How to Cite:
Saif, M. Y. S., Awadein, A. R., Samir, A. M., El-Naggar, O. A., & El-Sawy, A. E.-D. I. M. (2022). Macular optical coherence tomography (OCT) changes in anisometropic amblyopia before and after part time occlusion treatment. *International Journal of Health Sciences*, *6*(S6), 11405–11417. https://doi.org/10.53730/ijhs.v6nS6.13171

Macular optical coherence tomography (OCT) changes in anisometropic amblyopia before and after part time occlusion treatment

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Abstract---Background: Amblyopia denotes unilateral (or rarely bilateral) decrease of best corrected visual acuity (BCVA) with no identifiable organic pathology of the eye or visual pathway. It results from vision deprivation and/or abnormal binocular interaction. Aim and objectives: The aim of work was to measure the thickness of macula, nerve fiber layer, and ganglion cell layer by the use of optical coherence tomography (OCT) in eyes with anisometropic amblyopia before and after part-time occlusion therapy. Patients and methods: It was a prospective comparative clinical study conducted during the period from June 2020 through December 2020 and Mattaria teaching hospital. The total sample size is 50 eyes of 50 participants. Each treatment should have a confidence level of 95% and a margin error of 5%. Results: There was a statistically significant difference in the central macular thickness when compared before and after amblyopia treatment (the difference was more than 10 µm in 11 patients, while it was less than 10 µm in the rest of the patients), while the difference was statistically insignificant in either average macular thickness or total volume. There was a statistically significant difference in the superior parafoveal quadrant when compared before and after

Manuscript submitted: 9 May 2022, Manuscript revised: 18 July 2022, Accepted for publication: 27 August 2022

amblyopia treatment (the difference was more than 10 μm in 7 patients, while it was less than 10 μm in the rest of the patients), whereas the difference was statistically insignificant in other parafoveal quadrants. There were statistically insignificant differences in all perifoveal quadrants when compared before and after amblyopia treatment. As regards RNFL thickness, GCL+, and GCL++, we found statistically insignificant differences when compared before and after amblyopia treatment Conclusion: There was increased mean central macular thickness as well as increased thickness of the superior quadrant of inner macula after part-time occlusion treatment if compared to those before treatment. On the other hand, there was NO significant difference in the average macular thickness, the thickness of outer macula, the thickness of three quadrants of inner macula (nasal, temporal, and inferior), the RNFL thickness, and the thickness of GCL+ and GCL++ after part-time occlusion treatment if compared to those before treatment.

Keywords---macular optical coherence tomography (OCT), anisometropic, amblyopia, BCVA.

Introduction

The term “amblyopia” is derived from the Greek words “amblyos” (which means dull) and “opia” (which means vision) (1). Amblyopia denotes unilateral (or rarely bilateral) decrease of best corrected visual acuity (BCVA) with no identifiable organic pathology of the eye or visual pathway. It results from vision deprivation and/or abnormal binocular interaction (2). Amblyopia can result from some disorders that occur in the early stages of life such as strabismus, refractive errors (ametropic and/or anisometropic), or visual deprivation. Amblyopia will not develop if such disorders occur later in life (3). Optical Coherence Tomography (OCT) is a recent mode of ophthalmic investigation. OCT uses a beam of partially coherent light to create tomographic images. Currently, there are two basic types of OCT: Time-domain OCT and Fourier-domain OCT. The former is used as an ophthalmic diagnostic tool (4). Although pattern electroretinograms were found to be significantly reduced in human amblyopic eyes, the retinal OCT changes are still inconclusive and controversial (5).

Patients and Methods

It was a prospective comparative clinical study conducted during the period from June 2020 through December 2020 and Mattaria teaching hospital. The total sample size is 50 eyes of 50 participants. Each treatment should have a confidence level of 95% and a margin error of 5%.

Ethical considerations

Approval of ethical committee of Beni-Suef University was taken. There was no obligation to participate in the study. Informed consents were signed from those who accepted to participate. Data were kept confidential and anonymous.

Participants were aware of the study steps. Participants were allowed to express their opinions and comments.

Inclusion criteria

Age: 6 to 12 years, Diagnosis: Anisometropic amblyopia, best-corrected visual acuity of the amblyopic eye < 6/12, est-corrected visual acuity of the sound eye: 6/12 or better, inter-eye visual acuity difference: ≥ 2 Snellen lines, no previous amblyopia therapy (other than spectacle correction).

Exclusion criteria

Other types of amblyopia e.g. strabismic, ametropic, or stimulus deprivation, mental retardation, ocular congenital anomalies, nystagmus, glaucoma, previous intraocular surgery and known skin reaction to patch or bandage adhesive.

