

SUBFOVEAL CHOROIDAL THICKNESS CHANGES IN DIABETIC MACULAR EDEMA WITH CYSTIC CHANGES BY USING SPECTRAL DOMAIN- OPTICAL COHERENCE TOMOGRAPHY

By

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ABSTRACT

Background: Diabetic macular edema (DME) results from breakdown of retinal vasculature integrity and hemodynamic abnormalities. Choroidal thickness is an important metric for the blood flow and choroidal health.

Objective: To correlate Subfoveal Choroidal Thickness (SFCT) with central macular thickness (CMT) in DME with and without cystic changes by using spectral domain optical coherence tomography (SD-OCT).

Patients and Methods: A prospective study was conducted on 120 eyes of 68 diabetic patients, divided according to OCT macula into three equal groups: Group A: Diabetic patients with normal CMT, Group B: Have non-cystic diabetic macular edema and Group C: Have cystic diabetic macular edema. Measurements of CMT and SFCT by using spectral domain optical coherence tomography (SD-OCT). This study was conducted at Ophthalmology Department, Bahtem hospital for specialized surgery, Health Insurance, during the period from August 2018 to February 2020.

Results: Sixty-eight patients had a mean age of 54.96 ± 8.36 years. The mean SFCT have insignificant correlation could be demonstrated between SFCT and CMT ($r = -0.323$, $P = 0.45$), in group B, a positive correlation was observed ($r = 0.614$, $P = 0.027$), while in group C a negative correlation with CMT ($r = -0.875$, $P = 0.02$). There was insignificant correlation could be demonstrated between SFCT and BCVA (LogMAR) in all groups: in group A ($r = -0.251$, $P = 0.35$), in the group B ($r = -0.318$, $P = 0.15$), and in group C ($r = -0.735$, $P = 0.23$).

Conclusion: Mean SFCT decrease with cystic changes in DME patients.

Key word: subfoveal choroidal thickness, central macular thickness, diabetic macular edema and spectral domain optical coherence tomography.

INTRODUCTION

The choroid provides nutrients and oxygen to the outer third of the retina and consists of 3 vascular layers: the choriocapillaris layer, the choroidal layer being composed of medium-sized vessels (Sattler layer), and Haller layer (large-vessel choroidal layer) (Barteselli *et al.*, 2012).

Because the choroid is involved in many diseases of the posterior segment, an analysis of changes in its morphological features and vasculature in chorioretinal diseases may be of clinical relevance (Falcao *et al.*, 2014). Thus, choroidal thickness is an important metric for the blood flow and choroidal health. Therefore, it is important to measurement

of choroidal thickness to better understand this vital structure (*Fong et al., 2011*).

Macular edema is one of most frequent and serious consequence with many ocular changes. Cystoid macular edema (CME) caused by accumulation of intraretinal fluid in cystic spaces at the outer plexiform and inner nuclear layers of the retina due to breakdown of the blood–retinal barrier (*Shahzad et al., 2018*).

The purpose of this study was to correlate the mean SFCT with CMT, using the SD-OCT technique.

PATIENTS AND METHODS

A prospective interventional study was conducted on 120 eyes in 68 patients (one eye of 16 patients and both eye in 52 patients). Females were 38 and 30 were males. This study was conducted at Ophthalmology Department, Bahtem hospital for specialized surgery, Health Insurance, during the period from August 2018 to February 2020. Patients were divided according to OCT macula into three equal groups:

1. **Group A:** Diabetic patients with normal CMT.
2. **Group B:** Non cystic Diabetic macular edema with increase CMT without cystic changes.
3. **Group C:** Cystic Diabetic macular edema with increase CMT with cystic changes.

Exclusion criterion: Patients with media opacities as corneal opacity or dense cataract precluding visualization of retinal fundus, high myopia or hypermetropia, diabetic retinopathy complication as

vitreous hemorrhage or ERM, and previous retinal surgery.

