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Original Article

CORRELATION BETWEEN VISUAL ACUITY AND OUTER RETINAL LAYER THICKNESS IN DIABETIC MACULAR EDEMA

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Abstract

Background: *Diabetes Mellitus has been a collection of metabolic diseases typified by persistently elevated blood sugar levels.* ***Aim:*** *This research used optical coherence tomography to examine the relationship among best corrected visual acuity & outer retinal layers thickness, which is the distance among the retinal pigment epithelium at the foveal center & the external limiting membrane.* ***Methods:*** *One hundred eyes of seventy-five studied cases had been comprised in this prospective, observational, case - control study. These cases had been collected from the ophthalmic out-patient clinic of Al-Azhar University Hospital, Assiut. These cases were split into two groups: Group 2 Diabetic Macular Edema (DME group) included fifty eyes from fifty diabetic studied cases, & Group 1 (Control group) included fifty eyes from twenty-five healthy individuals without a history of systemic or ocular illnesses.* ***Results:*** *There had been a highly significant correlation among BCVA & ORL ($p<0.001$) & a strong correlation among best corrected visual acuity and central foveal thickness (BCVA & CFT) but less than the correlation among BCVA & ORL in DME studied cases. This research presented a statistically significant positive correlation among ORL thickness & CFT.* ***Conclusion:*** *The study shed light on the importance of outer retinal layers thickness as a novel OCT parameter in the evaluation of diabetic macular edema with a potential visual prognostic value. It also revealed thinning of both choroid and outer retinal layer (ORL) in DME cases which may be related to its pathogenesis.*

Keywords: *Visual acuity, Outer retinal layer thickness, Diabetic, Macular edema.*

1. Introduction

Diabetes Mellitus has been a collection of metabolic diseases typified by persistently elevated blood sugar levels [1]. A serious side effect of diabetes that can arise at any point in the progression of diabetic retinopathy is diabetic macular edoema, which is 1 of the main reasons for visual impairment in people of working age. DME affects around twelve percent of diabetic retinopathy studied cases & results in over 10,000 new cases of blindness annually [2]. Duration of diabetes, proteinuria, gender, cardiovascular disease, high levels of Diabetic retinopathy are associated with systemic risk factors, including HbA1c & diuretic use [3].

Microvascular dysfunction is the most widely recognised pathophysiological explanation for diabetic kidney disease. Retinal capillaries are altered, the hemato-retinal barrier breaks, microaneurysms, haemorrhages, & exudates ensue, & this causes discernible retinal thickness in the OCT (Optical Coherence Tomography). These changes are caused by changes in the metabolism of glucose [4]. Slit lamp examination & stereo fundus photography are the main methods used to evaluate DME; however, several novel modalities are being developed & employed to assess diabetic macular edema. To photograph the retina & determine its thickness, high-resolution imaging methods like fluorescein angiography & optical coherence tomography have been employed. OCT has been better tolerated than FA since it is less intrusive. When evaluating macular thickness, OCT offers both quantitative & qualitative information, in contrast to slit lamp & stereo fundus photography [5]. Because OCT gives reliable diagnosis & tracks the course of macular edema & its response to pharmaceutical treatment, it has been integrated into ophthalmologists' everyday work [6]. The management guidelines for diabetic macular edema have primarily focused on the use of intravitreal injections of steroid (dexamethasone, triamcinolone, & fluocinolone) or anti-vascular endothelial growth factor (bevacizumab, ranibizumab, & aflibercept) drugs either alone or in conjunction with laser photocoagulation (focal or macular grid). Effective treatment of DME should include control of systemic risk factors as well as therapeutic or surgical treatment [7]. Baseline best-corrected visual acuity, central macular thickness, & early BCVA response all affect long-term treatment success [8]. Retinal thickness & functional condition were shown to be strongly correlated, although changes in CMT only seem to explain a tiny amount of the diversity in changes in VA, indicating that CMT should not be used as a stand-in for VA when making therapeutic decisions [9]. While a correlation among VA & total retinal thickness in the central subfield has been demonstrated, it is not as strong as the correlation between specific retinal layers [10]. It has been shown that the more often utilized macular thickness cannot predict visual acuity in DME as well as the length of the photoreceptor outer segment [11]. A thinner choroidal thickness may propagate DME [12]. The external limiting membrane, a significant retinal segmentation seen on spectral-domain OCT, & its relationship to visual acuity in diabetic macular edema have not been thoroughly investigated. ELM is positioned among the inner segments of photoreceptors & the cell nucleus, suggesting that it could be an indirect OCT-based criterion for evaluating photoreceptor function [13]. This research uses optical coherence tomography, a novel parameter in the evaluation of diabetic macular edema, to examine the relationship among best corrected visual acuity & outer retinal layers thickness, or the distance among the external limiting membrane & the retinal pigment epithelium at foveal center).

