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Evaluation of Retinal Nerve Fiber Layer Thickness in Axial High Myopic Patients after Uncomplicated Phacoemulsification

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Background: On examining the RNFL thickness by OCT, the media opacity caused by cataract will increase light scattering
and absorption, so the RNFL thickness measurement can be increased after uncomplicated cataract surgery also, inflammatory reaction by mechanical injury of phacoemulsification surgery, traction reaction of optic nerve head induced by parts of vitreous liquefaction in ultrasonic emulsification process, with the addition of optic neuropathy from ultrasonic energy. For all above, these factors could increase NFL thickness.
Aim: Evaluation of retinal nerve fiber layer thickness in axial high myopic patients after uncomplicated phacoemulsification.
Patients and Methods: Our patients collected from outpatient clinic of Ophthalmology department; Tanta University and outpatient clinic at Ophthalmology department of Matarya Teaching Hospital during the period from December 2019 to June 2020 and extended to December 2020 due to Covid_19 pandemic.
Results: This study including 20 eyes of high axial myopic cataracts patients (group Ⅰ) and 10 eyes of normal cataracts patients (group II) from which age range between (50-70) years old , males were (30%) and females were (70%) in group Ⅰ and males (50%) were equal to female (50%) in group II.

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Conclusion: There is a significant increase in thickness of peripapillary RNFL measured by OCT after 1 week of uncomplicated phacoemulsification cataract surgery. This increase in thickness occurs as the media opacity caused by cataracts increases the light scattering and absorption thus affects the quality of measurements which improves after cataract extraction.

Keywords: Optical coherence tomography; time domain; spectral domain dnaretinal nerve fiber layer.

1. INTRODUCTION

Cataract is a clouding of the lens in the eye which leads to a decrease in vision. Cataracts often develop slowly and can affect one or both eyes. Symptoms may include faded colors, blurry vision, halos around light, trouble with bright lights, and trouble seeing at night [1].

Cataracts are most commonly due to aging but may also occur due to trauma or radiation exposure, be present from birth, or occur following eye surgery for other problems. The underlying mechanism involves accumulation of clumps of protein or yellow-brown pigment in the lens that reduces transmission of light to the retina at the back of the eye. The only treatment for cataract is surgery to remove the cloudy lens and replace it with an artificial lens [2].

Phacoemulsification cataract surgery is a procedure in which an ultrasonic device is used to break up and then remove a cloudy lens, or cataract, from the eye to improve vision with insertion of an intraocular lens [3].

High myopia is defined as refractive error above -6.0 D and axial eyeball length above 26 mm. High myopia and its complications are considered to be one of the most significant causes of blindness and visual impairment in young people [4].

Optical coherence tomography (OCT) provides high resolution objective and quantitative measurements of the optic disc parameters and RNFL thickness. The recent introduction of spectral domain (SD)-OCT technology offers significant advantages over the previous time domain (TD)-OCT, allowing 3-D imaging of the retina and optic disc with ultra-high acquisition speed and ultra high resolution [5].

The retinal nerve fiber layer (RNFL) is formed by the expansion of the fibers of the optic nerve; it is thickest near the optic disc, gradually diminishing toward the ora serrata [6].

RNFL is a sensitive structure. Some process can excites its natural apoptosis. Harmful situation can make some damage on RNFL such as high intraocular pressure, high fluctuation on phase of intraocular pressure, inflammation, vascular disease and any kind of hypoxia. Sudden intraocular fluctuation in any kind of intraocular surgeries may be harmful to RNFL due to ischemic effect caused from micro emboli that clog micro vessels and from mechanical stress on sudden compression [7].

1.1 Aim of the Work

Evaluation of retinal nerve fiber layer thickness in axial high myopic patients after uncomplicated phacoemulsification.

