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Optical Coherence Tomography Assessment of Macular and Choroidal Thickness in Patients with Proliferative Diabetic Retinopathy in Relation to Hemoglobin A1C

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ABSTRACT

Background: Diabetic retinopathy affects up to 80 % of all patients who have had diabetes for 10 years or more. Despite these intimidating statistics, research indicates that at least 90% of these new cases could be reduced if there were proper treatment and monitoring of the eyes blindness.

Objective: To evaluate the relation of macular and choroidal thickness to HbA1c in patients with proliferative diabetic retinopathy.

Patients and methods: This study included 40 eyes of 33 patients with a diagnosis of proliferative diabetic retinopathy (PDR). Patients were recruited from Retinal Clinic in Imbaba Eye Hospital and they were asked to participate in this study. This study was designed as an observational, cross-sectional and non-coherent study in the period from 5/2018 to 4/2019.

Results: the results showed that the macular thickness was higher and the choroidal thickness was lower in uncontrolled HbA1c group than controlled HbA1c group. We assumed that increase level of glycosylated hemoglobin lead to increase macular thickness and decrease choroidal thickness and increase incidence of diabetic macular edema and choroidal atrophy.

Conclusion: Optical coherence tomography is a sensitive and noninvasive diagnostic tool in the evaluation of macular and choroidal thickness. Hypertension is also an important risk factor in the development of diabetic retinopathy, diabetic macular edema and diabetic choroidopathy.

Keywords: Optical Coherence Tomography, Macular and Choroidal Thickness, Proliferative Diabetic Retinopathy, Hemoglobin A1C.

INTRODUCTION

Diabetic retinopathy (DR) is the most common cause of blindness in Europe, affecting 1.9% of patients with DM. Furthermore, 2.64% of diabetic patients have visual sight-threatening diabetic retinopathy (STDR) [(1)].

The prevalence of diabetic retinopathy (DR) remains high at 40% of diabetic patients. Globally, there are approximately 93 million people with DR, 70 million with proliferative diabetic retinopathy (PDR), 21 million with diabetic macular edema (DME) and 28 million with a sight- threatening retinopathy as proliferative diabetic retinopathy (PDR) [(2)]. Diabetic retinopathy affects up to 80 % of all patients who have had diabetes for 10 years or more [(3)].

Despite these intimidating statistics, research indicates that at least 90% of these new cases could be reduced if there were proper and vigilant treatment and monitoring of the eyes [(4)]. The longer a person has diabetes, the higher is his or her chances of developing diabetic retinopathy [(5)].

Diabetic retinopathy is a progressive disease predominantly affects the integrity of the microscopic vessels found in the retina. DR can be broadly divided into two clinical stages: non proliferative and proliferative diabetic retinopathy (PDR)[(6)].

Proliferative diabetic retinopathy develops following the occlusion of retinal capillaries leading to retinal ischemia, which promotes the development of neovascularization, a process by which new blood vessels proliferate on the surface of the retina. However, these vessels are fragile and bleed easily. The resulting accumulation of blood in the vitreous cavity from these hemorrhaging vessels seriously impairs vision. This may be permanent due to further complications such as traction retinal detachment leading to registered blindness. It has been estimated that without treatment for PDR, 50% of all patients will become blind within 5 years following diagnosis [(7)].

Optical Coherence Tomography (OCT) is a high-resolution, cross-sectional imaging technique that allows detailed assessment of retinal thickness and morphologic evaluation of the neurosensory retinal layers. OCT imaging has rapidly been integrated into diagnosis and management of DME in routine clinical practice and clinical trials [(8)].

One major advantage of OCT is that it allows measurement of retinal thickness from the tomograms by means of computer image-processing techniques, OCT is more sensitive to small changes in retinal thickness than slit-lamp biomicroscopy [(9)].

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Risk factors that contribute to the progression of DME include increasing level of hyperglycaemia, diabetes duration, severity of diabetic retinopathy at baseline, diastolic blood pressure and the presence of gross proteinuria [10].

Periodic glycosylated hemoglobin (HbA1c) measurements can reflect the long-term control of hyperglycemia. Intensive glycemic control had been proved to be effective in decreasing incidence rate of development and progression of diabetic retinopathy in type 1 and type II diabetic mellitus as demonstrates by diabetes control and complication trials [11].

AIM OF THE WORK

To evaluate the relation of macular and choroidal thickness to HbA1c in patients with proliferative diabetic retinopathy.

PATIENTS AND METHODS

This study included 40 eyes of 33 patients with a diagnosis of proliferative diabetic retinopathy (PDR). Patients were recruited from Retinal Clinic in Imbaba Eye Hospital they were asked to participate in this study.

This study was designed as an observational, cross-sectional and non-coherent study in the period from 5/2018 to 4/2019.

Ethical approval and written informed consent:

An approval of the study was obtained from Al- Azhar University academic and ethical committee. Every patient signed an informed written consent for acceptance of the operation.

Study Population:

Patients were divided into 2 groups:

- Controlled HbA1c group: 20 eyes with proliferative diabetic retinopathy with controlled glycosylated hemoglobin (HbA1c ≤7 %).
- Uncontrolled HbA1c group: 20 eyes with proliferative diabetic retinopathy with uncontrolled glycosylated hemoglobin (HbA1c > 7%).