2. Patients & Methods

One hundred eyes of 75 studied cases had been comprised in this prospective, observational, case - control study. These cases had been collected from the ophthalmic out-patient clinic of Al-Azhar University Hospital, Assiut throughout the period from October 2020 till December 2021. These cases had been split into two groups: Group1 (Control group): fifty eyes of twenty-five healthy

people with no history of systemic & ocular diseases. Group2 (DME group): 50eyes of50 diabetic studied cases with the following inclusion & exclusion criteria.

2.1. *Inclusion criteria*

Age > twenty-five years, Diabetic studied cases with diabetic macular edema, free of intraocular diseases other than diabetic retinopathy and duration of diabetes > 5 years.

2.2. *Exclusion criteria*

Previous history of intraocular surgery, previous history of trauma, patients with systemic diseases, ocular media opacity that renders retinal visualization with OCT difficult, resulting in unsatisfactory image acquisition. the existence of non-DME macular diseases that can impact macular thickness, like retinal venous occlusion, age-related macular degeneration, vitreomacular traction, epiretinal membrane, full thickness or lamellar macular holes, & other conditions that can produce macular edema. Since thickness in this research is characterized as the distance among the external limiting membrane & retinal pigment epithelium, subretinal fluid at the fovea provides an artificially high assessment of the outer retinal layers thickness. For this reason, it had been removed from the investigation. Prior to enrollment, all individuals provided verbal informed consent, & each participant also provided written informed consent. Every ethical guideline was adhered to throughout the research process.

2.3. *Methods*

Every patient had a thorough ophthalmologic examination, which included a review of their medical & family histories. An auto refractometer (Topcon Auto refracttometer) was used to determine non-cycloplegic refraction. By adding spherical refractive error values (in diopters [D]) to one-half of the cylindrical refractive power, stereoscopic fundus examination with a fully dilated pupil, slit lamp biomicroscopy using a 90D lens, BCVA measurement using Snellen's visual acuity chart, & IOP measurement using an application tonometer, refraction data had been converted to spherical equivalents.

2.3.1. Optical coherence tomography scanning

Using the integrated 3D macula report scan technique, OCT (Scanning with Topcon3D-1 Maestro2; TOPCON Corporation, Tokyo, Japan) had been carried out. Low-quality images were not included in the OCT scans. Before taking images, mydriatic eye drops were used to dilate each study participant's eyes. studied cases were told to focus their attention on the intrinsic fixation target for the duration of the OCT scan. A manual correction was made if the studied case was having trouble fixating & the picture center was not in the center of the fovea. The same skilled physician did the OCT scans.

2.3.2. Determination of retinal & choroidal thickness

The same retina specialist examined the SD-OCT results. The studied case's horizontal line scans that crossed their foveal centres had been selected for examination. The outside boundary of choroid segmentation had been manually determined, while the internal limiting membrane, external limiting membrane, & retinal pigment epithelium were all automatically detected. Following the identification of the hyperreflective layers, the positions of the matching ELM & RPE bands were determined by measuring each band's point of highest brightness.

2.3.3. Statistical analysis

Version 20of the Statistical Package for Social Science had been used to enter, code, & amend the data. For the quantitative data with parametric distribution,

the data were given as mean, standard deviations, & ranges; for the qualitative data, they were given as numbers & percentages; & for the quantitative data with non-parametric distribution, they were given as median with interquartile range.