1.2 Patients and Methods

1.2.1 Study design

This present study is a prospective comparative study. It includes 30 eyes diagnosed of having cataract. Patients were classified into two groups. Group (1) (high myopic group) of 20 eyes with axial length more than or equal to 26 mm and group (2) (control group) of 10 eyes with normal axial length.

Our patients collected from outpatient clinic of Ophthalmology department; Tanta University and outpatient clinic at Ophthalmology department of Matarya Teaching Hospital during the period from December 2019 to June 2020 and extended to December 2020 due to Covid_19 pandemic.

All patients were gone to receive complete explanation of the nature and purpose of the study.

All the names of the participants will be hidden and replaced by a code number to maintain their privacy and confidentiality of the data.

1.2.2 Inclusion criteria

- Patients aged from 50y to 80y (the common age group of senile cataract diagnosis).

- Cataract patients with nuclear grades 2 or 3 and posterior subcapsular cataract.

1.2.3 Exclusion Criteria

- Patients with history of glaucoma

- Patients with any media opacity as corneal opacity or vitreous opacity interfering with OCT imaging

- Uneven operative procedure or postoperative complication

- Pre-existing diseases of the vitreous, retina or optic nerve

- Complicated cataract cases were be excluded from our study

- Patients with any history of previous intra ocular surgery or ocular trauma.

- Cataract with nuclear grade 1 or ≥ grade 4

1.3 Methods

Ophthalmological evaluation (history, examination and investigations) by use of a pre-designed checklist in conjunction with a designed database computerized program for data entry and analysis.

1.4 Pre-operative Preparation

Detailed medical & ophthalmic history

Complete ophthalmic examination

- **Visual acuity assessment**

Unaided, aided and pin hole using Landolt (C) broken ring chart.

- **Refraction**

Using autorefractometer if possible.

- **External examination**

Lids, lashes, lacrimal apparatus and orbit.

- **Examination of ocular alignment and motility**

- Examination of ocular motility in the nine positions of gaze.

- **Assessment of pupillary function**, (shape, position, regularity and reactivity to light).

- **Intra-ocular pressure measurement**

Using goldman applanation tonometer.

- **Slit-Lamp biomicroscopic examination.**

- **Fundus examination**

For examination of the macula and optic disc (by Volk's non- contact double aspheric biconvex lens (power:+90D), peripheral retina (by Indirect ophthalmoscopy) and vitreous.
Contact B- scan
Biometry using (LENSTAR) made in Switzerland
Laboratory investigations including:
- CBC-INR
- HCV-AB & HBV-Ag
- Random blood glucose for all patients
- Fasting, post-prandial and HBA1C in diabetic patients
- Corneal & Conjunctival swap for culture
Hospital admission the day before operation

The pre-operative OCT scan was done the day before operation using TOPCON30 OCT-machine made in EUROPE

Contact B- scan

1.5 Statistical Analysis

Statistical presentation and analysis of the present study was conducted, using the Median, IQR, Person's Correlation Coefficient, by SPSS V20.

2. RESULTS

Show Table (1) and Fig. (1). There is significant increase in RNFL post- operative 1 week and gradual increase in RNFL thickness after 1 month of operation.

Show Table (2) and Fig. (2).There is significant increase in RNFL post- operative 1 week and gradual increase in RNFL thickness after 1 month of operation.

Show Table (3) and Fig. (3). Significant change in RNFL thickness 1 month post- operative between 2 groups.

Table 1. Correlation between change in RNFL thickness in pre-operative - post-operative 1 week and pre-operative -post-operative 1 month in group I

Person's Correlation Coefficient				
Group I	**Range**	**Median**	**Pre -Post 1 Week**	
Peri Papillary RNFL	1.49 - 17.65	4.43	r	P-value
Pre -Post 1 Month	6.6 - 58.82	17.81	0.819	<0.001*