Inclusion criteria:

Type I and type II proliferative diabetic retinopathy patients (PDR).

Exclusion criteria:

1- Non proliferative diabetic retinopathy (NPDR).
2- Opaque cornea.
3- Opaque lens.
4- Refraction more than +6 or -6.
5- Laser, intravitreal injection and intraocular surgery that have been done within 3 months before OCT assessment.
6- Glaucoma.
7- Systemic diseases complicated with significant fluid retention as hypertension, heart failure, renal failure, liver cell failure and chronic obstructive pulmonary disease (COPD).

Study design:

All subjects participating in the study were asked to sign consent before inclusion. Then they were subjected to:

1. Full Medical history.
2. Blood sample was taken on the day of OCT assessment to measure HbA1c level.
3. Measurements of the IOP, and CMT and SFCT measurements by SD OCT (EDI).

Ocular examination included:

a- Best corrected visual acuity (BCVA) using a Snellen chart.
b- Intraocular pressure by Goldman applanation tonometer.
c- Anterior and posterior segment examination by a slit-lamp biomicroscopy.
d- Dilated fundus examination with both slit-lamp biomicroscopy with a 90D lens and indirect ophthalmoscopy.

The proliferative diabetic retinopathy (PDR) was diagnosed according to the simplified Early Treatment Diabetic Retinopathy Study (ETDRS) severity scale (ETDRS Research Group 1991) by the presence of the fibrovascular, proliferation, new vessels elsewhere, and new vessels at < 1 disc diameter of the disc, preretinal hemorrhage, or vitreous hemorrhage.

SD-OCT scanning protocols

OCT examination was done to all patients using The Spectralis OCT device (Heidelberg Engineering, Dossenheim, Germany) (software version 5.6.3.0; Heidelberg Engineering). The Spectralis OCT has an acquisition rate of 40,000 A-scans per second. It uses a dual-beam SD-OCT and a confocal scanning laser ophthalmoscope (CSLO) that uses a scanning laser diode with a wavelength of 870 nm and an infrared reference image simultaneously to provide images of ocular structures. The instrument incorporates a real-time eye tracking system that couples CSLO and SD-OCT scanners to adjust for eye motion.

Macular scan was conducted using preset fast scan with macular cube volume of (20º×20º), with number of scans 25 A-scan and distance between scans 259 µm with scan angle 20º.

The changes in the SFCT were recorded with the EDI-OCT technique, with retinal scans performed along horizontal lines (7 lines, 30º × 10º) through the center of the fovea. For the EDI-OCT technique, each section was obtained using eye tracking, and 25 scans were averaged to improve the signal-to-noise ratio. The CMT was defined as the distance between the internal limiting membrane (ILM) to the RPE, and the SFCT was defined as the distance between the outer border of the hyperreflective line corresponding to the RPE and the outer border of the choroid beneath the centre of the fovea**.**

Patients with HbA1c ≤7 % were defined as controlled group and patients with HbA1c > 7% were defined as uncontrolled group.

Statistical Analysis:

Data Management and Analysis:

The collected patient's data were revised, coded, tabulated and introduced to a PC using statistical package for social sciences (IBM SPSS VERSION 20.0). Data were presented and suitable analysis was done according to the type of data obtained for each parameter.

I- Descriptive Statistics:

1. Mean and standard deviation (SD).
2. Frequency and percentage of non-numerical data.

II- Analytical Statistics:

1. **Independent sample t-test** was used to assess the statistical significance of the difference of a parametric variable between two independent means of two study groups; while **Mann Whiney U test** was used in case of non-parametric variable.
2. **Chi square test** was used to examine the relationship between two qualitative variables but when the expected count is less than 5 in more than 20% of the cells; **Fisher's Exact Test** was used.
3. **Pearson Correlation Coefficient (r) in parametric variables and Spearman correlation coefficient (Rho) in non-parametric variables** was used.
4. ***P-value: Level of significance:*** P>0.05: Non significant (NS) - *p*<0.05: Significant (S) - *p*<0.01: Highly significant (HS).

RESULTS

The demographic characteristics and selected risk factors are presented in table 1.

Both groups were comparable as regard age, sex, type of DM and BCVA, but controlled HbA1c group had shorter duration of DM, lower HbA1c level, lower center macular thickness (CMT), lower total macular volume and higher subfoveal choroidal thickness than uncontrolled HbA1c group (statistically significant difference between controlled HbA1c group and uncontrolled HbA1c group p<.05).

Table (1): Demographic characteristic and selected risk factor for proliferative diabetic retinopathy patients Values are numbers (percentage).

Characteristic	Controlled HbA1c group	Uncontrolled HbA1c group
Mean (SD) age (years)	53.66±8.48	56.87±6.46
Number of male patients	6 (30%)	4 (20%)
Number of female patients	14 (70%)	16 (80%)
Number of type I DM	3 (15%)	2 (10%)
Number of type II DM	17 (85%)	18 (90%)
Mean (SD) duration of DM (years)	9.44±6.29	14.31±6.22
Mean (SD) HbA1c (%)	6.78±0.22%	8.68±1.07%
Mean (SD) BCVA	0.18±0.78	0.19±0.81
Mean (SD) CMT (μm)	232.41±94.96	317.21±133.66
Mean (SD) total macular volume	8.27±0.89	9.46±1.53
Mean (SD) SFCT (μm)	302.45±28.64	257.76±39.18

Table (2): Comparison between controlled HbA1c group and uncontrolled HbA1c group as regard Age.

