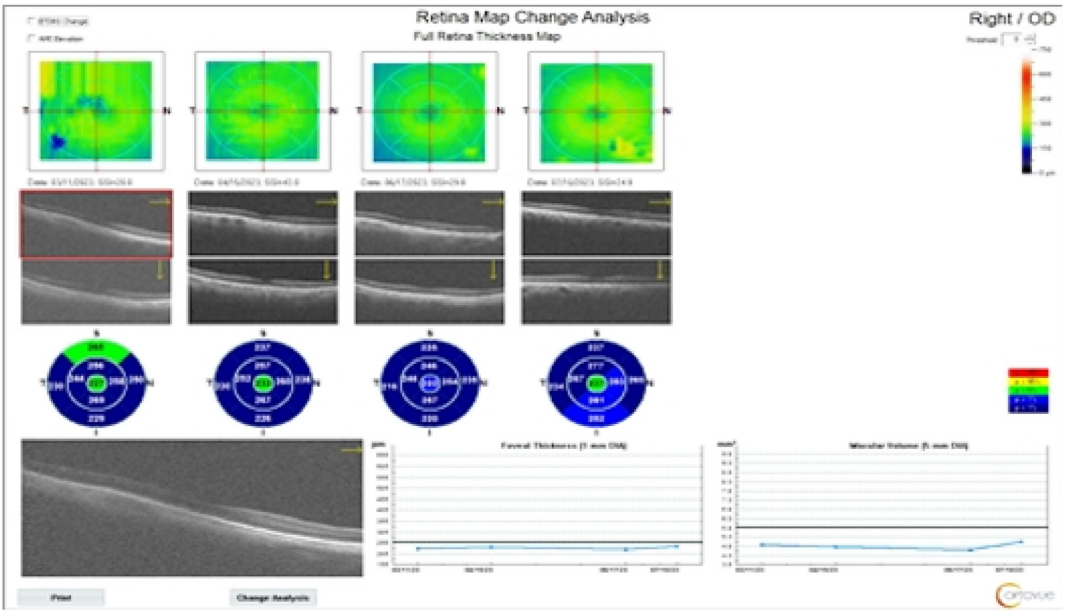
Case 5: OCT (CMT, GCC) pre-Nd:YAG laser.

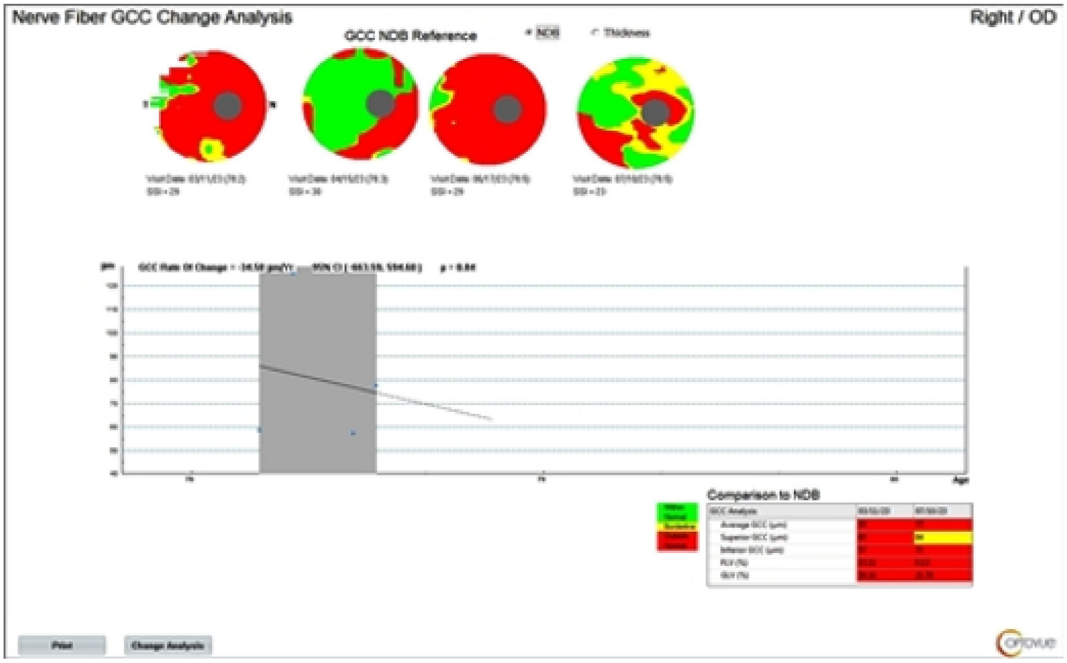


OCT (CMT, GCC) 3 months post-Nd:YAG laser.