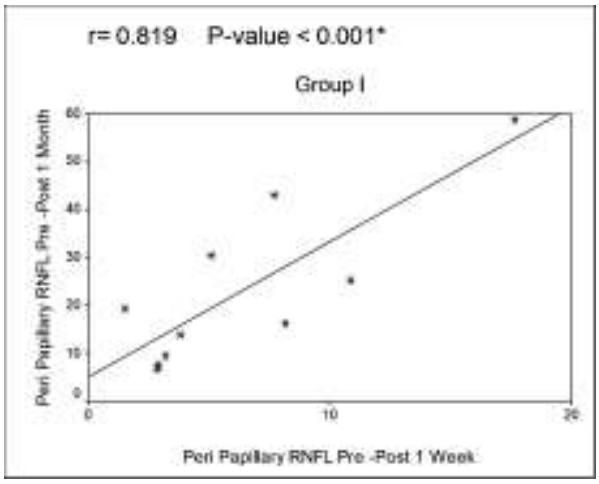

Fig. 1. Correlation between change in RNFL thickness in pre-operative - post-operative 1 week and pre-operative -post-operative 1 month in group I

Table 2. Correlation between change in RNFL thickness in pre-operative - post-operative 1 week and pre-operative - post-operative 1 month in group II

Person's Correlation Coefficient				
Group II	**Range**	**Median**	**Pre -Post 1 Week**	
Peri Papillary RNFL	1.68 – 3.42	2.63	r	P-value
Pre -Post 1 Month	3.45 – 7.69	6.01	0.526	0.018*

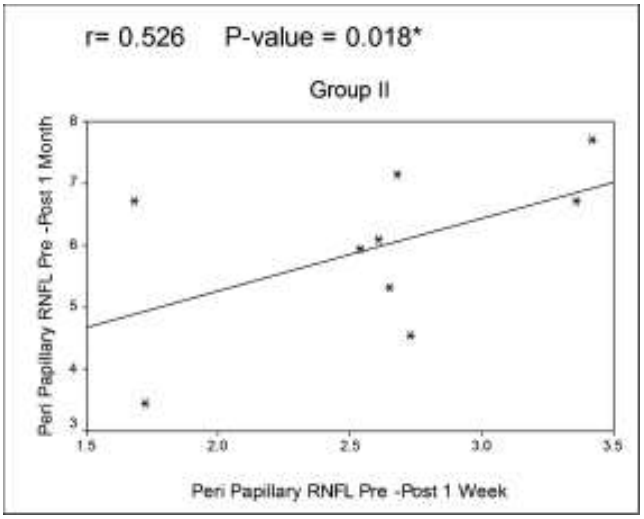

Fig. 2. Correlation between change in RNFL thickness in pre-operative - post-operative 1 week and pre-operative -post-operative 1 month in group II

Table 3. Correlation between change in RNFL thickness in pre-operative-post-operative 1 month and pre-operative - post-operative 1 month in 2 groups

Person's Correlation Coefficient		
	Peri Papillary RNFL % of Change Group I Pre -Post 1 Month	
	r	**P-value**
Peri Papillary RNFL % of Change Group II Pre -Post 1 Month	-0.484	0.031*

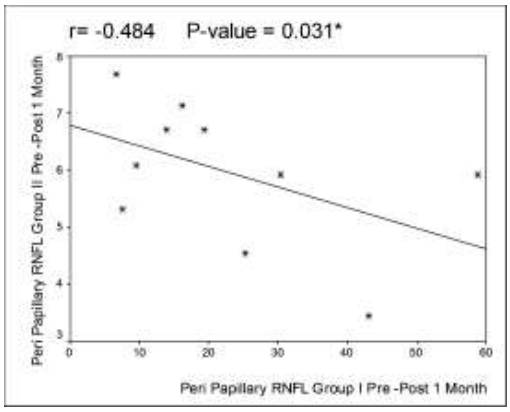

Fig. 3. Correlation between change in RNFL thickness in pre-operative - post-operative 1 month and pre-operative - post-operative 1 month in 2 groups

3. CASE PRESENTATION

Case 1.

