IJMA

International Journal of Medical Arts

Volume 7, Issue 5 (May 2025)

http://ijma.journals.ekb.eg/

P-ISSN: 2636-4174

E-ISSN: 2682-3780

Available online at Journal Website
https://ijma.journals.ekb.eg/
Main Subject [Ophthalmology]

Original Article

Correlation Between Diabetic Macular Edema and Subfoveal Choroidal Thickness by Optical Coherence Tomography

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Article information

Received: 22-06-2024

Accepted: 16-03-2025

DOI: 10.21608/ijma.2024.298571.1985.

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Citation: El-demiri MMA, Alkady AMM, Sayed SA. Correlation Between Diabetic Macular Edema and Subfoveal Choroidal Thickness by Optical Coherence Tomography. IJMA 2025 May; 7 [5]: 5698-5701. doi: 10.21608/ijma.2024.298571.1985.

Abstract

Background: The choroidal thickness [CT] in patients with diabetic macular edema [DME] exhibited different patterns, including thickening, thinning, or no changes. Research indicated that the average thickness of the choroid layer beneath the fovea, known as subfoveal choroidal thickness [SFCT], was dramatically decreased in these individuals. However, other studies found that SFCT was greater in thickness.

Aim of the study: The aim of the study was to assess subfoveal choroidal thickness in patients with diabetic macular edema [DME].

Patients and Methods: This cross-sectional observational controlled study included 60 human eyes divided into three groups, Group I which included 20 diabetic eyes with central macular thickness [CMT] > 400 µm, Group II which included 20 diabetic eyes with CMT < 400 µm, and Group III [Control] which included 20 normal eyes. All participants were subjected to optical coherence tomography [OCT] imaging by swept source Topcon 3D OCT 2000. OCT exam includes measurement of CMT and SFCT.

Results: In group I, the mean CMT was 469.25 ± 63.795 µm, and SFCT mean value was 258.35±63.14 µm. In group II, the mean CMT was 317.25±35.437 µm, and SFCT was 275.05±90.213 µm. In control group, CMT mean value was 237.56±9 µm, and SFCT mean value was 214.33±71.97 µm. There is a statistically significant difference between group I, group II and control group as regard CMT [P =0.001]. However, the difference between the three groups was insignificant statistically in terms of SFTC [P = 0.34]. The difference between each two groups of our study regarding SFCT was insignificant statistically [P= 0.2, 0.08, and 0.5 respectively].

Conclusion: There was an insignificant relation between CMT and SFCT in patients with DME. Choroidal thickness evaluation does not indicate the severity of DME and cannot be used to track its progression.

Keywords: Diabetic Retinopathy; Macular Edema; Optical Coherence Tomography; Choroidal Thickness.

INTRODUCTION

Diabetes mellitus [DM] is a metabolic condition that affects the blood vessels in the eyes [1]. The primary alterations in the posterior segment of the eye in diabetes typically affect the blood vessels in the retina. However, there are also accompanying modifications in the choroid, which plays a crucial role in supplying blood to the outer layer of the retina[2]. Diabetic choroidopathy refers to abnormal changes in the choroid, which is a layer of the eye, that occur in individuals with diabetes. These changes might contribute to a loss in visual acuity [3]. Macular edema and proliferative retinopathy are significant contributors to visual impairment [4]. Research suggests that choroidal vasculopathy in diabetes may play a role in the development of diabetic retinopathy[5]. Histopathologic studies of diabetic eyes have documented the presence of different choroidal abnormalities, such as chorio-capillaris degeneration, choroidal aneurysms, and choroidal neovascularization [6].

The choroidal thickness [CT] in patients with DM, particularly those with DR, exhibited a range of alterations, including thickening, thinning, or no changes. Research indicated that the average thickness of the choroid layer beneath the fovea, known as subfoveal choroidal thickness [SFCT], was much lower in these individuals according to studies [7,8]. However, some studies claimed that SFCT was higher [9]. Therefore, the current understanding of the condition of the choroid in patients with DM, whether they have diabetic retinopathy [DR] or not, is uncertain and requires additional research. Optical coherence tomography [OCT] has been utilized to capture images of the choroid and assess its thickness [3]. So, the aim of this study was to assess SFCT in patients with DME.

PATIENTS AND METHODS

This is a cross-sectional observational study included 60 human eyes divided into three groups, Group I which included 20 diabetic eyes with central macular thickness [CMT] > 400 µm, Group II which included 20 diabetic eyes with CMT < 400 µm, and Group III [Control] which included 20 normal eyes. Our study was done at Al-Azhar university hospital in Cairo. Ethical approval was obtained from the institutional review board of our institution. Our study followed the Helsinki declaration principals. Written informed consent was obtained from every patient at the time of recruitment. We included the patients according to the following criteria:

The inclusion criteria: Patients with DME, with an age of 30 to 50 years old. DME was detected at the fovea [500 µm region] by OCT as a diffuse thickening of 300 µm or more or presence of cystic change.

