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Central Corneal Thickness: Comparison between diabetics and nondiabetics

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Abstract

Background and objectives: The cornea play a significant role in eye refraction. With early detection and prompt treatment, ocular problems linked to diabetes mellitus can be prevented from progressing. The purpose of this study was to compare the central corneal thicknesses of diabetic and non-diabetic patients.

Methods: In Duhok Teaching Eye Hospital; a comparative cross-sectional study had been conducted between 01.01.2022 and 30.06.2022. There were 100 participants, 50 in diabetes group, and 50 in a control group. The diabetic group is further subdivided into three categories based on the duration of diabetes (less than 5 years, more than 5 to10 years, and above 10 years), as well as two subgroups based on the type of diabetes mellitus (type I and type II). The thickness of the central cornea was measured using SIRIUS corneal pachymetry and topography.

Results: There was no statistically significant difference between the non-diabetic and diabetic groups in terms of central corneal thickness (549.6 micrometers 541.4 micrometers, P > 0.05). There was a statistically significant difference (P 0.05) between the mean central corneal thickness of diabetics with diabetes mellitus for more than ten years and non-diabetics and diabetics with diabetes for five years.

Conclusion: In comparison to both non-diabetics and diabetics with diabetes for five years or less, those with long-term diabetes mellitus (diabetes for more than ten years) had a bigger statistically significant average central corneal thickness.

Key words: Central Corneal Thickness, Corneal Endothelium, Diabetes Mellitus.

Introduction

The cornea provides a rigid, robust outer layer to the eye. It occupies one-sixth of the globe's total surface area. The cornea is translucent and clear, with important optical properties such as transparency and refractive power.[1]The trigeminal nerve's ophthalmic division serves both the deeper stromal nerve plexus in the cornea and the subepithelial nerve plexus, making the cornea the body part with the densest innervation.[2]

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The average central corneal thickness (CCT) is 540 m, with the peripheral cornea being thicker at 1mm. The CCT is affected by age, gender, race, and ethnicity. The average corneal diameter is 12 millimeters horizontally and 11.5 millimeters vertically.[2] Diabetes mellitus (DM) is a disease characterized by chronically elevated blood sugar levels, which leads to microvascular and macrovascular complications.[3]Diabetes mellitus has a substantial impact on health Due to the intricate nature of its complications and the substantial mortality rate associated with it; thus, early detection is critical for optimal management and prevention of complications.[4]Diabetes mellitus (DM)-related ocular complications are on the rise and are soon becoming one of the most notable causes of morbidity worldwide. These consequences can be avoided if they are detected early and treated promptly. Diabetes mellitus is associated with the following visual problems: diabetic retinopathy, maculopathy, papillopathy, cataract, glaucoma, and ocular surface abnormalities (Diabetic keratopathy).[5]Diabetes keratopathy is a prevalent disorder that affects almost 70% of diabetes patients and is characterized by several alterations, mainly in the epithelium and endothelium.[6]Among the clinically observed diabetic corneal changes are increased corneal thickness, epithelial defects, epithelial vulnerability, recurrent damage, ulcers, edema, superficial punctate keratitis, delayed and insufficient wound repair, endothelial changes, and neuropathy characterized by decreased corneal sensitivity.[7]Diabetes mellitus patients commonly have diminished corneal sensitivity, which is proportional to the severity of the disease. A thorough examination, which included the use of in vivo confocal microscopy, revealed increased nerve tortuosity and thickness, as well as aberrations in nerve fiber density, length, and branch density.[7]Diabetic keratopathy (DK) has a clinical range that includes corneal edema, Descemet folds, corneal hypoesthesia, chronic epithelial erosions, and superficial punctate epitheliopathy.[8] Although faint vertical folds in the deep stroma and Descemet membrane (Waite-Beetham lines) are not specific to DM, they may indicate early endothelial dysfunction and increased stromal hydration.[9, 10]Diabetic keratopathy is caused by three problems with the way enzymes work: an active polyol pathway, a buildup of advanced glycation end products (AGEs), and faster no enzymatic glycation of protein components in the corneal epithelium's basement membrane.[8]Aldose reductase, a polyol pathway enzyme, converts extra glucose into sorbitol. Sorbitol accumulates in the corneal stroma, perhaps causing osmotic consequences. Age generation is slow and consistent in healthy people, but hyperglycemia accelerates the process. Non-enzymatic interactions between extracellular proteins and glucose produce AGEs. AGEs form an irreversible crosslink with collagen. Collagen crosslinking may result in increased corneal stiffness and thickness.[11]Corneal thickness measurement provides therapeutically important information regarding the physiological status of the cornea, and CCT is a vital indicator of a healthy cornea. A CCT examination is useful for refractive surgery planning, glaucoma diagnosis, and contact lens use.[12]In this study; we aimed to compare the central corneal thicknesses of diabetic and non-diabetic patients.