All patients were subjected to complete ophthalmological examination after reviewing the medical history. The examination included best corrected visual acuity (BCVA) measured by the Snellen chart and converting it to the logarithm of the minimum angle of resolution (logMAR) using visual acuity conversion tables before conducting statistical analysis, slit-lamp examination, measuring IOP by using Goldmann applanation tonometer, fundus examination using an indirect ophthalmoscope, and macular status evaluation using slit-lamp biomicroscopy with the +90 D lens.

SD-OCT (3D OCT 2000; Topcon, Tokyo, Japan) using high resolution 12 radial macular scans was done in all patients. This 6-mm line scan with an axial resolution of about 5 μ m in tissue. This process gives better visualization of the choroid.

The subfoveal choroidal thickness was measured by using the calipers within the software of the OCT machine and positioning them from the outer aspect of Bruch's membrane to choroidoscleral interface.

Statistical methods: Data were collected, tabulated and entered to the Statistical Package for the Social Sciences software version 23. Quantitative data were presented as mean \pm standard deviations (SD) and ranges when non-skewed. Qualitative variables were presented as number and percentages.

ANOVA test was used for comparison of quantitative variables between more

than two groups of normally distributed data was applied to compare mean retinal and choroidal thicknesses among the three patient groups. Kruskal Wallis test was used for comparison of quantitative variables between more than two groups of not normal distributed data, was applied to compare mean BCVA among the three patient groups. Post hoc test was used for comparison between each tow group separately.

Comparison of means to check for statistically significant difference for different variables was conducted using the unpaired t-test for continuous independent variables. Pearson correlation was used to calculate the correlation between different variables in the same group was applied to correlate mean CMT & SFCT in the same groups. The confidence interval was set at 95% and the margin of error was set to 5%. So, the p-value was considered significant when < 0.05.

RESULTS

A prospective interventional study conducted on 120 eyes 68 diabetic patients (one eye of 16 patients and both eye in 52 patients) female 38 and 30

males. The mean age± SD of in a group A (51.8± 6.3 y years), a group B (55.4± 11.2 years) and a group C (57.7±7.6 years) (Table 1).

Table (1): Comparing the three groups as regards age and sex

Parameters \ Groups	Group A	Group B	Group C
Mean age± SD	51.8± 6.3 y	55.4± 11.2	57.7±7.6
Male/female %	18/22 (45%/55%)	19/21 (47.5%/52.5%)	16/24 (40%/60%)

In this study, revealed the mean CMT± SD was 233.36±25.65, 291.25±34.87, 454.6 ± 86.58µm in groups A, B, and C, respectively, Also, when analyzed the choroidal thickness revealed the mean SFCT±SD was 317.54±45.5, 296.12±64.5, 224.92±34.2 µm in groups A, B, and C, respectively and the mean BCVA (logMAR) ±SD was 0.33± 0.24, 0.51±

0.32, 0.71± 0.29 in groups A, B, and C, respectively (Table 2).

There was significant different in the CMT & SFCT between three groups (p-value= 0.047) & (p-value= 0.003) respectively (by using one-way ANOVA test), also there was no significant different in the BCVA between three groups (p-value= 0.08) (by using Kruskal-Wallis test) (Table 2).

Table (2): Comparison between three groups regarding SFCT, CMT and BCVA (logMAR) (Mean ±SD)

Parameters \ Groups	Group A	Group B	Group C	P-value
CMT	233.36 ± 25.65µm	291.25 ± 34.87µm	454.6 ± 86.58µm	0.047
SFCT	317.54 ±45.5 µm	296.12 ±64.5 µm	224.92 ± 34.2 µm	0.003
BCVA (logMAR)	0.33± 0.24	0.51± 0.32	0.71± 0.29	0.08

* SFCT &CMT done by one-way ANOVA test and BCVA done by Kruskal-Wallis test.

There was no significant difference in the retinal thickness between group A&B (p-value=0.07), but was significant between group A&C (p = 0.05) and Also between group B&C (p-value= 0.03). There was no significant difference in the retinal thickness between group A&B (p-

value=0.4), but was significant between group A&C (p = 0.003), Also between group B&C (p-value= 0.2). When comparing the significant p-values between each two groups in BCVA was not applicable by using post-hoc test (Table 3).