Technique

All patients will undergo the following procedures:

- **Ophthalmological examination:** UCVA and BCVA (by Snellen chart), cycloplegic refraction (by cyclopentolate eye drops), anterior segment examination (by slit-lamp), fundus examination (by either indirect ophthalmoscopy or slit-lamp biomicroscopy) and motor evaluation. Patients with any tropia > 4 PD were excluded from the study
- **Macular OCT examination of the amblyopic eye:** By the use of Topcon OCT machine, the spectral domain OCT was used to measure the thickness of macula, nerve fiber layer (NFL), and ganglion cell layer (GCL): before part-time occlusion treatment, after 3 months of part-time occlusion treatment (2, 4 or 6 hours daily according to mild, moderate or severe amblyopia, respectively) and after additional 3 months of part-time occlusion treatment (if there is no improvement of amblyopia).

Statistical analysis

The collected data were coded to fit the program of statistical analysis i.e. statistical package for special sciences (SPSS) version 22 under windows 7.

Results

The present study included 50 patients: 24 females (47.5%) and 26 males (52.5%). The age ranged from 5 to 12 years (with a mean of 8.57 ± SD 2.52) (Table 1).

Table 1
Demographic data distribution of the study group

Demographic data	Total (n=50)
Sex Female	 24 (48%)

Male	26 (52%)
Age (years) Range Mean±SD	 6-12 8.57±2.52

Considering refraction of the study group, myopic patients were 31 (62%) with a mean of -7.07 ± SD 4.55, whereas hyperopic patients were 19 (38%) with a mean of +3.93 ± SD 1.96 (Table 2).

Table 2
Refraction distribution of the study group

Refraction	No.	%	Amblyopic eye		Sound eye		t-test	
			Range	Mean±SD	Range	Mean±SD	t	p-value
Myopia	31	62.0%	-16.75 to -1	-7.07±4.55	- 4.50 to -1	-2.75±1.02	5.156	<0.001**
Hyperopia	19	38.0%	1 to 8	3.93±1.96	1 to 2.50	1.75±0.65	-4.602	<0.001**
Total	50	100.0 %	-16.75 to 8	-3.22±6.51	-4.50 to 2.50	-1.00±0.37	-0.800	0.429

Using: Independent Sample t-test;
p-value >0.05 NS; *p-value <0.05; **p-value <0.001 HS

This table shows statistically significant difference between amblyopic eye and sound eye according to refraction about myopia and hyperopia, with p-value (p<0.001).

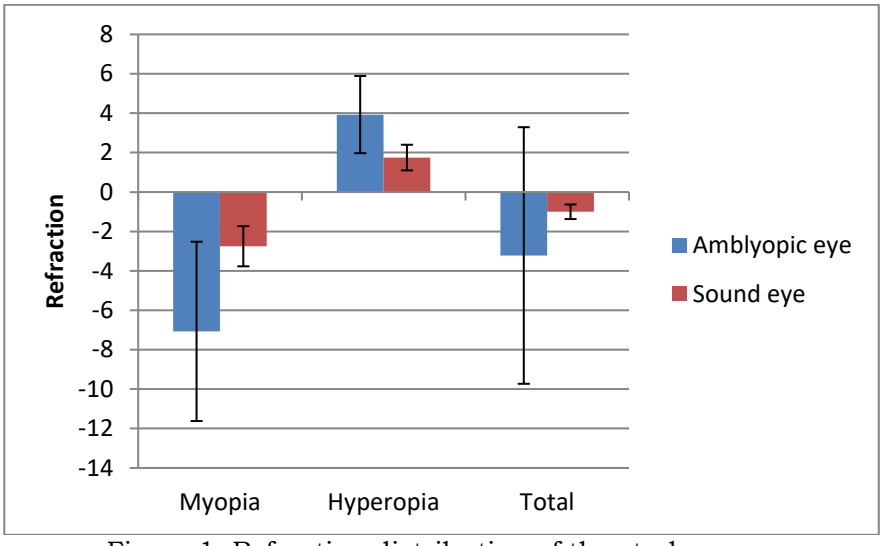

Figure 1. Refraction distribution of the study group

Table 3
Relation between refraction and improved of BCVA

Improved of BCVA		Refraction		Total
		Myopia	Hyperopia	
Yes	No.	28	13	41
	%	90.3%	68.4%	82.0%
No	No.	3	6	9
	%	9.7%	31.6%	18.0%
Total	No.	31	19	50
	%	100.0%	100.0%	100.0%

Using: Fisher's exact (p=0.067).