The Exclusion criteria: Age group < 30 to > 50 years old; retinal detachment; high myopia; factors causing macular edema other than diabetes (e.g., age-related macular degeneration, retinal vein occlusion, retinoschisis, retinitis pigmentosa, and inflammatory eye diseases); conditions like uveitis; eye tumors; trauma; and eye surgery (e.g., glaucoma, retinal or cataract surgery).

Data collection: All of the included participants [Patients and control] underwent complete medical history taking, general examination and ocular examination including best corrected visual acuity[BCVA], anterior segment examination by using slit lamp bio microscopy [Topcon, Japan], fundus examination using +90 D lens and HbA1c.

All participants were subjected to OCT imaging by swept source Topcon 3D OCT 2000. OCT exam includes measurement of, CMT and SFCT. The appropriate OCT imaging mode was selected. For the assessment of subfoveal choroidal thickness and DME, the macular OCT imaging was selected. The SFCT was measured as a perpendicular line from the outer limit of the hyperreflective line [Retinal Pigment Epithelium], to the line representing sclero-choroidal interface.

Statistical Analysis: The collected data were coded, processed, and analyzed using SPSS program [Version 25] for windows. For continuous variables, it was represented as Mean ± SD, and the independent t-test or one-way ANOVA test were performed to compare the means of normally distributed data, while Mann–Whitney U test or Kruskal Wallis test were used to compare the median differences of the data that were not normally distributed. For qualitative data they were described as numbers and percentages and were compared using the chi-square test or the Fisher exact test. The results are considered clinically significant if P-value < 0.05.

RESULTS

A total number of 60 eyes were included in our study [40 diabetic eyes and 20 control]. Among our included DM group, 50% were males and 50% were females and their mean age was 40.73±6.98 years. In control group, 70% were males and 30% were females; their mean age value was 42.45±6.08 years [Table 1]. In terms of the CMT and SFCT, in patients with DME [Group 1 + 2], the means CMT was 393.25±92.296 µm and the mean SFTC was 266.70±77.23 µm. In group I, the mean CMT was 469.25±63.795 µm, and SFCT mean value was 258.35±63.14 µm. In group II, the mean CMT was 317.25±35.437 µm, and SFCT was 275.05±90.213 µm. In control group, CMT mean value was 237.56±9 µm, and SFCT mean value was 214.33±71.97 µm. There is a statistically significant difference between group I, group II and control group as regard CMT [P =0.001]. However, the difference between the three groups was insignificant statistically in terms of SFTC [P = 0.34]. The difference between each two groups of our study regarding SFCT was insignificant statistically [P= 0.2, 0.08, and 0.5 respectively] [Table 2].

Diabetic eyes were categorized into three groups according to SFCT: SFCT >300u [No. 14/35%] in which the mean SFCT was 340.07 ± 39.134um, and the mean CMT was 368.29 ± 78.55um. SFCT <160u [No. 5/ 12.5%] in which the mean SFCT was 134.20 ± 18.67um, and the mean CMT was 365.20 ± 101.02um. SFCT >160 & <300u [No. 21, 52.5%] in which the mean SFCT was 246.33 ± 40.97um, and the mean CMT was 413.28 ± 99.77um [Table 3]. Most diabetic patients with macular edema 52.5% showed average normal SFCT while 35% of them had thicker choroid and only 12.5% had thinner choroid.

Table [1]: Basic characteristics of the patients

		DM N=40 eyes		Control group N=20 eyes	
		N	%	N	%
Sex	Male	20	50%	14	70%
	Female	20	50%	6	30%
Examined eye	OD	21	52.5%	10	50%
	OS	19	47.5%	10	50%
Age	Range	31-50		25-50	
	Mean ± SD	40.73±6.98		42.45±6.08	

Table [2]: Comparison of Mean CMT & SFCT among the three groups as regard clinical data

Variables	Group I [CMT > 400 um]	Group II [CMT < 400um]	Control	P value a	P value b
CMT [µm]	469.25 ± 63.79	317.25±35.43	237.56±9.02	0.001*	P1=0.006*; P2=0.001* P3=0.001*
SFCT [µm]	258.35±63.140	275.05±90.21	214.3±71.97	0.155	P1=0.2; P2=0.08 P3=0.5

[a]: One-way ANOVA. b: Independent t test. P1: Group I vs Group II. P2: Group I vs control group. P3: Group II vs Control group. *: significant P value.

Table [3]: Various groups of choroidal thickness [mean SFCT] and their associated macular edema [mean CMT].