Case 1 Group 1.

Female patient 52 years, medically free, with nuclear cataract grade 2 and BCVA was 6/60

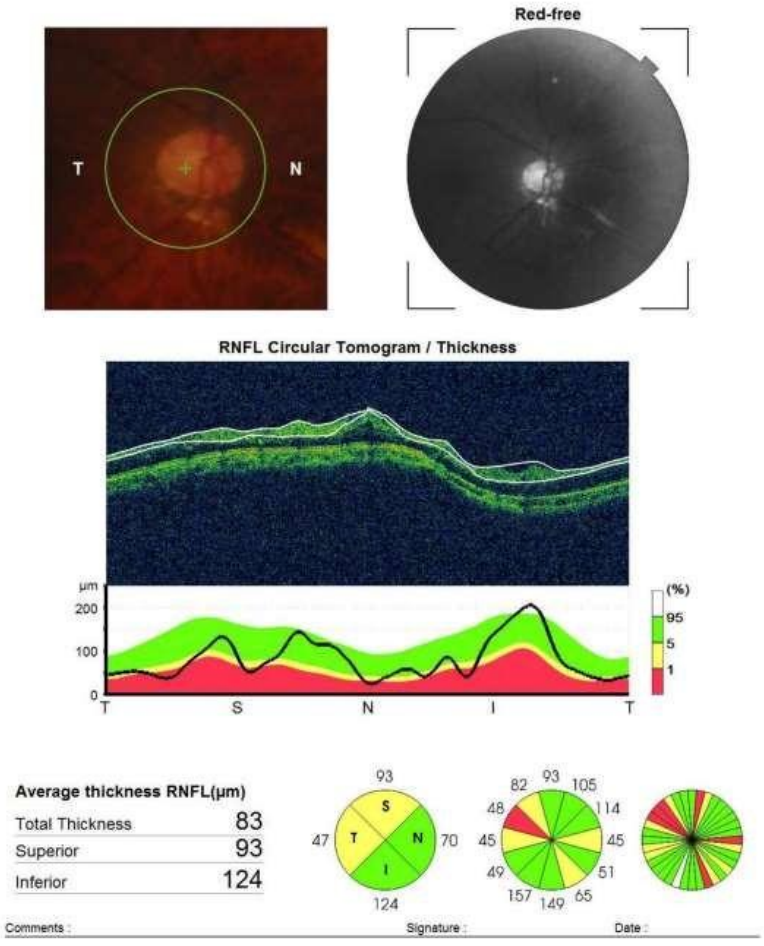

Fig. 4. OCT showing Peripapillary RNFL preoperative

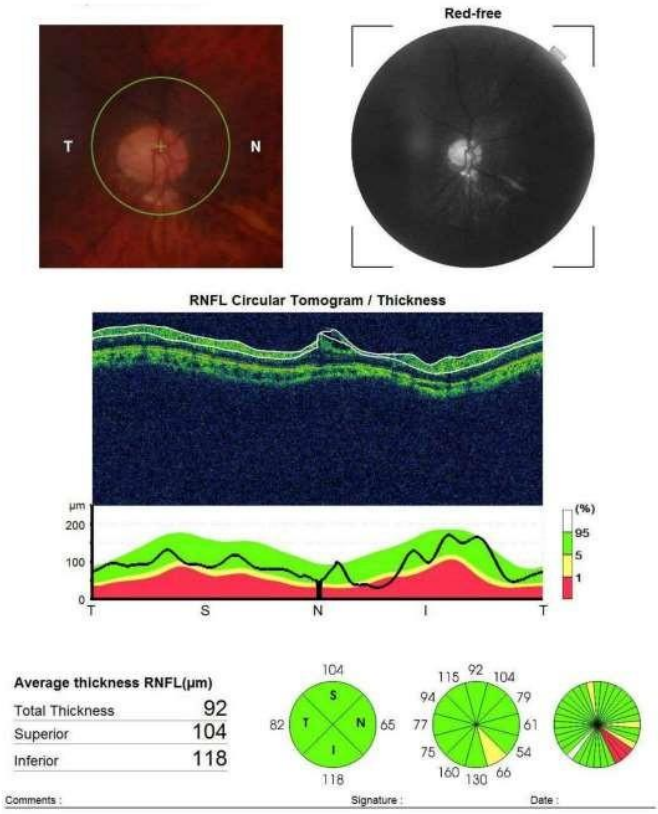