Table (3): Comparison of the significant p-value between each tow group regarding SFCT, CMT and BCVA (logMAR) (post-hoc test).

Parameters \ Groups	Group A & B	Group A & C	Group B & C
CMT	0.07	0.005*	0.03
SFCT	0.4	0.003*	0.02
BCVA (logMAR)	NA	NA	NA

NA= not applicable.

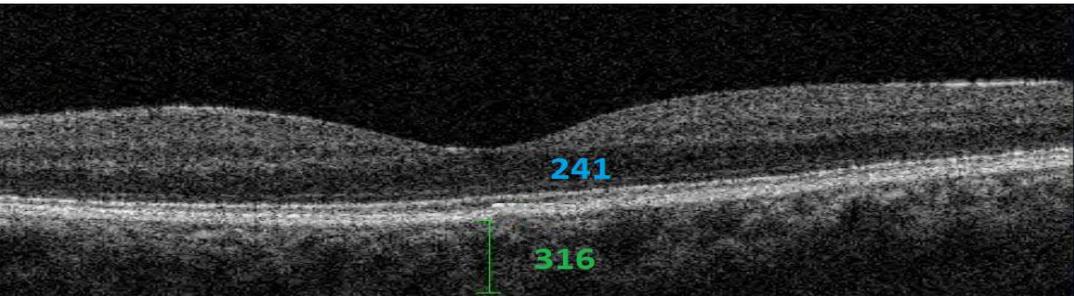
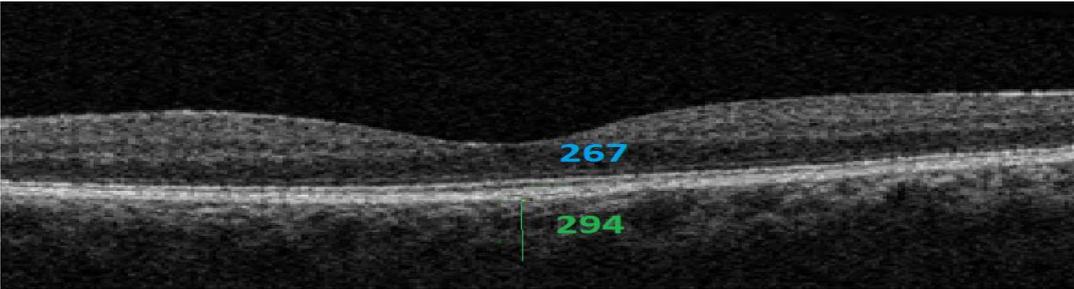
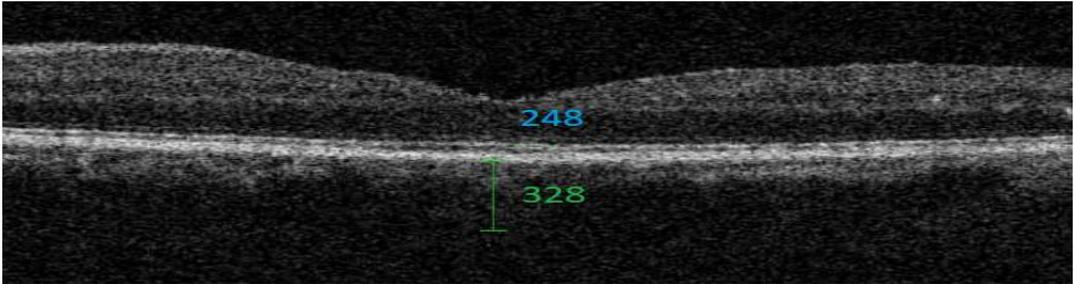
The correlation between CMT and SFCT was measured in each group separately revealed no significant correlation could be demonstrated between SFCT and CMT in group A, (r= -0.323, P= 0.45 Spearman rank correlation), while in group B, a positive correlation was observed between SFCT and CMT (r= 0.614, P=0. 027) indicating that the CMT increase as the SFCT increase and in group C, a negative correlation was observed between SFCT

and CMT (r= -0.875, P=0.02), indicating that the CMT increase as the SFCT decrease (Table 4).