Of the 31 myopic patients, 28 (91.3%) had improvement in visual acuity after occlusion therapy, while 3 (9.7%) patients had not. On the other hand, from 19 hyperopic patients, 13 (68.4%) patients had improvement in visual acuity after occlusion therapy, while 6 (31.6%) patients had not. As regards amblyopia, the right eye was amblyopic in 26 patients (52%), whereas the left eye was amblyopic in 24 patients (48%) (Table 3). Considering BCVA, there was a statistically significant difference before and after amblyopia treatment (Table 4).

Table 4
Improvement of visual acuity of amblyopic eye distribution of the study group

BCVA	Total (n=50)
Improved	41 (82%)
Not improved	9 (18%)

Table 5
Comparison between BCVA before and after amblyopia treatment

BCVA (LogMar)	Range	Mean±SD	Mean Diff.	Wiloxon rank test	
				z-test	p-value
Before	0-0.7	0.182±0.186	0.002	-0.045	0.964
After	0-0.7	0.184±0.183			

The range of BCVA in the amblyopic eyes before occlusion therapy was 0-0.7 (logMAR), the mean BCVA was 0.182±0.186 (logMAR). The range of BCVA in the amblyopic eyes after occlusion therapy was 0-0.7 (logMAR), the mean BCVA was 0.184±0.183 (logMAR). There was a statistically significant difference in the central macular thickness when compared before and after amblyopia treatment (the difference was more than 10 µm in 11 patients, while it was less than 10 µm in the rest of the patients), while the difference was statistically insignificant in either average macular thickness or total volume. There was a statistically significant difference in the superior parafoveal quadrant when compared before and after amblyopia treatment (the difference was more than 10 µm in 7 patients, while it was less than 10 µm in the rest of the patients), whereas the difference was statistically insignificant in other parafoveal quadrants.There were statistically insignificant differences in all perifoveal quadrants when compared

before and after amblyopia treatment. As regards RNFL thickness, GCL+, and GCL++, we found statistically insignificant differences when compared before and after amblyopia treatment (Fig.1 and 2).

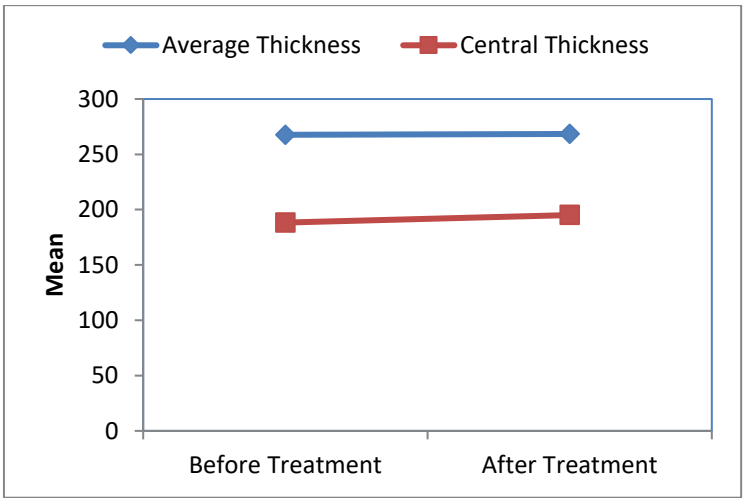

Figure 1. Pre-treatment VS. Post-treatment OCT macula (average thickness and central thickness)

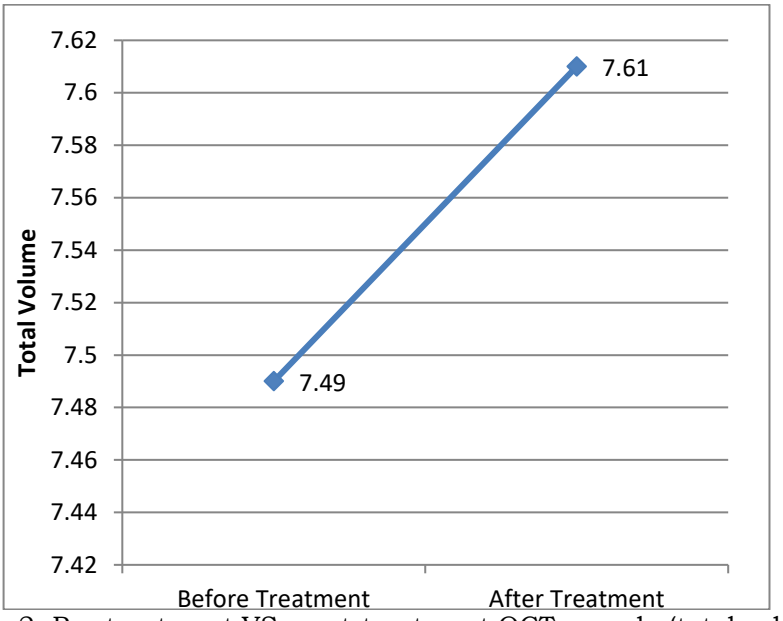

Figure 2. Pre-treatment VS. post-treatment OCT macula (total volume)