Fig.5. OCT showing Peripapillary RNFL postoperative one week

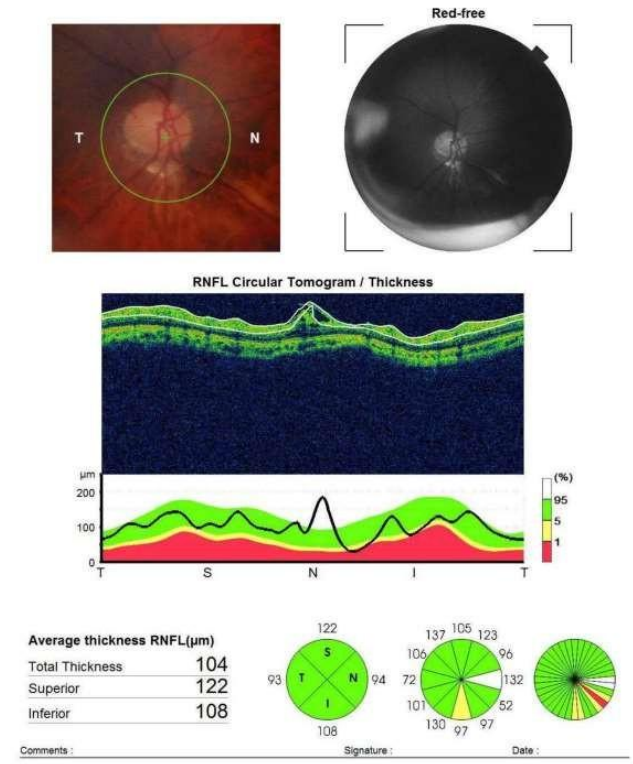

Fig.6. OCT showing Peripapillary RNFL postoperative one month

Case 2. Group 2.

Female patient 60 years, medically free, with nuclear cataract grade 2 and PSC. Her BCVA was 6/60