Patients and methods

A cross-sectional comparative study was carried out at Duhok Teaching Eye Hospital from the beginning of January 2022 to the end of July 2022. The convenience sample includes 50 individuals with diabetes who attend Duhok Teaching Eye Hospital outpatient clinics and 50 normal, age-

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matched volunteers. Exclusion criteria included those people with ocular diseases that affect the corneal thickness including corneal dystrophy, anterior chamber neovascularization, uveitis, contact lens wearing, corneal opacity, previous history of corneal trauma and any previous history of corneal refractive surgery. The data for each candidate was gathered through direct interviews. A candidate was classified as diabetic if he or she had a referring physician's diagnosis of type II diabetes or type I diabetes and was prescribed diabetes medication. Age-matched healthy participants who did not have DM confirmed by a random blood sugar test comprised the control group. The diabetic group is separated into three groups based on the duration of DM (younger than 5 years), more than 5 to10 years, and older than 10 years, and further subdivided into two groups based on the type of DM (type I DM and type II DM). The gender, duration of diabetes, and medications used at the time were all recorded. Each participant in this study had both of their eyes examined. The Snellen chart was used to assess visual acuity, an air puff tonometer was used to measure intraocular pressure, and each patient had slit-lamp biomicroscope. All CCT measurements were taken after tonometry during the time period (9 a.m.–12 p.m.) using noncontact Sirius Corneal Pachymetry and Topography. The subjects were advised to concentrate on the fixation point while sitting comfortably in a chair. Three measurements were taken, and an average was computed. In this mode, the gadget recognizes when the correct focus and alignment with the corneal apex have been achieved and then runs a scan. After each eye's CCT measurement, the fundus was examined with a +90-diopter condensing lens. At the end of each interview, the participant was thanked for his or her cooperation. All participants signed written informed consent forms. The Kurdistan Higher Council of Medical Specialties Ethics Committee accepted the study protocol. The data were initially entered into an Excel spreadsheet before being transferred to a statistical package for social sciences file version 24 (SPSS v24) for analysis. Means and standard deviations serve to represent continuous variables, whereas numbers and percentages serve to represent discrete variables. The T test for two independent samples was used to examine the significance of the difference in means between the two independent samples. When applicable, the chi-square test for independence was used to investigate the significance of the link between discrete variables. A p value of 0.05 or less was used to determine the degree of significance.

Results

This study included 100 participants ranging in age from 21 to 57 years old, with a mean age of 43.3±9.2 years. The study's participants were separated into two primary groups: the control (non-diabetic) group (50 or 50% of the total sample) and the diabetic group (50 or 50% of the entire sample). The diabetic group included 10 cases of type I diabetes and 40 cases of type II diabetes. In this investigation. The mean age wasn't showing significant differences between the two study groups (diabetic and non-diabetic), also the mean age wasn't showing significant differences between the two diabetes subgroups (type I and type II) ($P > 0.05$).

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Table (1): Mean age of candidates according to study group.