Variables	Controlled (HbA1c≤ 7)		Uncontrolled (HbA1c< 7)		*p*-value
	Mean	±SD	Mean	±SD	
Age	53.66	8.48	56.87	6.46	>0.05

There was a statistically insignificant difference between controlled HbA1c group and uncontrolled HbA1c group regarding age.

Table (3): Comparison between controlled HbA1c group and uncontrolled HbA1c group as regard sex, and type of diabetes mellitus (DM).

		HbA1c_group				*p*-value
		Controlled (HbA1c ≤7)		Uncontrolled (HbA1c >7)		
		No.	%	No.	%	
Sex	Male	6	30%	4	20%	>0.05
	Female	14	70%	16	80%	
Type of DM	Type I	3	15%	2	10%	>0.05
	Type II	17	85%	18	90%	

There was statistically insignificant difference between controlled HbA1c group and uncontrolled HbA1c group regarding sex and type of DM. In controlled HbA1c group 65% patients were normotensive and 35% patients were hypertensive and in uncontrolled HbA1c group 25.0% patients were normotensive and 75.0% patients were hypertensive, so there was a highly statistically significant difference between controlled HbA1c group and uncontrolled HbA1c group regarding BP.

Table (4): Comparison between controlled HbA1c group and uncontrolled HbA1c group as regard best corrected visual acuity (BCVA), intraocular pressure (IOP) and duration of diabetes mellitus (DM).

Variables	Controlled (HbA1c ≤7)		Uncontrolled (HbA1c>7)		*p*-value
	Mean	+ SD	Mean	+ SD	
BCVA	0.18	0.78	0.19	0.81	>0.05
IOP	16.93	1.38	18.22	1.91	0.002**
Duration	9.44	6.29	14.31	6.22	<0.001**

(**) Highly statistically significant at $p<0.01$

There was a highly statistically significant difference between controlled HbA1c group and uncontrolled HbA1c group regarding IOP and duration of DM, but there was statistically insignificant difference between controlled HbA1c group and uncontrolled HbA1c group regarding BCVA.

Table (5): Comparison between controlled HbA1c group and uncontrolled HbA1c group as regard average MT, total macular volume, superior inner MT, superior outer MT, temporal inner MT, temporal outer MT, inferior inner MT and nasal inner MT.

Variables	Controlled (HbA1C≤ 7)		Uncontrolled (HbA1C> 7)		*p*-value
	Mean	+ SD	Mean	+ SD	
Average MT	287.52	32.02	328.24	53.45	0.006**
Total macular volume	8.27	0.89	9.46	1.53	0.005**
Superior inner MT	307.99	45.31	352.11	62.84	<0.02*
Superior outer MT	284.99	38.74	321.16	49.03	0.001**
Temporal inner MT	296.03	48.94	343.35	77.57	<0.03*
Temporal outer MT	275.62	34.78	316.13	56.05	<0.01**
Inferior inner MT	292.60	53.28	350.39	94.57	<0.03*
Nasal inner MT	303.05	63.11	351.10	86.90	>0.05

(**) Highly statistically significant at $p<.01$

There was a highly statistically significant difference between controlled HbA1c group and uncontrolled HbA1c group as regard Average MT, total macular volume, Superior inner MT, Superior outer MT, Temporal inner MT, Temporal outer MT, Inferior inner MT and Nasal inner MT (p<.01).

Table (6): Comparison between controlled HbA1c group and uncontrolled HbA1c group as regard center macular thickness (CMT), foveal macular thickness (FMT), inferior outer MT and nasal outer MT.

Variables	Controlled (HbA1C≤ 7)		Uncontrolled (HbA1C> 7)		*p*-value
	Mean	+ SD	Mean	+ SD	
Center MT	232.41	94.96	317.21	133.66	0.007*
Foveal macular thickness	249.27	82.76	329.56	116.29	0.001**
inferior outer MT	282.80	33.83	317.26	82.54	0.039*
nasal outer MT	298.33	44.48	331.18	67.37	0.006*

(*) Statistically significant at $p<.05$, (**) Highly statistically significant at $p<.01$

There is a highly statistically significant difference between controlled HbA1c group and uncontrolled HbA1c group as regard center MT, foveal thickness, inferior outer MT and nasal outer MT ($p<.05$).

Table (7): Show comparison between controlled HbA1c group and uncontrolled HbA1c group as regard choroidal thickness (CT).

Distance from fovea	Controlled (HbA1c≤7)		Uncontrolled (HbA1c >7)		*p*-value
	Mean	+ SD	Mean	+ SD	
Temporal 1000 µm CT	275.62	34.78	241.52	41.60	<0.01**
Temporal 500 µm CT	284.36	33.18	244.40	39.89	<0.002**
Subfoveal CT	302.45	28.64	257.76	39.18	0.000**
Nasal 500 µm CT	291.02	31.63	243.89	41.55	0.000**
Nasal 1000 µm CT	286.70	32.29	240.32	46.76	0.000**

(**) Highly statistically significant at $p<.01$

There was a highly statistically significant difference between controlled HbA1c group and uncontrolled HbA1c group as regard CT measurement subfoveal, at 500 µm and 1000 µm temporal to fovea and 500 µm and 1000 µm nasal to fovea ($p<.01$).