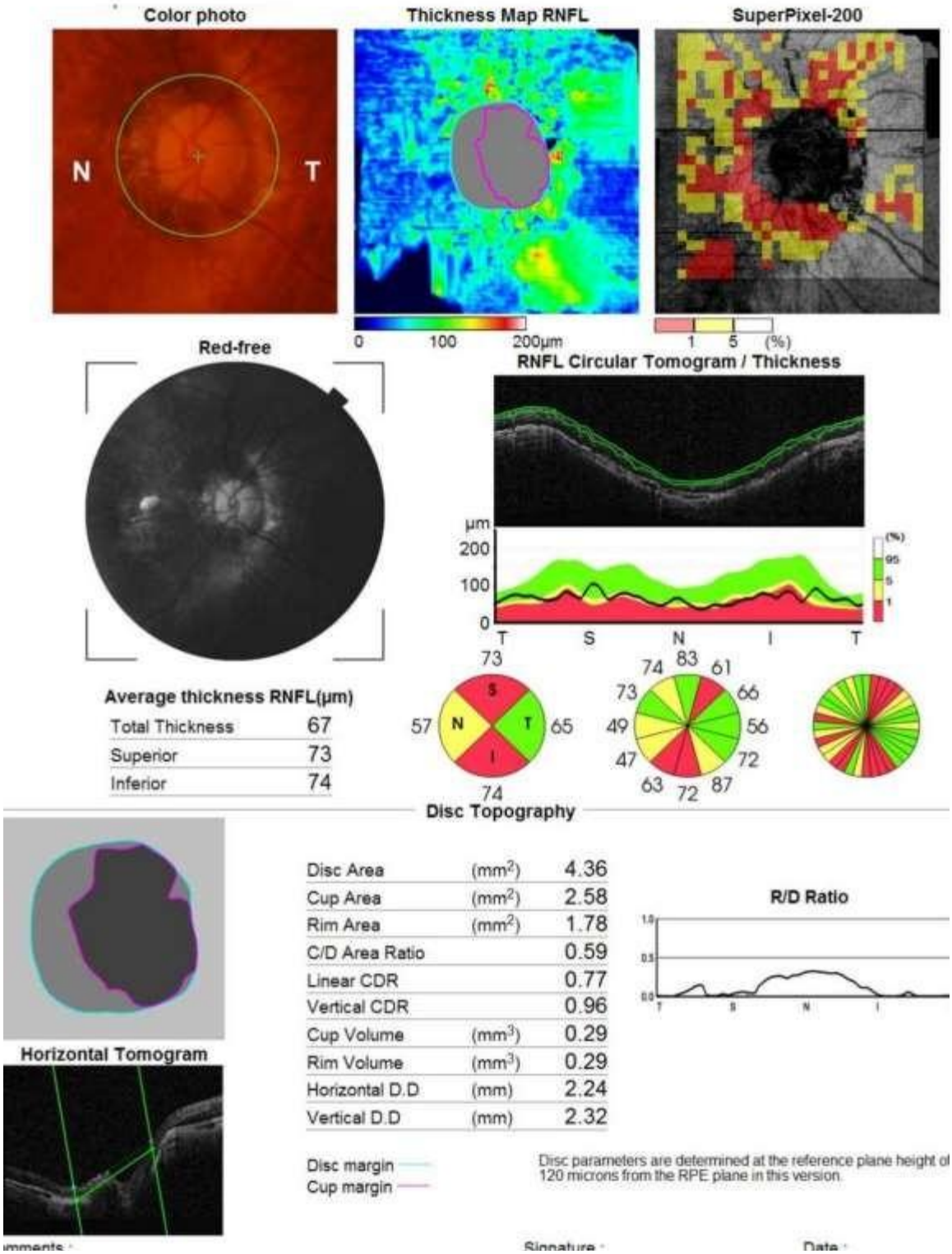

Fig.7. OCT showing Peripapillary RNFL preoperative

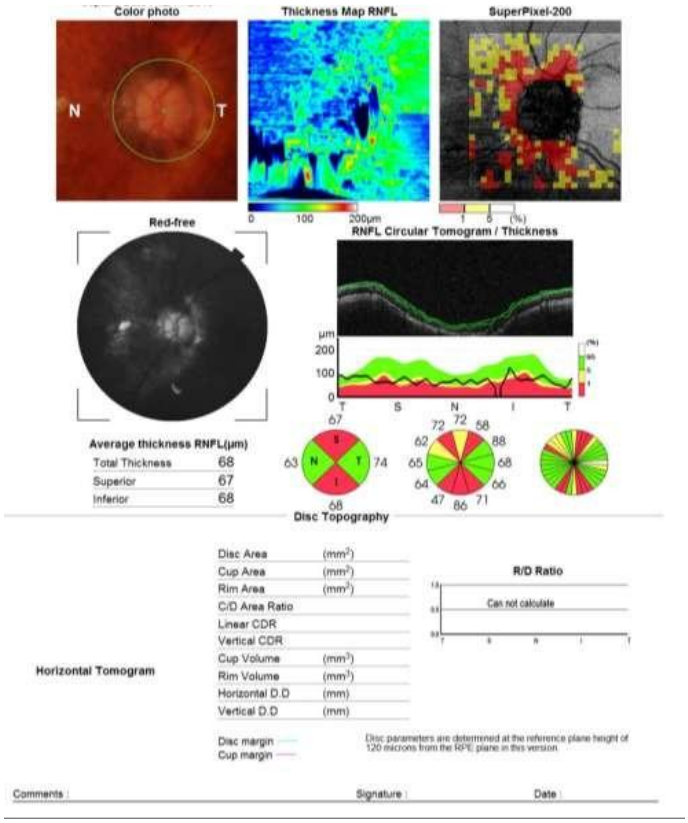

Fig.8. OCT showing Peripapillary RNFL postoperative one week

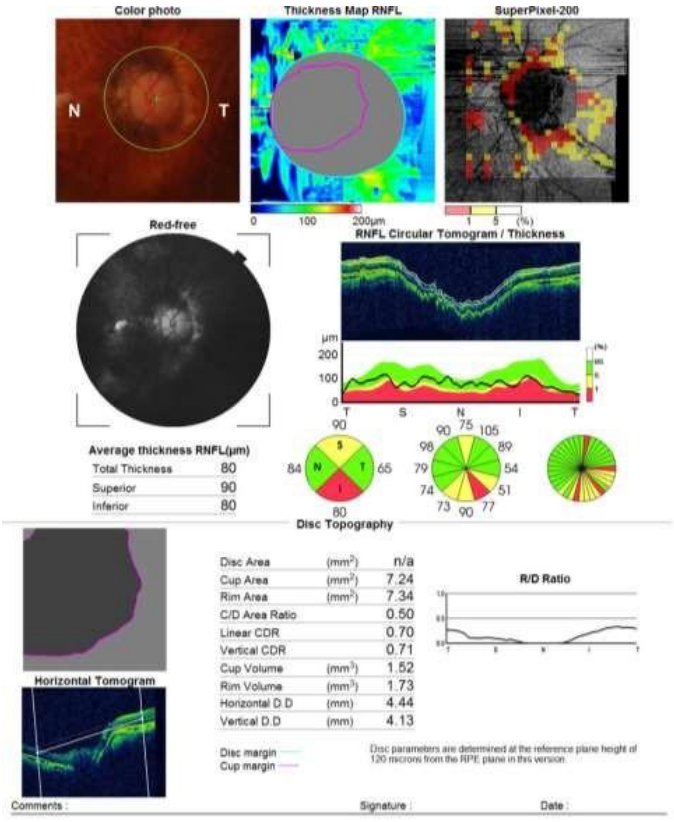

Fig.9. OCT showing Peripapillary RNFL postoperative one month

4. DISCUSSION AND CONCLUSION

Phacoemulsification is considered the most modern modality of cataract surgery and still is the preferred surgical technique in ophthalmologic practice worldwide [8].

Phacoemulsification uses the ultrasonic energy to remove the cataractus lens, which is then replaced with an IOL [8].

Sudden intraocular fluctuation in any kind of intraocular surgeries maybe harmful to RNFL in accordance with mechanical stress or sudden compression and also ischemic effect of micro emboli as the result of the sudden decompression that may generate micro bubble that can clog micro vessels [9].

Many studies have found that phacoemulsification gives satisfactory results and is considered very safe for all patients and makes a major contribution in the treatment, and ability of surgeon to avoid any complications of cataract, as well as being scientifically proven safe enough for the cornea, anterior chamber angle, iris and retina.

Also many have shown a significant increase in the RNFL thickness measurement in the operated eyes which confirms the high incidence of subclinical changes in the respective postoperative period.

In our study we evaluate the peripapillary RNFL thickness after phacoemulsification cataract surgery by using OCT in group (1) 20 eyes of high myopic patients with axial length more than or equal to 26 mm and group (2) (control group) of 10 eyes with normal axial length.

All cases have the same phacoemulsification time and total energy.

As regarding retinal nerve fiber layer in our study; we have compared the preoperative values of the peripapillary retinal nerve fiber thickness one day before the phaco operation to its thickness after one week then one month post operative. The retinal nerve fiber thickness has significantly increased after one week of phacoemulsification ($p<0.001$) and also has significantly increased after one month of phacoemulsificaton ($p<0.001$).