This table shows statistically significant higher mean difference in improved in BCVA compared to not improved in BCVA according to central thickness and superior, with p-value ($p<0.05$); while the rest have insignificant. Figure 3, 4, 5

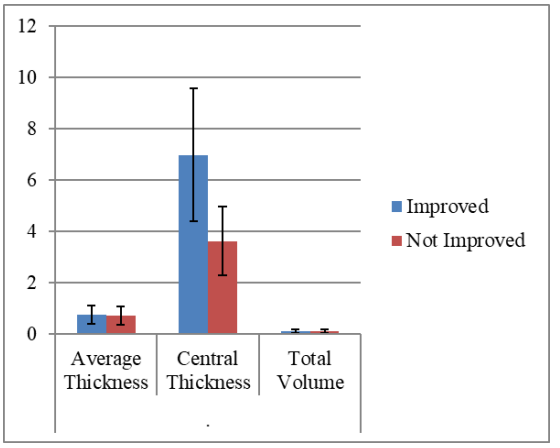

Figure 3. Comparison between improved and not improved of BCVA according to change (before-after) of OCT macula about average thickness, central thickness and total volume

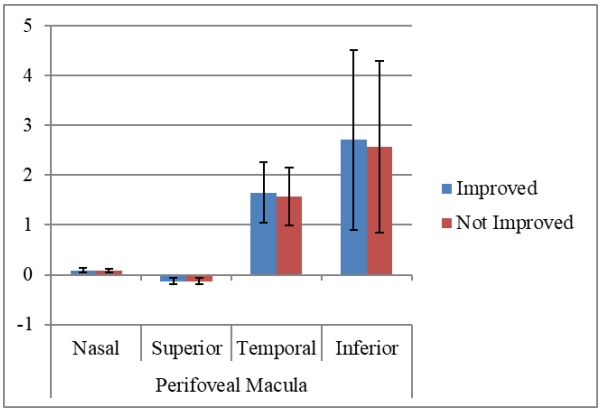

Figure 4. Comparison between improved and not improved of BCVA according to change (before-after) of OCT macula about perifoveal macula

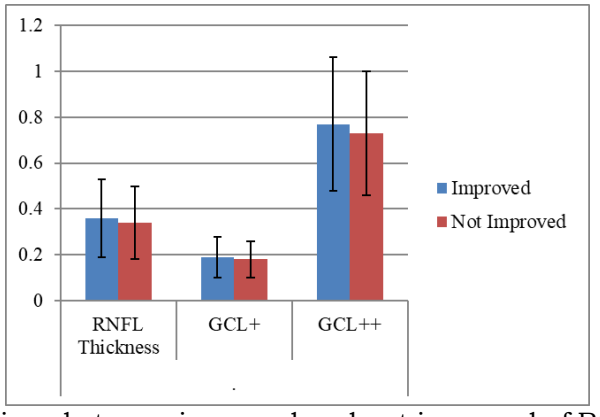

Figure 5. Comparison between improved and not improved of BCVA according to change (before-after) of OCT macula about RNFL thickness, GCL+ and GCL++

Case 1

A 10-year-old girl; Post-cycloplegic refraction was as follows: Right eye: -6.00 sphere -3.00 x 5° axis cylinder and left eye: -1.50 spheres. BCVA: Right eye (amblyopia): 6/18 (before treatment) and 6/12 (after treatment) and Left eye: 6/6. Anterior segment and fundus examination: Normal. IOP: Normal (17 mm Hg bilaterally). Ocular motility examination: Ortho. OCT examination: as shown in figures 21, 22, 23, and 24.