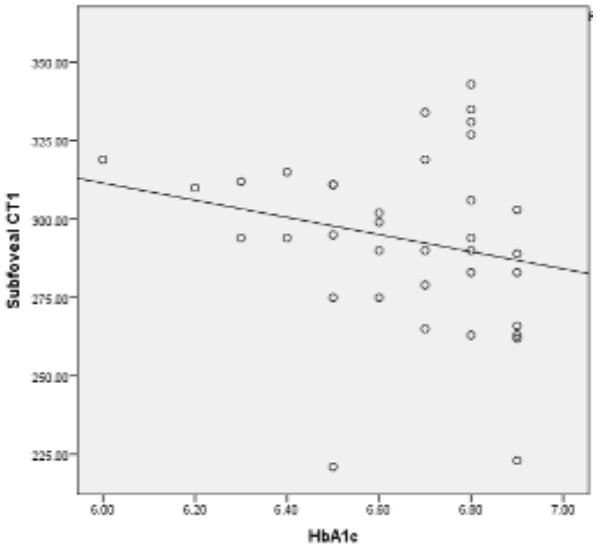


Figure (1): Correlation between glycosylated hemoglobin (HbA1c) and subfoveal choroidal thickness (SFCT) in controlled HbA1c group.

There was weak negative correlation between glycosylated hemoglobin (HbA1c) and subfoveal choroidal thickness (SFCT) in controlled HbA1c group, which was statistically insignificant ($p>.05$)

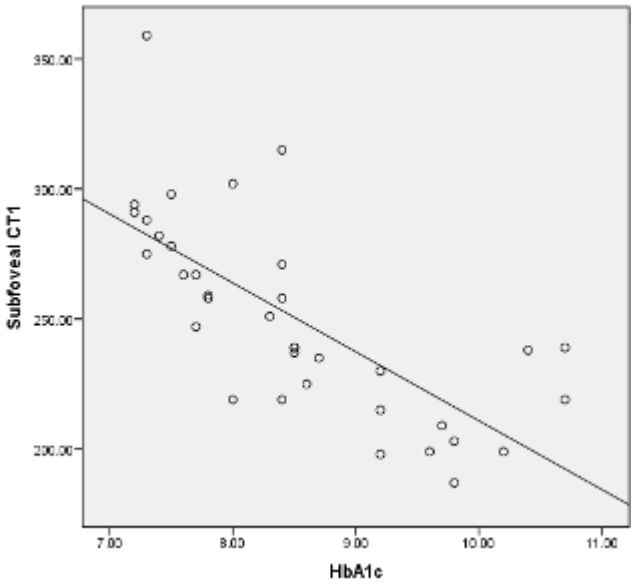


Figure (2): Correlation between glycosylated hemoglobin (HbA1c) and subfoveal choroidal thickness SFCT in uncontrolled HbA1c group.

There was a strong negative correlation between glycosylated hemoglobin (HbA1c) and subfoveal choroidal thickness (SFCT) in uncontrolled HbA1c group, which was statistically significant (p>.05).

Spearman correlation coefficient test was computed to assess the relationship between foveal macular thickness (FMT) and subfoveal choroidal thickness (SFCT) in controlled HbA1c group (Figure 3) and uncontrolled HbA1c group (Figure 4).

In controlled HbA1c group, there was a very weak negative correlation between foveal macular thickness (FMT) and subfoveal choroidal thickness (SFCT), which was statistically insignificant (r= -.041, p=.762).

In uncontrolled HbA1c group, there was a weak negative correlation between foveal macular thickness (FMT) and subfoveal choroidal thickness (SFCT), which was statistically insignificant (r= -.249, p=.240).

The results suggested that increase in FMT correlated with decrease in SFCT.

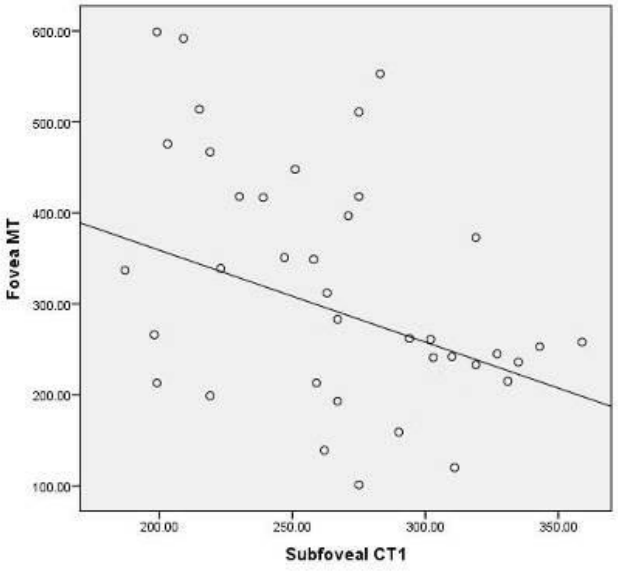


Figure (3): Correlation between subfoveal choroidal thickness (SFCT) and foveal macular thickness (FMT) in controlled HbA1c group.