3. Results

A total of one hundred eyes of seventy-five cases were contained in this research, with mean age 51.42 ± 8.55 years old. These cases had been split into a control group (fifty eyes of twenty cases) & DME group (50 eyes of 50 studied cases). 53% of cases were male (40/75) while females were 47% (35/75). The mean age of control group 47.56±8.4 years old versus 54.26±8.96years old in DME group, tab. (1). In comparing of the control group, which had a mean BCVA of 0.94 ±0.05, or around 6/6 & 0.1 Log-MAR, the DME group's BCVA was smaller, at 0.21 ± 0.11, or roughly 6/24 & 0.60 LogMAR. A statistically significant difference was viewed (P value < 0.001), tab. (2). Table 3 and figs. (3-6) show the correlations between control and patients' group among central macular thickness, outer retinal layer and subfoveal central thickness Figure (7) OCT macula of his LT eye revealed cystoid macular edema with CMT 440 um His ORL thickness was 84 um. his SFCT 217 um and his BCVA was 0.7 log MAR. OCT macula of her Lt eye revealed cystoid macular edema with CMT 310 um, her ORL thickness was 86 um, her SFCT was 192 um, and her BCVA was 0.7 log MAR fig. (8).,

Table 1: Patients' demographics

		Control	DME
Age (mean ± SD) years		47.6 ±8.4	54.3 ±8.96
Sex	***Male***	13 (52.0%)	27 (54.0%)
	Female	12 (48.0%)	23 (46.0%)
Eye	***Right***	25 (50%)	30 (60%)
	Left	25(50%)	20 (40%)
DM duration (mean ± SD)		Nil	15.16 ±4.2
Type of DM	***Type1***	Nil	26 (52.0%)
	Type2	Nil	24 (48.0%)

Table 2: Comparing of BCVA among the studied groups

	Patients group (No.=50)		Control group (No.=25)		Independent t test	
	Mean	***SD***	***Mean***	***SD***	***t***	***p value***
BCVA	0.21	0.11	0.94	0.05	-31.407	<0.001

Table 3: Comparison between patients group and control group among CMT (Central Macular Thickness), ORL (Outer retinal layer), SFCT

	Patients group (No.=50)		Control group (No.=25)		Independent t test	
	Mean	***SD***	***Mean***	***SD***	***t***	***p value***
CMT (um)	393.94	72.57	227.36	4.82	11.425	<0.001
ORL (um)	73.10	9.17	110.56	4.10	-19.434	<0.001
SFCT (um)	200.68	42.73	249.08	4.64	-5.628	<0.001