In agreement with our study; El- Ashry et al. (2006)(10) detected that after cataract surgery, RNFL thickness measurements increased significantly. Analysis of cataract subgroups revealed that cortical and posterior subcapsular cataracts significantly affected OCT images, however, nuclear cataracts had less influence on OCT signal strength and RNFL values. These observations may be due to the fact that nuclear cataracts pass near-infrared light and cause minimal light scattering, while cortical and posterior cataracts scatter reflected light to a greater extent [10].

Our study agreed with Cheng et al. (2011) which investigated the influence of cataract on RNFL thickness measurements with Time domain and Spectral dimain OCT, he found that after removal of cataract, the observed signal strength value was significantly increased in Stratus OCT scans so he documented a positive correlation between the increase in signal measured parameter and the increase in RNFL thickness [11].

Another study by Lee et al. (2010) demonstrated lower RNFL values measured by Stratus OCT in patients with cataract prior to surgery which improved significantly following phacoemulsification. This increase was marked in eyes with cortical and posterior subcapsular opacities, which may be attributed to lower the signal strength [12].

Pašová and Skorkovská (2016) concluded that presence of cataract affects OCT measurements of RNFL thickness. The reproducibility of the method significantly improves after the surgery. The increase is due to improvement in the quality of the scanned image and thus to the greater accuracy of the OCT examination [13].

In contrast to El-Ashry et al. (2006), [14] Cheng et al. (2011) and Lee et al. (2010) studies ,they have only preoperative evaluation of peri papillary RNFL thickness and one time postoperative evaluation of peri papillary RNFL but in our study we evaluate the peripapillary retinal nerve fiber thickness one day before the phaco operation, one week then one month after phacoemulsification in The two groups , we found gradual increase of peripapillary retinal nerve fiber layer thickness ($p<0.001$) after 1 week of operation till 1 month after operation.

In agreement with our study, Moustafa K Nasar et al. (2018), evaluate the peripapillary retinal nerve fiber thickness one day before the phaco operation, one week then one month after phacoemulsification but in normal axial length

catatrcats patients only, and found gradual increase of peripapillary retinal nerve fiber layer thickness ($p<0.001$) after 1 week of operation till 1 month after operation [10].

Qu S, et al. (2016) , evaluate the peripapillary retinal nerve fiber thickness one day before the phaco operation, one day, one week , one month , 3 months and 6 months after phacoemulsification in normal axial length catarcats and high myopic catarcats patients, and found From the first postoperative week, RNFL thickness began thicken gradually; until the third postoperative month, the thickness was at its thickest of 100.65±10.25 μm; then it emerged trend of thinned gradually, and to the sixth month after operation in the two groups. The change of retinal nerve fiber layer thickness after phacoemulsification combined with intraocular lens implantation is due to inflammatory reaction by mechanical injury of phacoemulsification surgery, traction reaction of optic nerve head induced by parts of vitreous liquefaction in ultrasonic emulsification process, with the addition of optic neuropathy from ultrasonic energy. For all above, these factors could increase RNFL thickness [15].

In agreement with our study, Kurt, Ali et al. (2018), evaluate all retinal layers included the peripapillary retinal nerve fiber thickness one day before the phaco operation, one week , one month , 3 months then 6 months after phacoemulsification but in normal axial length catatrcats patients only ,and found decrease of peripapillary retinal nerve fiber layer thickness 1 day after postoperative then increase of peripapillary retinal nerve fiber layer thickness ($p<0.001$) after 1 week of operation till reach maximum after 1 month and 3 months after operation then gradually decrease till 6 months post operative but not reach preoperative value the decrease in thickness may be due to light scattering due to corneal oedema [16].

CONSENT

An informed written consent was obtained from all participants in the research before inclusion.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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