There was a very weak negative correlation between subfoveal choroidal thickness (SFCT) and foveal macular thickness (FMT) in controlled HbA1c group, which was statistically insignificant (p>.05).

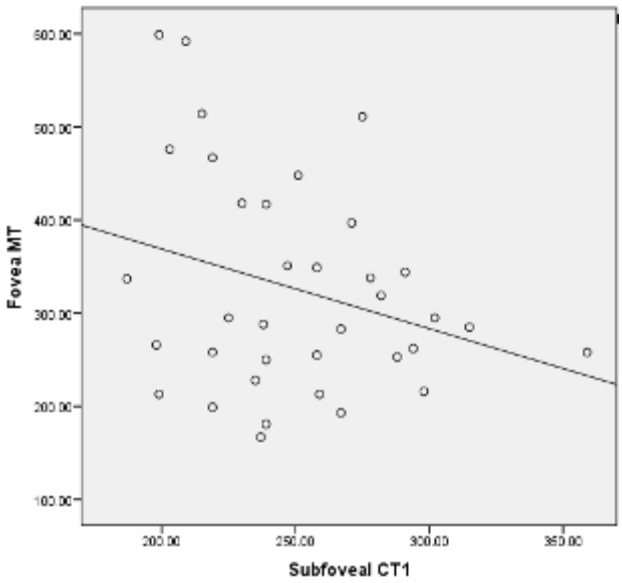


Figure (4): Correlation between subfoveal choroidal thickness (SFCT) and foveal macular thickness (FMT) in uncontrolled HbA1c group.

There was a weak negative correlation between subfoveal choroidal thickness (SFCT) and foveal macular thickness (FMT) in uncontrolled HbA1c group, which was statistically insignificant (p>.05).