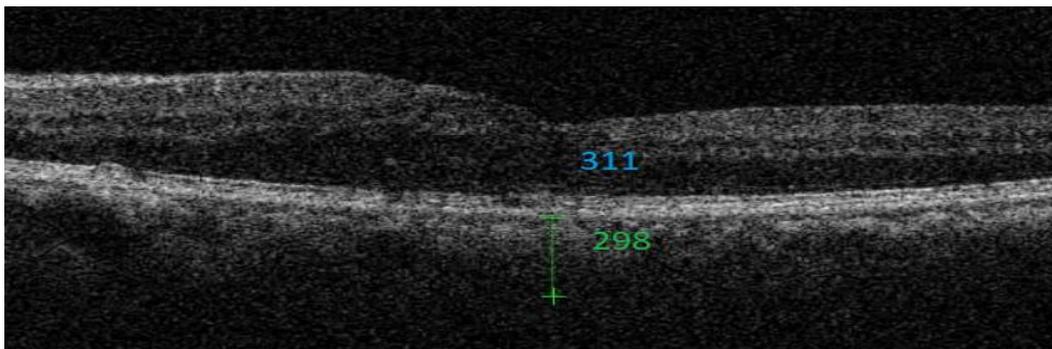
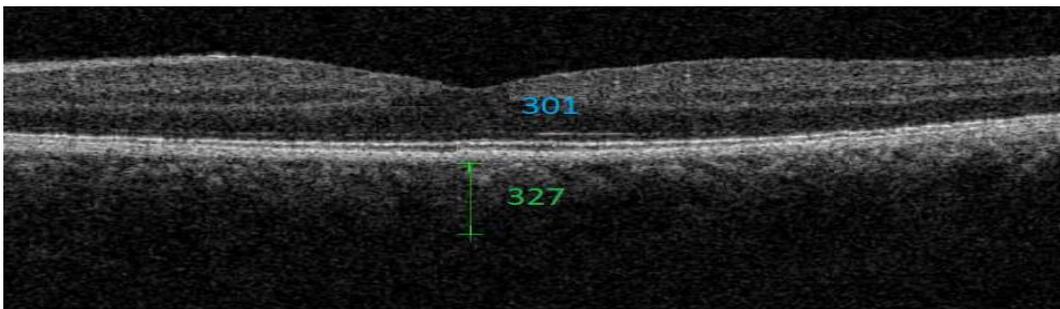
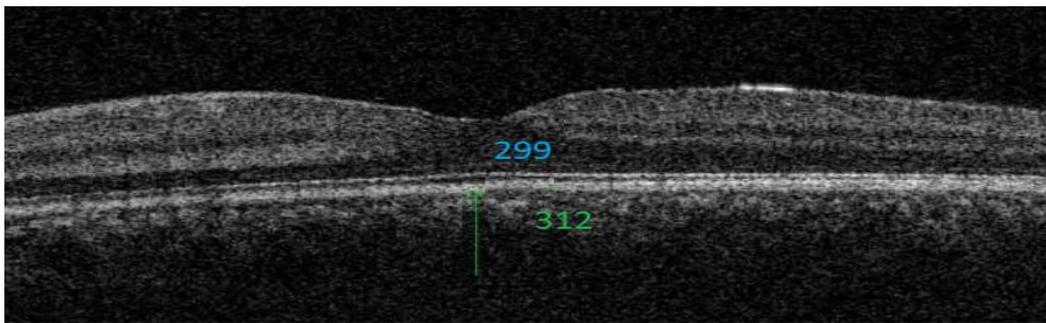
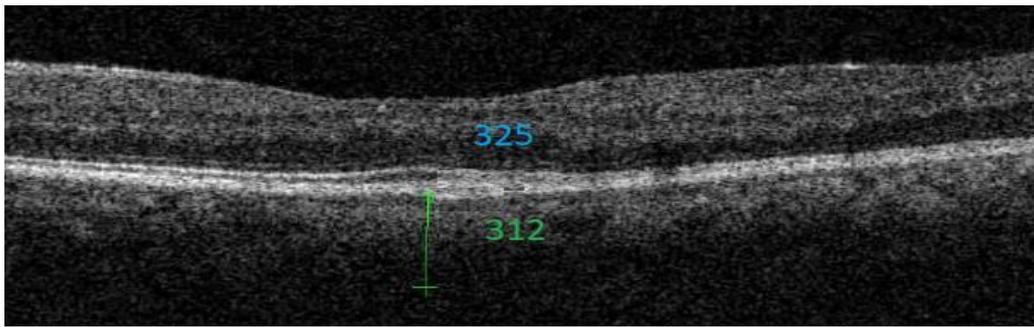
This study found no significant correlation could be demonstrated between SFCT and BCVA (LogMAR) in all groups: in group A (r= -0.251, P= 0.35), in the group B (r= -0.318, P=0.15), and in group C (r= -0.735, P=0.23) suggesting that SFCT is not directly related to BCVA (LogMAR) in these groups (Table 4).