Before treatment

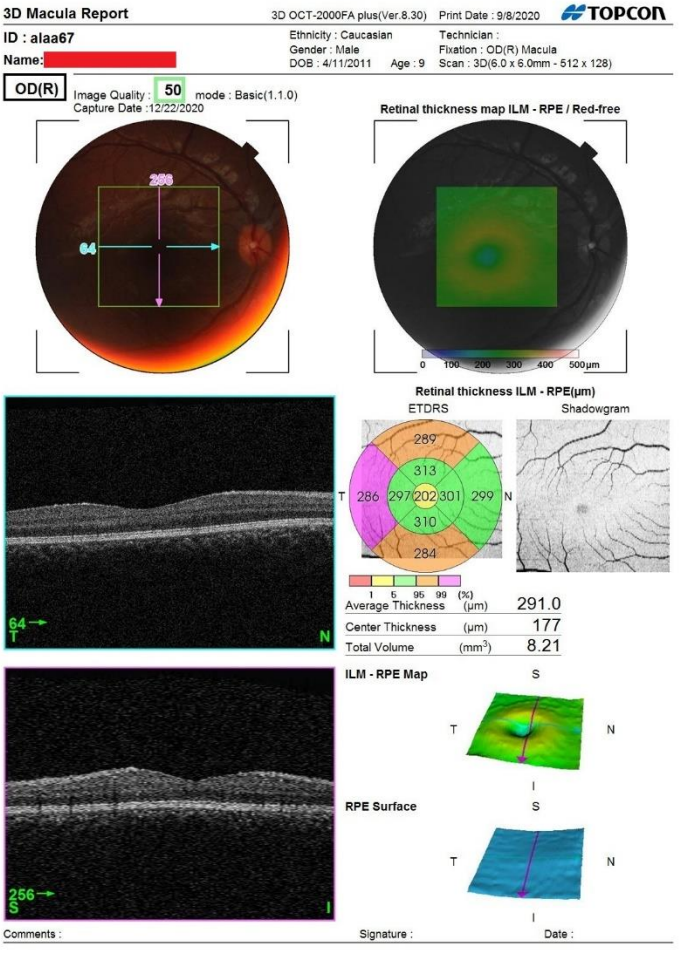

Figure 6. macular analysis print of case1 before treatment (OD) expressed by Topcon OCT machine (original picture)

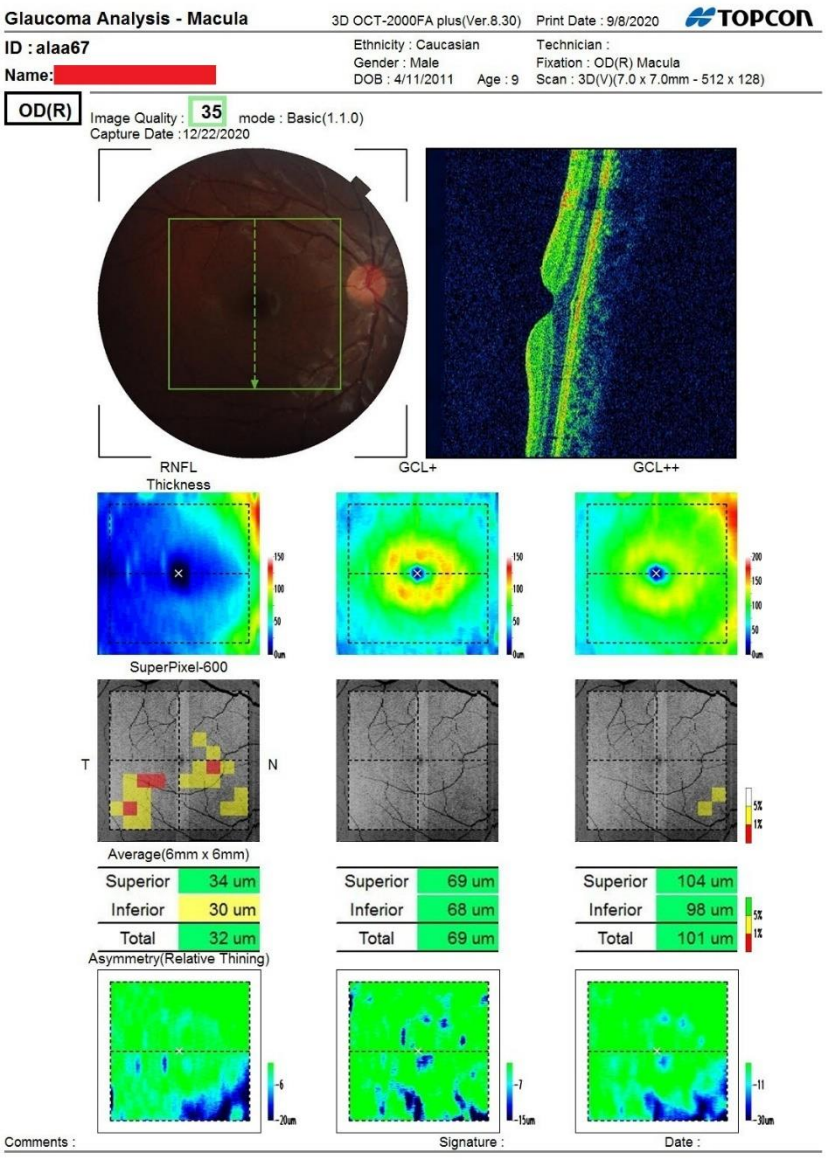

Figure 7. GCL and RNFL analysis print of case1 before treatment (OD) expressed by Topcon OCT machine (original picture)