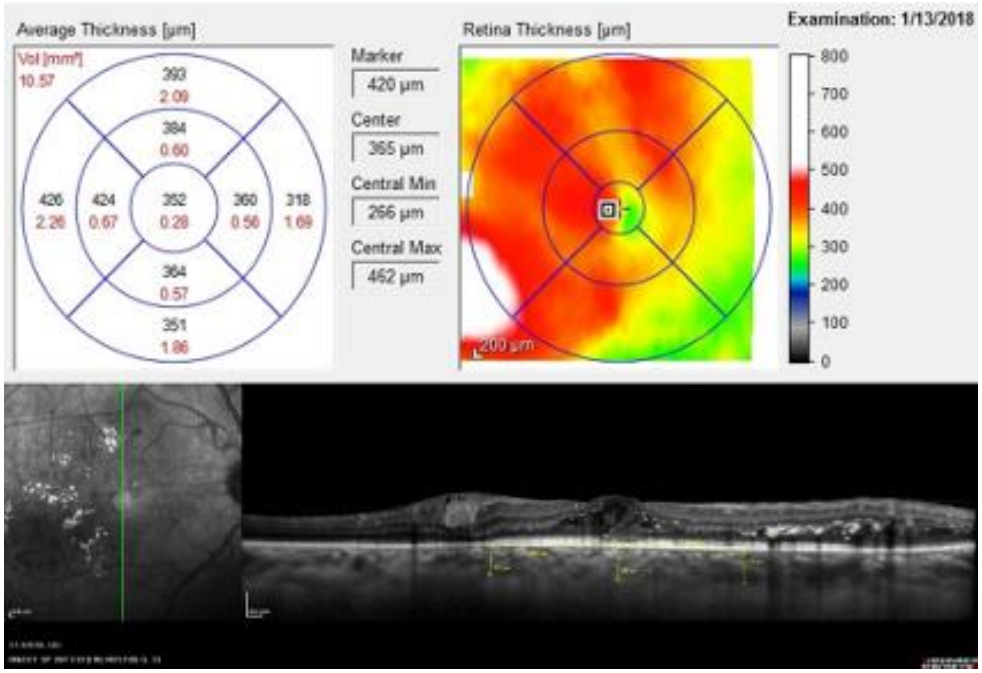


Figure (5): CMT and Choroidal thickness by EDI in Group 1 controlled HA1c

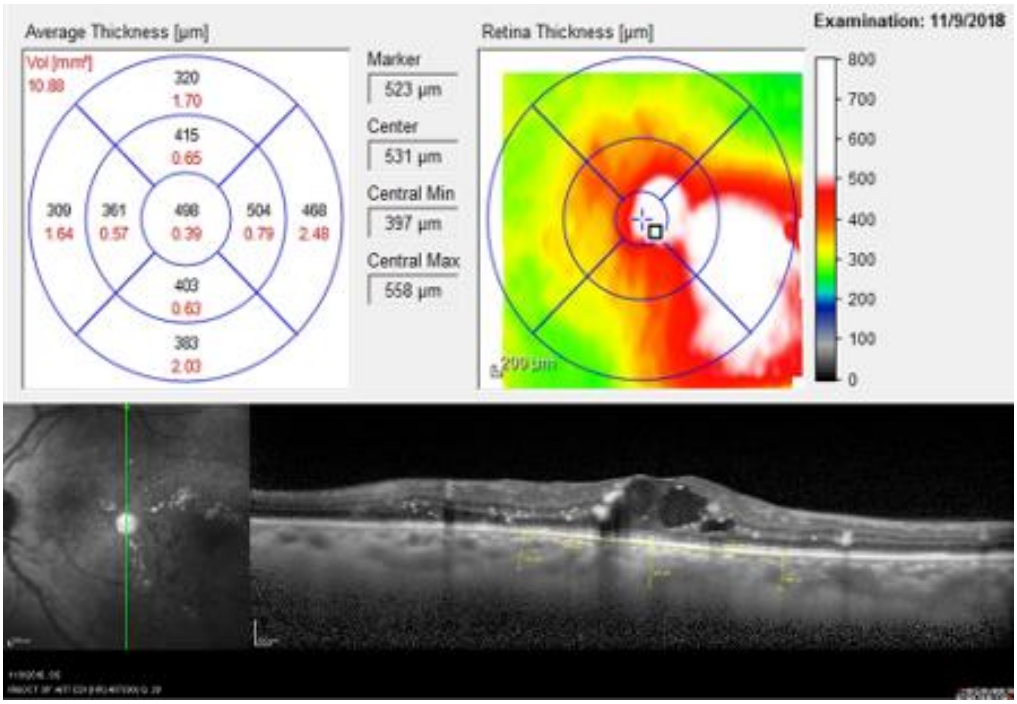
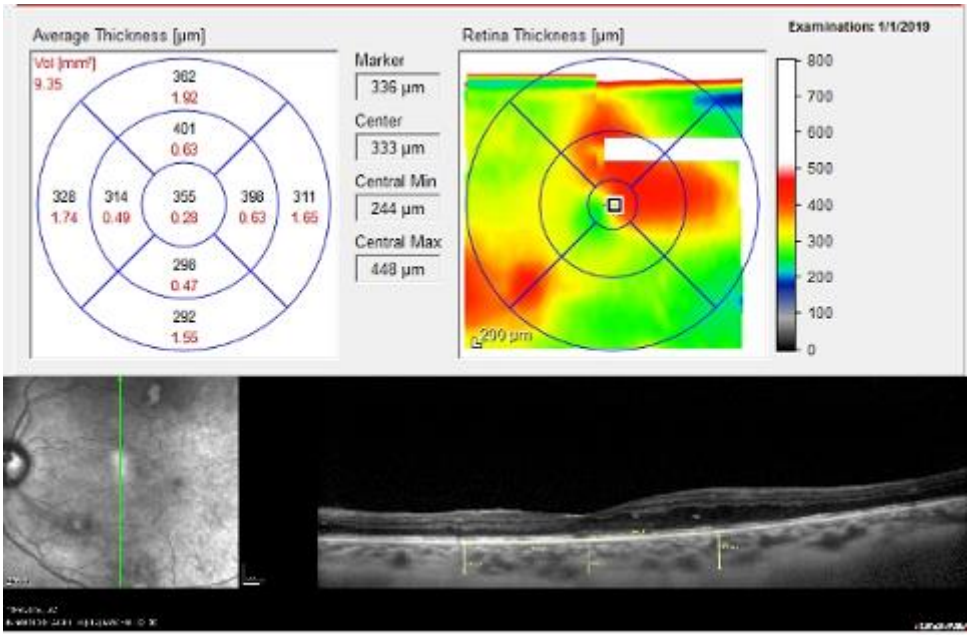


Figure (6): CMT and Choroidal thickness by EDI in Group 1 controlled HA1c



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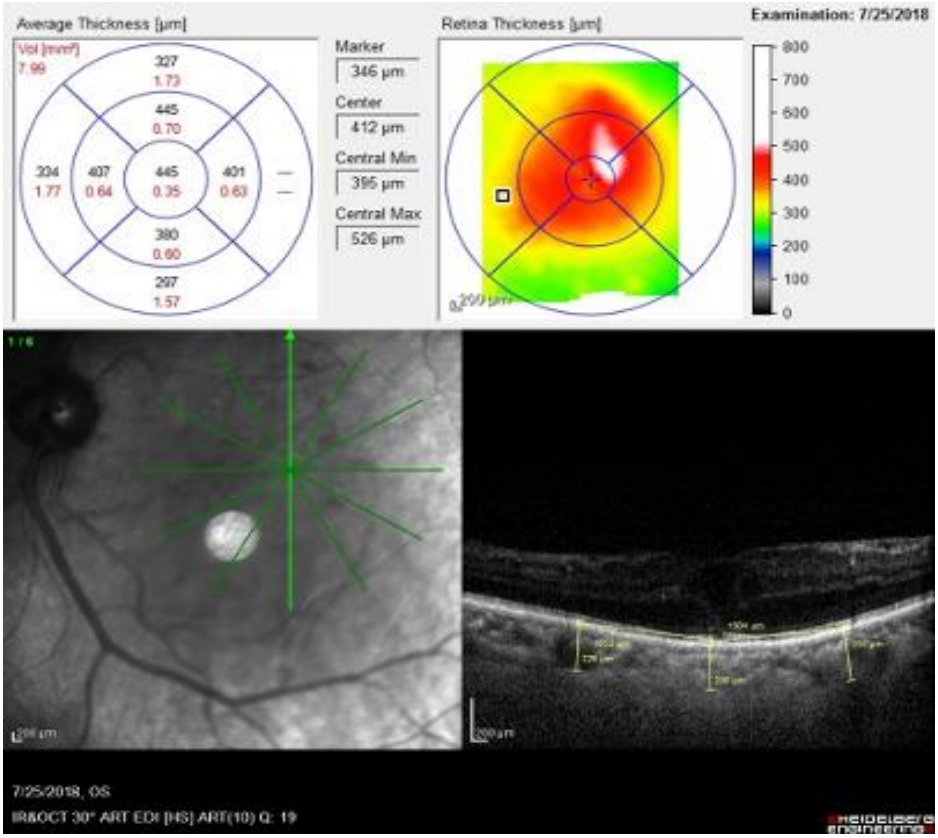