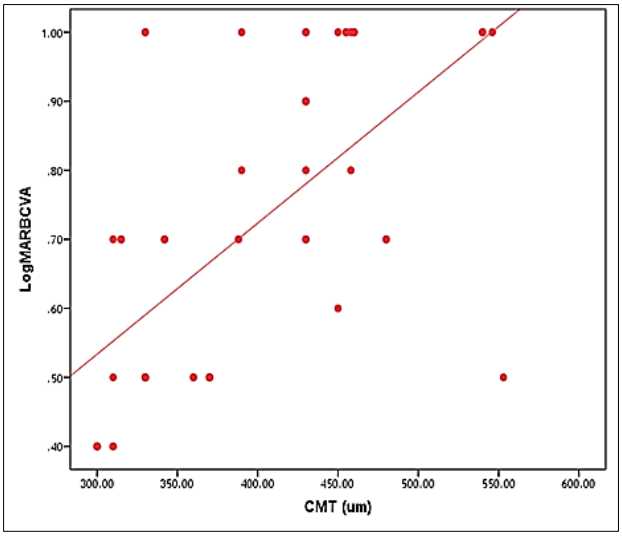

Figure 1: Correlation among Log MAR BCVA & CMT among patients' group

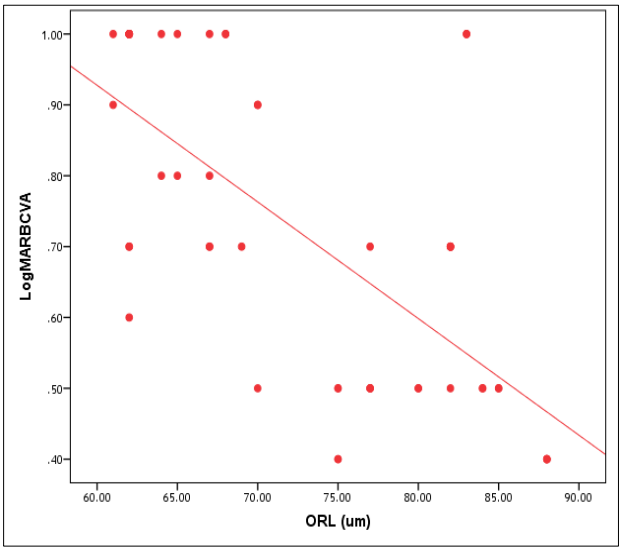

Figure 2: Correlation among Log MAR BCVA & ORL among patients' group

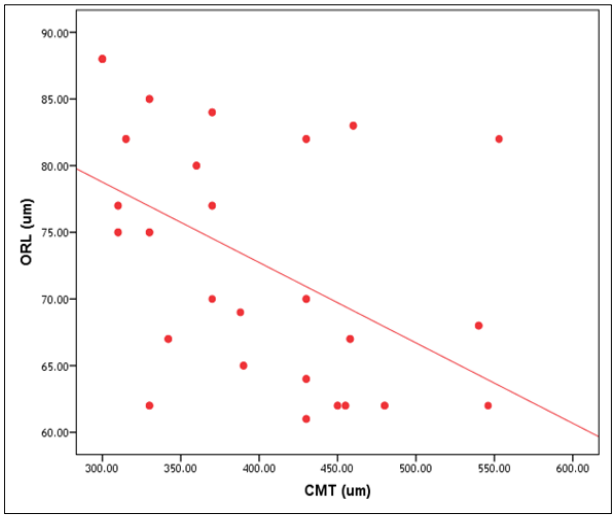

Figure 3: Correlation between ORL and CMT among patients' group.

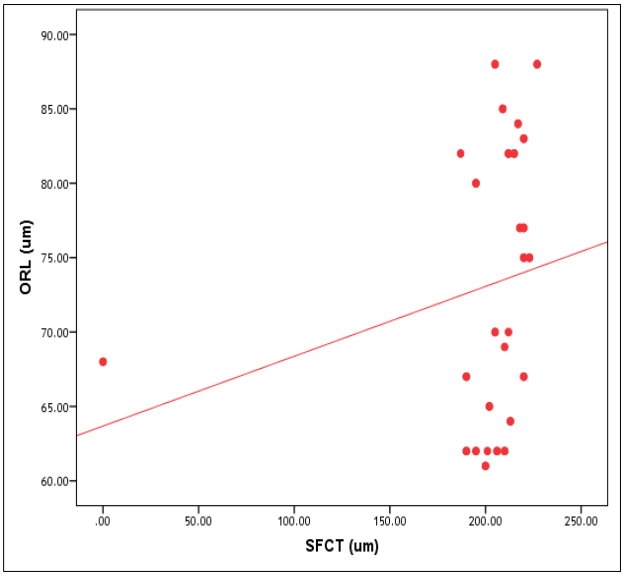

Figure 4: Correlation between ORL and SFCT among patients group.

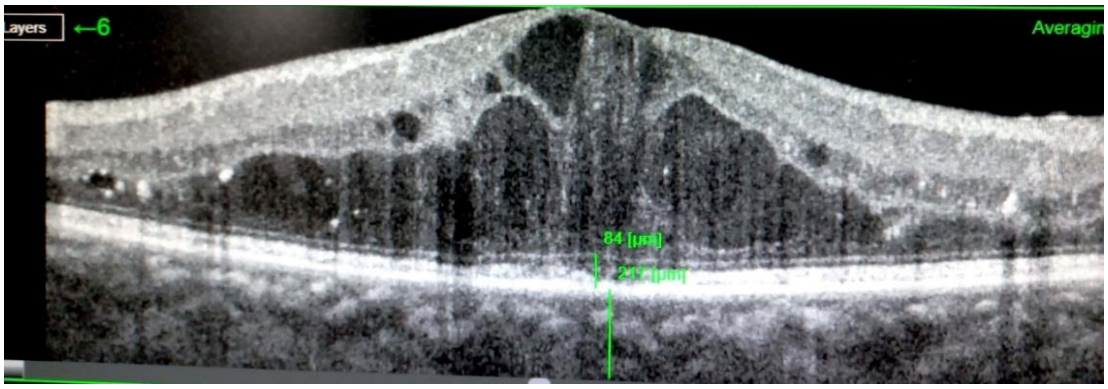

Figure 5: Male pt ,65 years old, diabetic type 1 (NIDDM) for 12 years

Figure 6: Female patient Pt ,55 years old ,diabetic (IDDM) for 15 years duration

4. Discussion

However, there has only been a weak & inconsistent relationship shown in several clinical investigations among macular thickness evaluated by OCT & visual acuity. Moreover, there are situations when variations in OCT-measured thickness are accompanied by paradoxical changes in visual acuity. These results imply that, while OCT can be a useful tool in the clinical assessment of DME studied cases,