After treatment

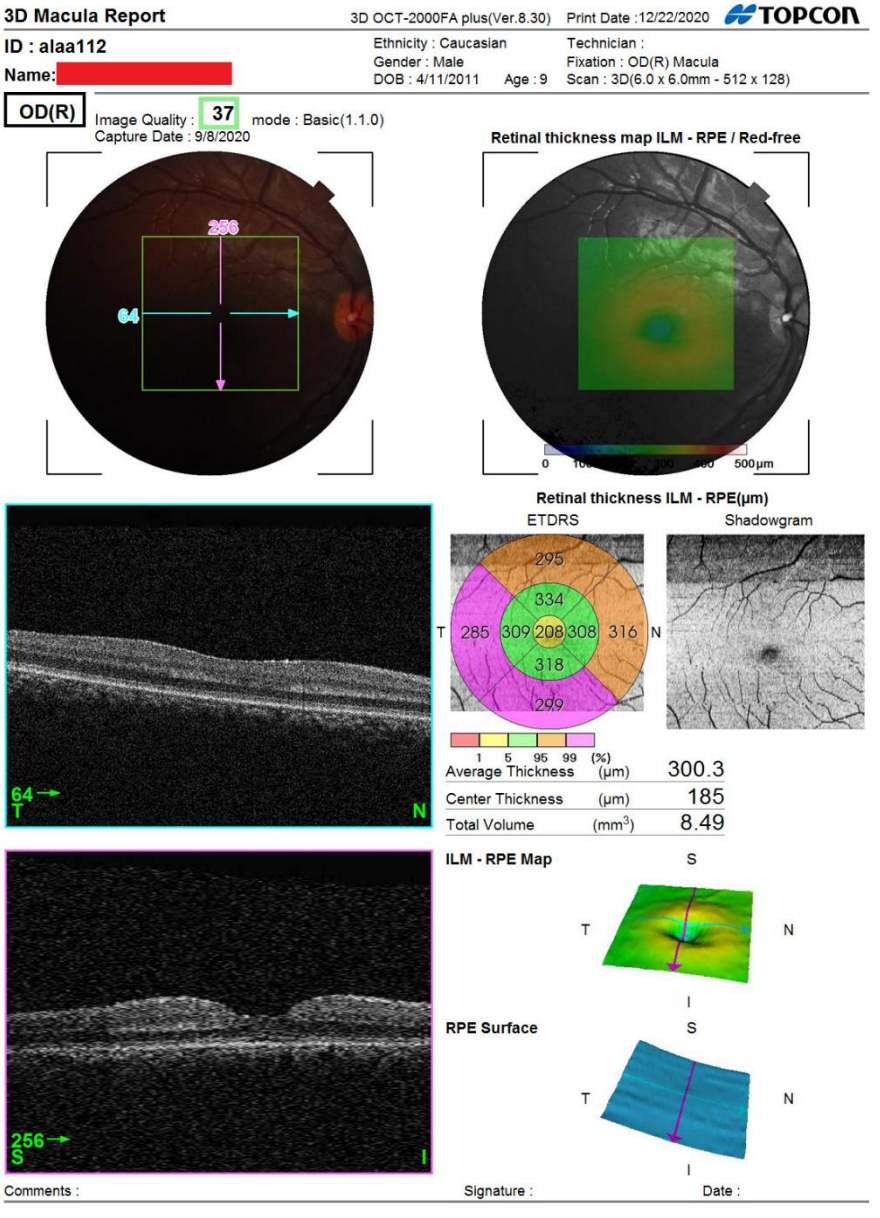

Figure 8. macular analysis print of case1 after treatment (OD) expressed by Topcon OCT machine (original picture)