Figure (8): CMT and Choroidal thickness by EDI in Group 2 in uncontrolled HA1c

Table (8): Comparison between time of examination and after 3 months according to all parameters in uncontrolled (HbA1C>7).

Uncontrolled (HbA1C> 7)	Pre		After 3 months		p-value
	Mean	±SD	Mean	±SD	
BCVA	0.19	0.81	0.21	0.88	>0.05
IOP	18.22	1.91	18.04	1.89	>0.05
Average MT	328.24	53.45	324.96	52.92	>0.05
Total macular volume	9.46	1.53	9.37	1.51	>0.05
Superior inner MT	352.11	62.84	348.59	62.21	>0.05
Superior outer MT	321.16	49.03	317.95	48.54	>0.05
Temporal inner MT	343.35	77.57	341.63	77.18	>0.05
Temporal outer MT	316.13	56.05	314.55	55.77	>0.05
Inferior inner MT	350.39	94.57	346.89	93.62	>0.05
Nasal inner MT	351.1	86.9	347.59	86.03	>0.05
Center MT	317.21	133.66	314.04	132.32	>0.05
Foveal macular thickness	329.56	116.29	326.26	115.13	>0.05
inferior outer MT	317.26	82.54	314.09	81.71	>0.05
nasal outer MT	331.18	67.37	327.87	66.70	>0.05
Temporal 1000 µm CT	241.52	41.6	244.18	42.06	>0.05
Temporal 500 µm CT	244.4	39.89	247.09	40.33	>0.05
Subfoveal CT	257.76	39.18	260.60	39.61	>0.05
Nasal 500 µm CT	243.89	41.55	246.57	42.01	>0.05
Nasal 1000 µm CT	240.32	46.76	242.96	47.27	>0.05

This table shows no statistically significant difference between time of examination and after 3 months according to all parameters in uncontrolled (HbA1C>7) after controlling HbA1C.

DISCUSSION

In our study the center macular thickness (CMT) was significantly lower in controlled HbA1c group than uncontrolled HbA1c group with medium effect size, the total macular volume (TMV) was significantly lower in controlled HbA1c than uncontrolled HbA1c with large effect size and the subfoveal choroidal thickness (SFCT) was significantly higher in controlled HbA1c group than uncontrolled HbA1c group with large effect size.

Diabetic retinopathy (DR) is a complication of diabetes mellitus (DM) and a leading cause of blindness worldwide. DR is generally thought to be caused by abnormalities of retinal microvasculature, but recent studies have shown that the choroid plays an important role in the progress of DR. The choroid is a layer of the eye that provides 95% of the ocular blood flow; it supplies oxygen and nutrients to the outer retina, including photoreceptors and retinal pigment epithelium, and is the sole provider of blood flow to the avascular fovea. This function of the choroid is affected in DR, in association with choroidal vasculopathy [(12)].

We excluded from the study patients with refraction more than +6 or -6 to exclude the effect of axial length on choroidal thickness (CT), patients had pan retinal photocoagulation (PRP) or intravitreal injection within 3 months before optical coherence tomography (OCT) assessment to exclude their effect on macular thickness (MT) and choroidal thickness (CT) and patients with systemic diseases complicated with significant fluid retention as heart failure, renal failure, liver cell failure, hypertension and chronic obstructive pulmonary disease (COPD) to exclude their effect on CT.

In our study the 2 groups were comparable regarding age and the mean age of the 2 groups was > 50 years old.

In agreement with our study **Lima *et al.*** [(13)] reported a greater chance of diabetic retinopathy (DR) in individuals aged 50–59 years and ≥60 years and **Raman *et al.*** [(14)] also reported the significance of age as a risk factor for DR**.**

In contrast to our study **Yang *et al.*** [(15)] reported no association between age and DR.

In our study the 2 groups were comparable regarding sex but in controlled HbA1c 72.2% patients were female and in uncontrolled HbA1c group 80.6% patients were female.

In agreement with our study **Maric-Bilkan** [(16)] reported greater chance of DR among females.

In contrast to our study **Raman *et al.*** [(14)] reported greater chance of DR among males.

In our study the 2 groups were comparable regarding BCVA although we used Snellen chart for visual acuity measurement not logMAR method.

In our study the mean duration of DM was longer and HbA1c level was higher in uncontrolled HbA1c group than controlled HbA1c group and the macular thickness (MT) was thicker and in uncontrolled HbA1c group than controlled HbA1c group.

In agreement with our study **Romero-Aroca *et al.*** [(17)] reported that the incidence of macular edema over the 8-year period was associated with higher levels of glycosylated hemoglobin and more severe retinopathy in both younger- and older-onset groups.