Study Group	Number of Candidates	Age (y) Mean± SD	p value
Control Group	50	43.4 ± 8.9	0.429
Diabetic Group	50	44.6 ± 4	
Type I Diabetes	10	42.5 ± 5.2	0.137
Type II Diabetes	40	45.2 ± 3.4	

Males made up 53 percent of all cases (53%), 27 percent of non-diabetic candidates (54%), 26 percent of all diabetic candidates (52%), four percent of type I diabetes cases (40%), and 22 percent of type II diabetes cases (55%).

The duration of diabetes ranged from 1 to 35 years, with a mean of 11.2±8.4 years. Diabetes lasted substantially longer in type I patients (24±9.2) than in type II patients (8.1±4) (P 0.05).

Table (2): The Mean duration of diabetes of participants according to type of diabetes.

Type of diabetes	Number of the candidates	Duration of D.M. Mean ± SD	p value
All Diabetics	50	11.2 ± 8.4	
Type II D.M	40	8.1 ± 4	0.000146
Type 1 D.M.	10	24 ± 9.2	

The center corneal thickness (CCT) of the 200 eyes studied ranged between 470 and 650 mm. The mean CCT in the diabetes group was 549.6±34 µm, while the mean CCT in the control group was 541.4±35.8 µm. Multiple CCT comparisons between study groups show no significant difference in mean CCT between non-diabetic applicants and each diabetes group, type I diabetes and type II diabetes. According to this study, there was no significant difference in the mean CCT between the two forms of diabetes. (P > 0.05).

Table (3): Mean CCT in µm according to studied group:

A) For Descriptive statistics B) For Comparative purpose

A)

Candidates Group	Number of candidates	Number of the eyes	CCT in µm Means SD
Control Group	50	100	541.4 ± 35.8
All Diabetics	50	100	549.6 ± 34
Type 1 DM	10	20	544.9 ± 35.5
Type 2 DM	40	80	550.8 ± 33.5

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B)

Group 1	Group 2	p value
Control Group	All Diabetics	0.098
Control Group	Type 1 DM	0.069
Control Group	Type 2 DM	0.07
Type 1 DM	Type 2 DM	0.49

Gender of candidates did not significantly influence a difference in mean CCT between the two study groups (normal and diabetic) and between the two subgroups of diabetes (type I and type II). ($P > 0.05$).

Table (4): Mean CCT according to gender of candidates and to studied group.

	Male			Female			
Study Group	No. of candidates	No. of the Eyes	CCT (µm) Mean ± SD	No. of candidates	No. of the Eyes	CCT (µm) Mean ± SD	p value
Total samples	53	106	544.3 ± 35.2	47	94	546.8 ± 35	0.68
Control Group (Normal Group)	27	54	538.8 ± 35.9	23	46	544.3 ± 35.5	0.52
Total Diabetic	26	52	550 ± 33.6	24	48	549.2 ± 34.3	0.84
Type I DM	4	8	555.1 ± 41.5	6	12	538.1 ± 28.9	0.75
type II DM	22	44	549.1 ± 31.9	18	36	552.9 ± 35.2	0.9

Comparing the mean CCT between the control group and the diabetic group, as well as between diabetic subgroups according to duration of diabetes (≤ 5 years or > 10 years), the following differences were found to be statistically significant (P 0.05, table 5), both genders for non-diabetic and diabetic group with > 10yrs. duration (541.4 ± 35.8 vs 557.3 ± 31.9 respectively). Male gender for non-diabetic and diabetic group with > 10yrs. duration (539 ± 36 vs 561.4 ± 30.8 respectively). Both genders for type II DM ≤ 5yrs. group and > 10yrs. group duration (539 ± 35 vs 563 ± 27.1 respectively)

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Table (5): Mean CCT comparison for non-diabetic group and diabetic group according to duration of diabetes and gender of participants:

Study Group	No. of the candidates	No. of the Eyes	CCT in (µm) Mean SD	Study Group	No. of the candidates	No. of the Eyes	CCT in (µm) Mean SD	p Value
Control Group Both genders	50	100	541.4 ± 35.8	Diabetic Group >10 yrs. Both genders	25	50	557.3 ± 31.9	0.0089
Control Group Male	27	54	539 ± 36	Diabetic Group >10 yrs. Male	14	28	561.4 ± 30.8	0.012
Control Group Female	23	46	544.3 ± 35.5	Diabetic Group >10 yrs. Female	11	22	552.2 ± 32.6	0.336
Diabetic Group >10 yrs. Male	14	28	561.4 ± 30.8	Diabetic Group >10 yrs. Female	11	22	552.2 ± 32.6	0.326
Type I > 10yrs group	8	16	545 ± 37.4	Type II > 10yrs group	17	34	563 ± 27.1	0.063
Control Group Both genders	50	100	541.4 ± 35.8	Diabetic Group <5 yrs. Both genders	9	18	539 ± 35	0.98
Control Group Male	27	54	539 ± 36	Diabetic Group <5 yrs. Male	4	8	529 ± 31.4	0.74
Control Group Female	23	46	544.3 ± 35.5	Diabetic Group <5 yrs. Female	5	10	547 ± 35.8	0.78
Diabetic Group <5 yrs. Male	4	8	529 ± 31.4	Diabetic Group <5 yrs. Female	5	10	547 ± 35.8	0.72
Type II < 5yrs. group	9	18	539 ± 35	Type II > 10yrs. group	17	34	563 ± 27.1	0.017

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Discussion

The measurement of central corneal thickness (pachymetry) has become an essential component of an eye exam, as it can be used to predict the health of the cornea as well as make decisions regarding glaucoma diagnosis and refractive surgery.[13]Damage to the corneal epithelium, nerves, and endothelium can result in increased CCT in diabetics. A dysfunctional epithelium may lose its barrier function, enabling fluid outflow into the stroma and therefore raising CCT. A lack of neuronal action and ocular hypoesthesia create intracellular edema. Diabetes can induce the loss or dysfunction of corneal endothelial cells, resulting in an abnormal fluid buildup in the stroma.In this investigation, there was no statistically significant difference in mean CCT between people who did not have diabetes and those who had type I or type II diabetes. Furthermore, there was no statistically significant difference in mean CCT between the two kinds of diabetes, other studies like El-Agamy[11], Sudhir [16], and Wiemer[17] reported similar findings, whereas researches like Mathebula[13], Stella[18], and Shifa [19] discovered that diabetic participant's CCT was statistically substantially greater than that of control people, this discrepancy could be explained by differences in race, ethnicity, and the CCT measurement method (Sirius Corneal Pachymetry and Topography in this study and Ultrasonic Pachymetry in previous investigations).Our research results showed that diabetic individuals with more than ten years of diabetes had thicker corneas than non-diabetics, other research like Singh M.[21] identified a significant statistical difference in CCT between diabetics who had been ill for more than ten years and non-diabetics.

In our study an additional investigation comparing CCT between diabetics with DM for less than five years and those with DM for more than ten years finds that those with DM for ten years have a thicker mean CCT, others like Varghese[26] discovered comparable results, indicating a significantly higher CCT in patients with diabetes for ten years or more compared to those with diabetes for ten years or less, as well as Singh M.[21] agreed with our findings, revealing a significantly higher CCT in participants with diabetes for more than ten years versus those with diabetes for less than ten years, also Lee[27] discovered a substantial relationship between diabetes duration and central corneal thickness, in addition to Abdulghani[29] discovered a greater CCT in those who had diabetes for ten years or more than in people who had diabetes for less than ten years, but it was not statistically significant. In our study there were some limitations as the hemoglobin A1C (HbA1C) status, blood pressure readings and lipid profile status were not measured and also the corneal endothelial cell count was not recorded. So farther researches including bigger candidate's samples and investigating more the other variables including the blood sugar (HbA1C) status and the influence of diabetes on the corneal endothelial cell count is recommended.

Conclusion

In comparison between diabetics with more than ten years diabetes duration and non-diabetics or diabetics with a diabetes duration of five years or less, people with long-standing diabetes mellitus (diabetes mellitus for more than ten years) had a bigger statistically significant average central corneal thickness. Increased CCT in diabetic patients may be an unrecognized marker for the disease's development.

Conflicts of interest

The author reports no conflicts of interest.

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