Table (4): Correlation between SFCT/CMT and SFCT/BCVA (logMAR) in group A, B and C (r = correlation coefficient)

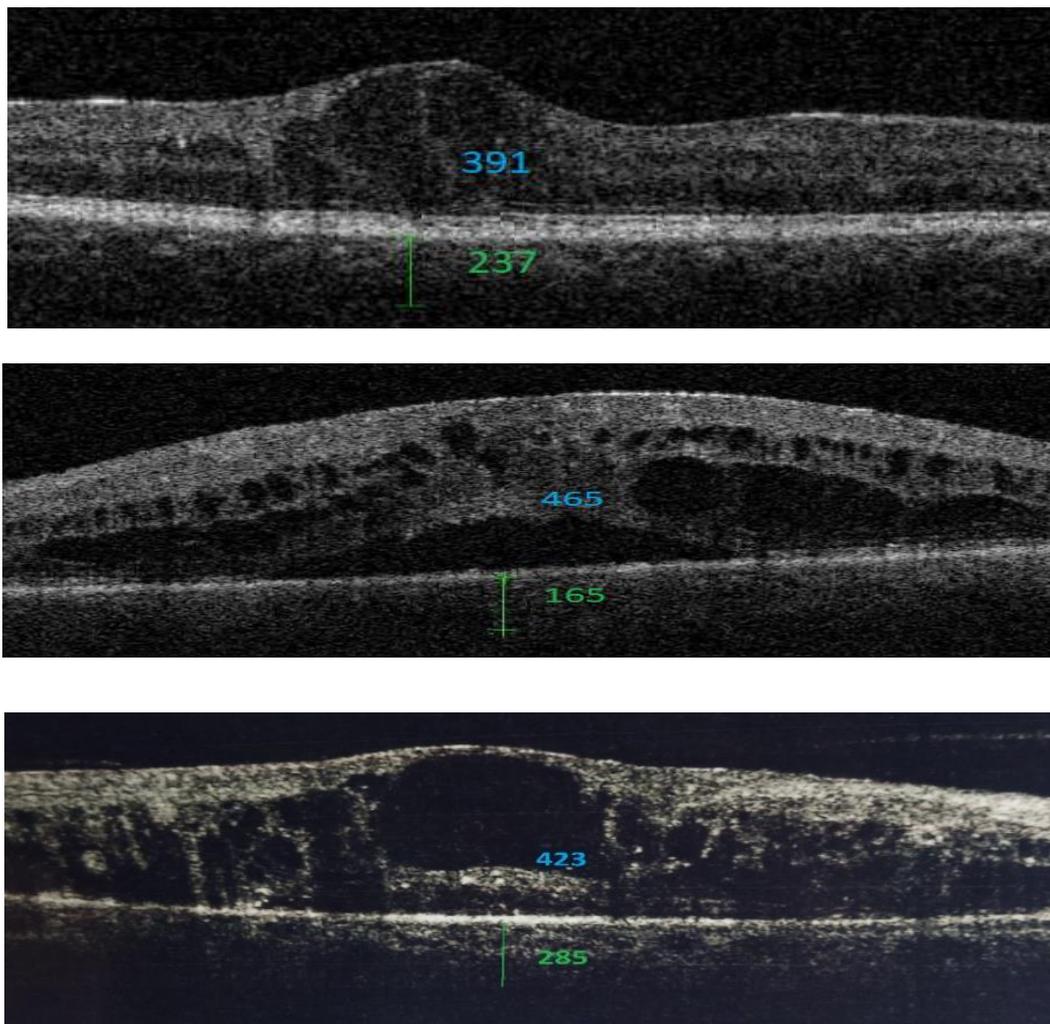
Parameters \ Groups	Group A		Group B		Group C	
	r	P	r	P	r	P
SFCT\CMT	-0.323	0.45	0.614	0.027	-0.875	0.02
SFCT\BCVA (logMAR)	-0.251	P= 0.35	-0.318	0.15	0.735	0.23