Yeoung *et al.* [(18)] also reported that HbA1c level positively correlated with macular thickness in patients with type I and II diabetes of 10 or more year's duration without diabetic macular edema. This study suggests that subclinical macular volume and thickness changes may occur before diabetic macular edema (DMO) becomes clinically evident.

So we could suggest that intensive glycemic control is associated with delaying the development and progression of diabetic retinopathy. HbA1c of 7 or above increased the risk of diabetic macular edema (DME).The duration of diabetes is also a risk factor for development of DME. However, the reported duration of type II DM is usually not reliable due to the non-specific symptoms of DM and difficulty of the patient to recall those symptoms. Some patients were diagnosed with known diabetic complications, indicating that they likely had the disease for years before being diagnosed.

Tuncer *et al.* [(19)] reported that CT shows mild decrease with age, so the age may have a minor effect on choroidal thinning.

In our study uncontrolled HbA1c group with thinner CT also have higher macular thickness (diabetic macular edema) and we included proliferative diabetic retinopathy (PDR) patients who had active neovascularization and we excluded patients who did laser within 3 months before OCT assessment.

In agreement to our study **Laíns *et al.*** [(20)] optical coherence tomography demonstrated a significant reduction of CT in PDR compared with controls. In the foveal region, the choroid appears to be thinner in DR eyes than in diabetic eyes without retinopathy. **Ünsal *et al.*** [(21)] also reported that CT decreases as the disease progresses from mild–moderate NPDR to PDR

and in DME than non DME patients, so we could conclude that the relation between the severity of HbA1c level and CT in diabetes mellitus, but they included PDR patients who had received PRP treatment and they found the CT was decreased significantly, in contrast to our study we excluded patients who had pan retinal photocoagulation (PRP) within 3 months before the OCT assessment.

Laíns *et al.* [20] also reported that significant decrease in choroidal thickness was observed in the mild-to-moderate NPDR, severe NPDR and PDR groups and eyes with macular edema showed significantly decreased choroidal thickness compared with the controls**. This is in** agreement with our study but our study included only PDR patients**.**

Wang *et al.* [22] reported that choroidal vascular density and volume are significantly reduced in more advanced stages of diabetic retinopathy. **Schocket *et al.* [23]** reported that choroidal volume and choroidal blood flow are significantly reduced in patients with PDR, but no significant correlations were observed between choroidal volume and choroidal blood flow and HbA1c**,** in contrast to our study in which we found that CT is significantly higher in controlled HbA1c group than uncontrolled HbA1c group.

In contrast to our study **Kim *et al.* [24]** reported that choroidal thinning in PRP-treated eyes, but eyes with DME had a thicker choroid than those without DME, In addition, they observed progressive thickening of the choroid layer with increasing severity of DR from mild/moderate NPDR to severe NPDR, or from severe NPDR to PDR and some degree of reduced choroidal thickness among eyes with no DR or early NPDR. But they did not enroll hypertension as a risk factor for choroidal thinning because the number of patients with hypertension was too small, statistical analysis could not be conducted. Whereas BP showed no association with CT, but in our study uncontrolled HbA1c group with thicker MT (DME) and thinner CT 75% patients were hypertensive patients compared to controlled HbA1c group 36% patients were hypertensive patients and in our study we included patients with PDR only.

Kim *et al.* [24] also detect that clinically the stage of PDR was associated with greater risk of systemic vascular complications, such as ischemic heart disease, This close association suggests that increased CT could be interpreted as a marker of compromised systemic vasculature, in contrast to our study we excluded patients with systemic diseases other than DM complicated with significant fluid retention as heart failure, renal failure, liver cell failure and chronic obstructive pulmonary disease (COPD).

We could assumed that the thinner choroid may indicate an overall reduction of choroidal blood flow (although we did not include an objective choroidal blood flow test) in patients with DME and more prominent in PDR patients with uncontrolled HbA1c, as was previously demonstrated with laser Doppler flowmetry and indocyanine green angiography **[23].**

Therefore, it is likely that the decreased CT may be related to retinal tissue hypoxia, as the choroid is the major source of nutrition for the RPE and outer retinal layers. What is not clear is whether the thinning detected is primary or secondary to overlying retinal ischemia. Laser treatment may make more choroidal thinning also. We exclude patients had PRP treatment within 3 months before OCT assessment and the age may had a minor effect on choroidal thinning since in our study the mean age in controlled HbA1c group was 52.61 years SD ± 8.31 and in uncontrolled HbA1c group was 55.75 years SD ± 6.33.

CONCLUSION

Intensive glycemic control might affect retinal and choroidal vasculature and decrease ischemia and affect the development and progression of diabetic retinopathy. Glycosylated hemoglobin of 7 or above increase the risk of macular edema and choroidal thinning.

Optical coherence tomography is a sensitive and noninvasive diagnostic tool in the evaluation of macular and choroidal thickness.

Hypertension is also an important risk factor in the development of diabetic retinopathy, diabetic macular edema and diabetic choroidopathy.

RECOMMENDATION

Periodic optical coherence tomography examination and glycosylated hemoglobin measurement may provide enough information about dynamic state of macular and choroidal thickness.

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