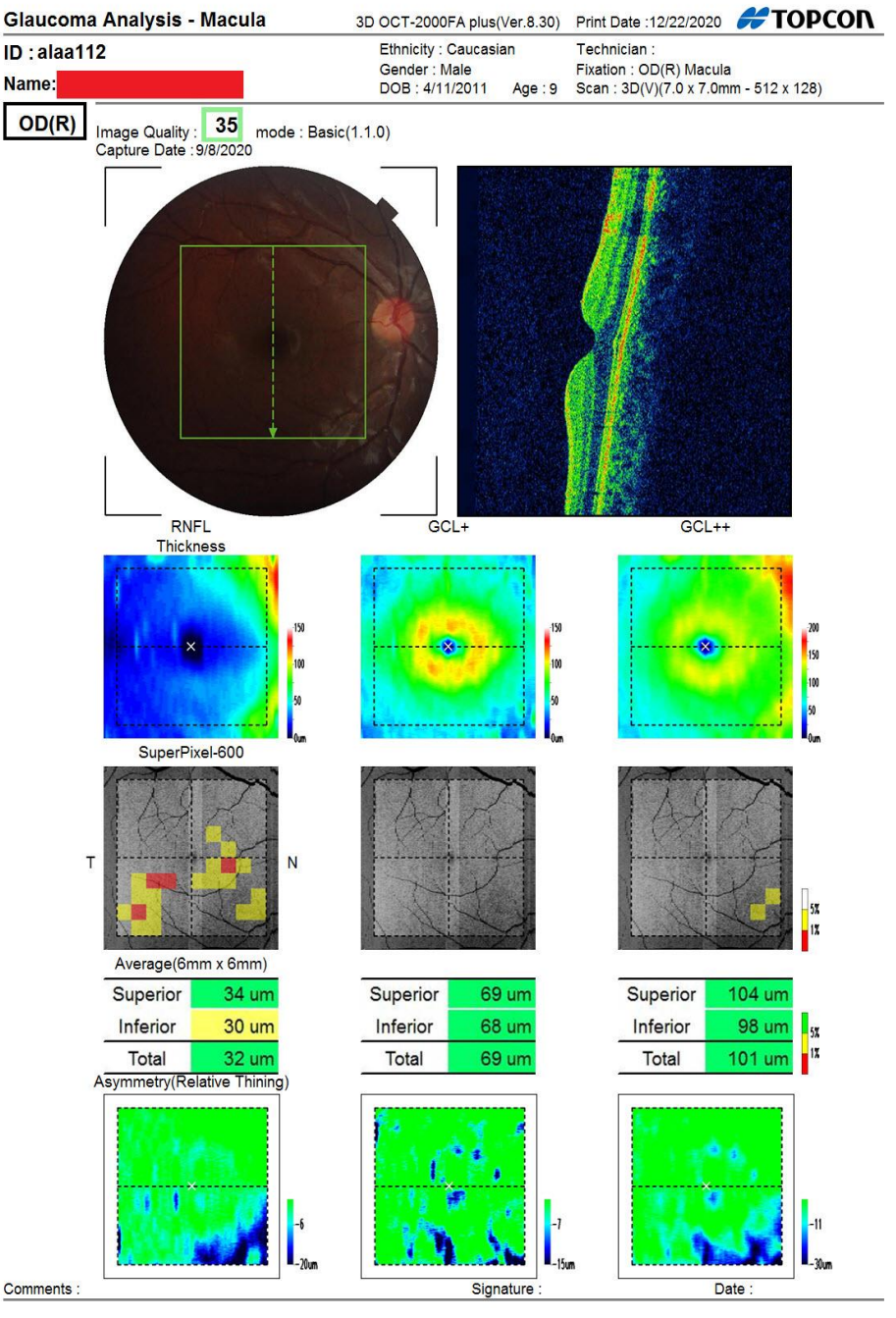

Figure 9. GCL and RNFL analysis print of case1 after treatment (OD) expressed by Topcon OCT machine (original picture)

Discussion

By examination of more than eighty amblyopic patients in the out-patient clinic, there were fifty patients who presented with inclusion criteria, from whom only thirty patients were free of exclusion criteria. Such fifty patients have undergone pre-treatment OCT macula, part-time occlusion treatment (1week / year of age), and then post-treatment OCT macula. The mean macular thickness, RNFL thickness and GCL thickness have been extensively studied before and after part-time occlusion treatment using OCT. Our study has revealed that part-time occlusion treatment resulted in a significant increase in the mean central macular thickness as well as in the superior quadrant of inner macula. On the other hand, our study has revealed insignificant difference in the average macular thickness, in the thickness of three quadrants of inner macula (nasal, temporal, and inferior), in the thickness of outer macula, in RNFL thickness, and in the thickness of GCL+ and GCL++.