a) Normal CMT.



b) DMT without cystic changes.



c) DME with Cystic changes.

Figure (1): SFCT measurement by SD-OCT a) normal CMT, b) DME without cystic changes, and c) DME with cystic changes

DISCUSSION

Diabetic retinopathy results from breakdown of retinal vasculature integrity and hemodynamic abnormalities. SFCT was measured at subfoveal from the outer border of the hyperreflective layer corresponding to the RPE/Bruch membrane complex and the choroidal-scleral interface. Reproducibility of the total SFCT measurement has been reported.

There was significant different in the CMT and SFCT between three groups. Also there was no significant different in the BCVA between three groups.

The correlation between CMT and SFCT was measured in each group. In group A, no significant correlation could be demonstrated between SFCT and CMT. In group B, a positive correlation was observed between SFCT and CMT indicating that the CMT increase as the SFCT increase. In group C, a negative

correlation was observed between SFCT and CMT, indicating that the CMT increase as the SFCT decrease.

This study found no significant correlation could be demonstrated between SFCT and BCVA (LogMAR) in all groups.

There was a great controversy regarding changes of SFCT in diabetic retinopathy and DME. Most studies reported a decrease in Choroidal thickness in diabetic eyes either related to the stage of diabetic retinopathy (DR) or progressive decrease in Choroidal thickness with advance of the stage of DR. *Lee et al. (2013)* detected a significant decrease in SFCT in the mild-to-moderate NPDR, severe NPDR, and PDR groups while there were no significant differences among the three groups ($p > 0.05$). Similarly, *Esmaelpour et al. (2012)* in a multicenter trial have found a remarkably thinner choroid in DME patients than in healthy volunteers. *Al-Nashar et al. (2017)* showed a choroidal thinning with DME. The SFCT significantly decreased in DME group compared with the other two groups. A negative correlation was detected between CMT and SFCT in patients with DME while no correlation between them was found in other two groups. A significant correlation was observed between BCVA and SFCT in Group I while; in other two groups no correlation between the two measures was detected.

Mansour and Hegazy (2018) revealed thinning of the choroid. SFCT is directly related to vision and macular thickness A weak inverse correlation was found between LogMAR and SFCT in all groups indicating that the vision may drop as the

SFCT decrease. A weak negative correlation was observed between CMT and SFCT in diabetic groups which indicate that the choroidal thickness may decrease as the central retinal thickness increases in diabetic patients.

Dalia et al. (2018) there was a statistically significant negative correlation between CMT and SFCT in patients with NPDR and DME. The SFCT decreased as the CMT increased. In addition, the subfoveal choroid was thinner in eyes with NPDR and DME than in eyes with NPDR without DME.