macular thickness measurements obtained from OCT could not be suitable as stand-in indicators of visual acuity [14]. In the current prospective study, there was a reduction in the ORL thickness in DME patients and reduction in the SFCT in DME patients than healthy individuals. There has been a highly significant correlation among BCVA & ORL ($p<0.001$) & a strong correlation among BCVA & CFT but less than the correlation among BCVA & ORL in DME studied cases ($p< 0.008$). This research confirmed a statistically significant positive correlation among ORL thickness & CFT. Also, there was strong positive correlation among CFT & duration of diabetes (P value was < 0.001) while no correlation was found between ORL thickness and duration of diabetes. A study was performed at Retina Clinic of the University of Hong Kong on DME patients on 2015. There was highly significant correlation among BCVA & ORL, also there was a significant positive correlation among BCVA & CMT but less than correlation among BCVA & ORL & those results nearly like the results in our study. A study carried by Eliwa, et al. [15]. which showed decrease in ORL thickness in diabetic macular edema patients and a strong & higher correlation among BCVA and ORL than that among CMT & vision, A study was performed in The Hospital of the Chinese university 2022 [12] the study also exposed decrease in ORL thickness in DME patients, strong and higher correlation among BCVA & ORL & there was strong positive correlation among BCVA & CFT, however variable result considering the correlation between BCVA and CFT have been found. In seventeen percent of the cases, the BCVA rose as the CFT increased, & in sixteen percent of the cases, it reduced as the CFT fell. This discrepancy runs counter to the overall findings, & it could be brought about by varying degrees of ELM & IS/OS of fracture in the eyes of the study's cases. A study was performed in retina clinic, Ophthalmology Dept., Hadi Hospital, Kuwait, 2017 [16]. There had been moderate significant correlation among Log MAR BCVA & ORL thickness, whereas there had been a weak correlation between BCVA and CMT. Considering the Weak correlation, in our study the selected cases never have been injected before, however in this study some of the cases may have been injected with anti VEGF, and this explains the better VA instead of presenting edema and vice versa. As the status and integrity of photoreceptor and ELM will persist after resolution of the edema. We showed that, although not as well as the link among PROS length & vision, there is a stronger relationship among ORL thickness & vision than there is among central retinal thickness & vision when compared to the results of prior investigations. It is important to remember that because ORL thickness is larger than PROS length, the same amount of systematic or random measurement error would have less of an impact on the outcome. Given that the measurement of PROS length exhibits subpar repeatability & that the shorter PROS length produces a higher percentage error for any absolute error compared to ORL thickness, a larger-scale study comparing the correlation among PROS length, ORL thickness & vision would be advantageous to better understand the advantages & disadvantages of the 2 distinct OCT parameters in the evaluation of DME [17]. Our analysis & the evaluation of ORL thickness have several shortcomings. Selection bias can arise in studied cases with subretinal fluid or disruption of ELM or RPE. Additionally, the manual measurement of the ORL at the foveal center may have resulted in some mistakes in the calculations of these measures. Although the results are encouraging, it is important to note that ORL thickness alone cannot

account for all differences in vision, as other factors such macular ischaemia may also be involved. In conclusion, we showed that ORL thickness is a novel OCT parameter that may be used in the evaluation of DME studied cases & that it has a stronger correlation with vision than total foveal point thickness [18].

5. Conclusion

The study shed light on the importance of outer retinal layers thickness as a novel OCT parameter in the evaluation of diabetic macular edema with a potential visual prognostic value. It also revealed thinning of both choroid and outer retinal layer (ORL) in DME cases which may be related to its pathogenesis. It has been demonstrated that ORL thickness at the foveal center is better associated with vision than the total retinal thickness at the foveal center, it may be a potential long term visual prognostic factor for studied cases with DME.

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