Tugcu et al. (6) have studied the macular thickness of 14 amblyopic eyes with persistent amblyopia (BCVA ≤ 20/25) as well as 18 amblyopic eyes with resolved amblyopia (BCVA > 20/25). They have revealed no significant difference in macular thickness between the two groups. However, eyes with persistent amblyopia started with worse logMAR BCVA (0.5 vs. 0.3) but achieved the same degree of visual improvement (3 logMAR lines) when compared with eyes with resolved amblyopia. These circumstances might contribute to their conclusion of insignificant difference between the two groups.

Chun-Hsiu Liu et al. (7) have studied 44 amblyopic patients; some of whom had persistent amblyopia while others had recovered amblyopia. They have reported no difference in either macular or choroidal thickness between the two groups. Huynhet al. (8) investigated 33 treated and 12 untreated unilateral amblyopic patients (due to either strabismus or hyperopic anisometropia). They found greater minimal foveal thickness as well as average foveal thickness in amblyopic eyes if compared with normal fellow eyes. In contrast, they found that the thickness of both inner and outer macula was lesser in amblyopic eyes if compared with the fellow eyes.

Anna Dickmann, et al, (9) reported that only macular and foveolar thickness values were slightly higher in the ―strabismic‖ amblyopic eyes than in the Fellow (sound) eyes (MT was 267 ± 14 and 253 ± 14 in the amblyopic and fellow eyes respectively), but such difference was not observed in the anisometropic amblyopic group (MT was 257 ± 20 and 256 ± 18 in the amblyopic and fellows eyes respectively), the study compared amblyopic and fellow groups both to a control group, and was limited to small sample size: (40 cases, 20 for each subgroup), with inclusion of a wide age range (ranged from 5 to 56 years). The same was the result of Dema Andalib, et al, study, except for comparing amblyopic to fellow eyes (10). The variations in such study results are probably attributed to different study parameters such as study populations, criteria definition, type of amblyopia, type of refractive error, and used measuring instruments.

Conclusion

There was increased mean central macular thickness as well as increased thickness of the superior quadrant of inner macula after part-time occlusion treatment if compared to those before treatment. On the other hand, there was NO significant difference in the average macular thickness, the thickness of outer macula, the thickness of three quadrants of inner macula (nasal, temporal, and inferior), the RNFL thickness, and the thickness of GCL+ and GCL++ after part-time occlusion treatment if compared to those before treatment

References

1. Alotaibi, A. G., & Al Enazi, B. (2011). Unilateral amblyopia: Optical coherence tomography findings. Saudi Journal of Ophthalmology, 25(4), 405-409.
2. Andalib, D., Javadzadeh, A., Nabai, R., & Amizadeh, Y. (2013). Macular and retinal nerve fiber layer thickness in unilateral anisometropic or strabismic amblyopia. Journal of Pediatric Ophthalmology & Strabismus, 50(4), 218-221.
3. Dickmann, A., Petroni, S., Salerni, A., Dell'Omo, R., & Balestrazzi, E. (2009). Unilateral amblyopia: an optical coherence tomography study. Journal of American Association for Pediatric Ophthalmology and Strabismus, 13(2), 148-150.
4. Donahue, S. P. (2005). The relationship between anisometropia, patient age, and the development of amblyopia. Transactions of the American Ophthalmological Society, 103, 313.
5. Huynh, S. C., Samarawickrama, C., Wang, X. Y., Rochtchina, E., Wong, T. Y., Gole, G. A., et al. (2009). Macular and nerve fiber layer thickness in amblyopia: the Sydney Childhood Eye Study. Ophthalmology, 116(9), 1604-1609.
6. Liu, C. H., Ong, S. J., Huang, C. Y., Wu, W. C., Kao, L. Y., & Yang, M. L. (2018). Macular thickness, foveal volume, and choroidal thickness in amblyopic eyes and their relationships to the treatment outcome. Journal of Ophthalmology, 2018.
7. Machoy, M., Seeliger, J., Szyszka-Sommerfeld, L., Koprowski, R., Gedrange, T., & Woźniak, K. (2017). The use of optical coherence tomography in dental diagnostics: a state-of-the-art review. Journal of healthcare engineering, 2017.
8. Salmon, J. (2019). Kanski's Clinical Ophthalmology E-Book: A Systematic Approach. Elsevier Health Sciences.
9. Szigeti, A., Tátrai, E., Szamosi, A., Vargha, P., Nagy, Z. Z., Németh, J., et al. (2014). A morphological study of retinal changes in unilateral amblyopia using optical coherence tomography image segmentation. PloS one, 9(2), e88363.
10. Tugcu, B., Araz-Ersan, B., Erdogan, E. T., Tarakcioglu, H., Coskun, C., Yigit, U., et al. (2014). Structural and functional comparison of the persistent and resolved amblyopia. Documenta Ophthalmologica, 128(2), 101-109.