Some studies reported an increase in choroidal thickness in diabetic eyes either related to the stage of diabetic retinopathy (DR) or progressive decrease in Choroidal thickness with advance of the stage of. *Kim et al. (2016)* reported that the SFCT in DME was significantly thicker than in non-DME, *Kase et al. (2016)* also noted increased SFCT in eyes with DR compared with those without retinopathy. *Xu et al. (2013)* revealed that the SFCT is thicker in diabetics but is not related to the severity of the DR.

Few studies reported no significant changes of Choroidal thickness in diabetic eyes related to the stage of diabetic retinopathy (DR).

Vujosevic et al. (2012) showed No significant SFCT difference was found between controls and diabetic eyes without detectable DR. Diabetic macular edema did not influence choroidal thickness. *Ünsal et al. (2014)* considered choroidal thinning in DME false as a result of inhibition of the signal transduction and reflection from the choroid secondary to increased ocular opacity caused by macular edema.

Explanation of this controversies assumed as early hypoxia with early diabetic changes due to microvascular choroidal insulation lead to edema associated with variable degree of increase SFCT and CMT but with progression and longstanding of diabetic changes and hypoxia lead to variable degree of choriocapillaris atrophy and thinning of SFCT followed by disturb RPE pump function, and possibly contribute to the pathogenesis of cystic changes of macula with bad visual prognosis.

CONCLUSION

SFCT have negative correlations with cystic changes in DME but need more study to demonstrate physiological and anatomical changes in different stages of diabetic retinopathy. SD-OCT is a non-invasive technique that helps to assess the choroid and may be useful in the evaluation of chorioretinal vascular changes in diabetic patients.

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دراسة التغيرات فى سُمْك طبقة المشيمية تحت الماقولة مع
تأدم مركز الإبصار الكيسى لمرضى داء السكرى باستخدام
التصوير المقطعي البصري المُتناسِق للمجال الطيفي
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خلفية البحث: يُعتَبَرُ تأدم المَاقولة من أهم أسباب ضعف الإبصار لمرضى داء السكرى، وينتج هذا التأدم عند حدوث خلل بالأوعية الدموية الشبكية وتغيرات فى ديناميكية سريان الدم. ويُعدُّ سُمْك المشيمية مقياس مهم لتدفق الدم وصحة المشيمية.

الهدف من البحث: رَبط سُمْك مركز المشيمة مع سُمْك مركز الماقولة لمرضى داء السكرى بِاسْتِخْدَام التصوير المقطعي البصري المُتناسِق للمجال الطيفي.

المرضى وطرق البحث: أُجريت هذه الدراسة فى مستشفى بهتيم للجراحات التخصصية، التأمين الصحى، على 120 عيناً بفحص 68 مريضاً بالسكري، وتم تقسيمهم لثلاث مجموعات متساوية:

المجموعة (أ) شملت مرضى السكري أصحاب سُمْك الماقولة الشبكي الطبيعي، و**المجموعة (ب)** شملت مرضى السكري أصحاب تأدم الماقولة الغير كيسي، و**المجموعة (ج)** شملت مرضى السكري أصحاب تأدم الماقولة الكيسي.

نتائج البحث: أثبتت الدراسة وجود علاقة طردية بين سُمْك طبقة المشيمية تحت الماقولة و سُمْك الماقولة مع تأدم مركز الإبصار الغير كيسي، ووجود علاقة عكسية بين سُمْك طبقة المشيمية تحت الماقولة و

سُمك الماقولة مع تَأدم الماقولة الكيسي, كما أثبتت الدراسة عدم وجود علاقة بين سُمك طبقة المشيمية تحت الماقولة و قوة الإبصار لمرضى داء السكرى.

الإستنتاج: توضح الدراسة أهمية متابعة التغيرات فى سُمك طبقة المشيمية تحت الماقولة لمرضى داء السكرى, وذلك لأهمية صحة المشيمية كمقياس مهم لتدفق الدم وصحة الماقولة.

الكلمات الدالة: سُمك طبقة المشيمية تحت الماقولة، تَأدم الماقولة لداء السكرى، و التصوير المقطعي البصري المُتناسِق للمجال الطيفي.