Serial OCT (CMT, GCC).





5. Discussion

PCO, sometimes referred to as secondary cataract, is the most frequently reported side effect of contemporary cataract surgery. With a reported success rate of over 95 %, Nd:YAG laser surgery is the preferred technique for PCO cases [3].

After receiving a Nd:YAG laser, the present study found statistically significant improvements in BCVA after 2 weeks, 1 month, and 3 months. This

result is consistent with earlier findings published by Mayuri and Gautam [4], whose study involved 100 eyes, and Abdel-Hafez *et al.* [5], whose investigation involved 50 eyes. Similar findings were also reported by Kumar and Prasad, who studied 160 eyes and discovered that 95 % of the patients had improved visual performance. Similar findings were also reported by Kumar and Prasad [6], who studied 160 eyes and discovered that 95 % of the patients had improved visual performance. In a similar way, El-Kady *et al.* [7] demonstrated a statistically significant improvement in BCVA at follow-up compared to pre-session after conducting their study on 50 eyes.

A variety of findings from earlier research on CMT assessment with OCT following Nd:YAG laser posterior capsulotomy have been published. In comparison to its pre-Nd:YAG laser mean value, the current study showed a statistically significant increase at 2 weeks that reversed to a statistically significant drop at 3 months post-Nd:YAG laser. Karahan *et al.* [8] published findings that were essentially same, indicating a notable rise in CMT 1 week after Nd-YAG posterior capsulotomy, which returned to precapsulotomy levels 1 month later. Similarly, Abded-Hafez *et al.* [5] reported in 2019 a considerable increase in macular thickness when comparing preoperative and 1 week postoperatively. However, 3 months after surgery, there was no change in macular thickness. In contrast, Moneeb *et al.* [3] found no discernible variation in CMT between preoperative and 2 weeks postoperative periods. Yõlmaz and Yõlmaz [9] conducted a study in Turkey in 2017 that assessed CMT at intervals of 1 week, 4 weeks, 3 months, 6 months, and 1 year. The study did not find any significant changes in CMT. At a 3-month follow-up after the operation, Ruiz-Casas *et al.* [10] likewise documented little changes in CMT. The primary reason for the variations in the current study's results when compared to prior research could be the three different follow-up periods − 2 weeks, 1 month, and 3 months − in contrast to the 1-day, 1-week, and 1-month follow-up in the majority of earlier investigations. Variations in the age groups, characteristics, and energy consumed by the patients under study, as well as the time elapsed since their last cataract operation, can also affect the study's outcome.

5.1. Limitations

The relatively small sample size of this study is one of its weaknesses, which could have had an impact on the findings. Confirmation of the research findings will need more studies with a larger patient population across other sites. Furthermore, a longer follow-up time might be required to assess Nd's long-term effects: laser capsulotomy with YAG.

5.2. Conclusion

The Nd:YAG laser capsulotomy technique is a noninvasive, outpatient PCO therapy option that greatly increases BCVA with negligible short-term negative effects on GCC and CMT.

Ethics information

The study was approved by The institutional committee's ethical criteria were followed during all proceedings. The Ethics Committee of the Scientific Research, GOTHI, Ministry of Health, Egypt approved the study (No. HSO00003). Following an explanation of the purpose, procedures, and nature of the study to all participants, signed informed consent was obtained from each participant.

Funding

No funding.

Author contribution

Data collection, scientific writing and statistical analysis: Mohammed S. Ahmed, Alyaa A. Ahmed.

Institutional review board (IRB) approval number

HSO00003.

Conflict of interest

There are no conflicts of interest.

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