	Mean±SD	N[%]
CMT [SFCT >300um]	368.29 ± 78.55 340.07 ± 39.134	14 [35%]
CMT [SFCT <160um]	365.20 ± 101.02 134.20 ± 18.67	5 [12.5%]
CMT [SFCT >160 -<300um]	413.28 ± 99.77 246.33 ± 40.97	21 [52.5%]

DISCUSSION

In Diabetes is a metabolic disorder that impacts the blood vessels throughout the body. Diabetic retinopathy occurs when the blood vessels in the retina get damaged and there are anomalies in blood flow. The measurement of SFCT was taken at the outer boundary of the hyperreflective layer that corresponds to the complex formed by the retinal pigment epithelium [RPE] and Bruch membrane, as well as the contact between the choroid and sclera. The replicability of the entire SFCT measurement has been documented [10].

In the present study, the mean of CMT in diabetic patients [of both groups] was 393.250±92.296 and their mean SFCT was 266.700 ± 77.23. this mean of SFCT is within normal range thus, this means diabetic macular edema did not influence SFCT significantly. This result agrees with that of **Melancia *et al.*** [11], **Galgauskas *et al.*** [12] **and Kase *et al.*** [13]. However, **Kase et al.** [13] found no correlation of SFCT between normal [272 ± 71 µm] and DM eyes [264 ± 77 µm]. The results of the current study also like that of **Wang and Tao** [14], who found that, SFCT was not a significant difference in 66 patients with DME as compared to controls [213.21±19.02 µm vs. 212.63 ± 11.99 µm, P = 0.849].

In the current study the SFCT of diabetic patients with macular edema shows thicker choroid than that of the controls, in spite of being did not reach a statistically significant difference. These results agree with that of Kim et al [9], who concluded that, the subfoveal choroid was thicker in eyes with DME than in those without DME. This means the healthy eyes had thinner choroids when compared to patients with DME. This results also were nearly agreeing with many previous studies [11, 15-18], which showed d that the total CT layer was significantly thicker in patients with DME than in diabetic patients without DME.

Vujosevic *et al.* [19] found no significant CT difference between controls and diabetic eyes without detectable DR however, SFCT in thinner in patient with DME than that of the normal control but did not reach a clinically statistically significant difference, their results dislike the results of the present study which found that the SFCT is thicker than the normal control.

The result of present study disagrees with that of **Unsal *et al.*** [17] and several studies [20–22] who found a further reduction of SFCT with diabetic macular edema in patients with diabetic retinopathy and reach a significant value. Also, **Esmaeelpour et al.** [23] stated that SFCT decreased in all grades of diabetic retinopathy in comparison with healthy eyes regardless of the disease stage. Subfoveally, the choroid was approximately 35% thinner in all diabetic groups compared with healthy eyes.

In the current study, the mean SFCT in group I [CMT>400 u] was 258.35±63.140 which is lesser than that 275.05±90.213 of group II, [CMT < 400 u] this may be due to occurrence of microangiopathy and inflammatory response early in diabetic retinopathy and with progression and persistence of the diabetic retinopathy and increased DME, there may be ischemia and thinning of the choroid. This in agreement with the result of **Vujosevic *et al.*** [19] who stated that SFCT reduced progressively with increasing level of DR. However, the results of the current study dislike that of Kim et al., [9], who concluded that, choroidal thickness increased significantly as the severity worsened from mild/moderate/NPDR.

When dividing the cases with DME according to SFCT, into three groups: Group A [SFCT >300u], Group B [SFCT <160u] and Group-C [SFCT >160 -<300u], it was found that,35% of patients with DME have thick choroid [SFCT=340.07 ± 39.134 u], 12.5% have thin choroid [SFCT =134.20 ± 18.67u] and 52.5% have average choroidal thickness [246.33 ± 40.97u]. The majority of patients has average SFCT in spite of severer DME [larger CMT]. This means that in some cases like in group-A, the burden of diabetic inflammation and microangiopathy occur more in the choroid than in the retina. In other cases of DME like in group B, there was thinning of SFCT may be

due associated choroidal ischemia from choroidal diabetic microangiopathy. The majority of case [52.5%] was in group C, where the SFCT showing average normal thickness in spite of severer DME, this may be due to that the main pathological changes occurred in retina than in the choroid.

Conclusion: The current study showed that diabetic macular edema did not influence SFCT significantly and there was no statistically significant difference between SFCT in patients with DME and normal control. However, SFCT in patients DME is thicker than that of normal control. The mean SFCT in group II [CMT <400 u] was greater than that of group I [CMT >400 u], which means progressive decrease of SFCT with progression of macular edema. DME can be associated with average SFCT, thin SFCT or thick SFCT, according to at which the burden of diabetic inflammation and microangiopathy occur and the occurrence of choroidal ischemia.

Disclosure: None to be disclosed

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IJMA

International Journal of Medical Arts

Volume 7, Issue 5 (May 2025)

http://ijma.journals.ekb.eg/

P-ISSN: 2636-4174

E-ISSN: 2682-3780