A STUDY OF CENTRAL CORNEAL THICKNESS AND CORNEAL ENDOTHELIAL CHANGES IN TYPE 2 DIABETES MELLITUS

Anubhav Baveja[1], Nitin Batra[2], Gurvinder Kaur[3]

[1]Senior Resident, Department of Ophthalmology, Christian Medical College and Hospital, Ludhiana, Punjab.
[2]Professor and HOD, Department of Ophthalmology, Christian Medical College and Hospital, Ludhiana, Punjab.
[3]Professor, Department of Ophthalmology, Christian Medical College and Hospital, Ludhiana, Punjab.

ABSTRACT

BACKGROUND

Corneal endothelium plays an important role in maintaining the corneal transparency. Evaluation of corneal endothelial cell morphology and central corneal thickness (CCT) is important in a wide range of disorders. Type 2 diabetes mellitus is one of the emerging health problems which also affects the corneal endothelial morphology and CCT.

Aims and Objectives- To compare CCT and corneal endothelial changes in type 2 diabetics and non-diabetic controls and to assess their correlation with duration of diabetes and HbA1c levels.

MATERIALS AND METHODS

A total of 200 eyes of type 2 diabetic subjects and 200 eyes of non-diabetic age and gender matched controls, presenting to the Department of Ophthalmology, Christian Medical College, Ludhiana were included in the study. The study was conducted over a period of one year and eight months. The CCT and corneal endothelial changes were measured using a specular microscope. Data was analysed using SPSS software version 21 using independent t-test, chi-square test and Spearmen correlation test.

RESULTS

The diabetic subjects had increased central corneal thickness, less endothelial cell density and more standard deviation and hexagonality of the corneal endothelium than the non-diabetic controls ($P<0.05$). Coefficient of variation for cell size was significantly higher for diabetics ($P<0.05$). It was observed that the central corneal thickness and corneal endothelial parameters had statistically significant correlation with the duration of diabetes mellitus. Whereas when correlated with HbA1c only CCT and CV had a statistically significant correlation ($p=0.041$ and $p=0.001$ respectively).

CONCLUSION

Diabetics have thicker corneas, less corneal endothelial cell density and hexagonality, and more irregular cell size. Therefore, routine assessment of central corneal thickness and corneal endothelial structure may be beneficial in all diabetic patients along with retinopathy assessment.

KEYWORDS

Central Corneal Thickness, Corneal Endothelium, Type 2 Diabetes Mellitus, Specular Microscope.

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BACKGROUND

Type 2 diabetes mellitus is a major public health problem and is emerging as a pandemic.[1] Diabetes mellitus can affect almost all structures of the eye and cause anterior ischaemic neuropathy, glaucoma, cataract, retinal vein and arterial occlusions and retinopathy or maculopathy. Patients can develop not only the above-mentioned ocular manifestations of diabetes but also corneal changes which comprise of epithelial and endothelial changes. Epithelial changes include epithelial defects, punctate epithelial keratopathy, recurrent corneal erosions and persistent epithelial defects. The development of many of the diabetic complications is related to the duration of the disease and the degree of metabolic dysregulation.[2-6]

Studies have indicated that corneal endothelial cells show morphological abnormalities in diabetics. These abnormalities include a decrease in endothelial cell density and hexagonality, increased polymegethism and pleomorphism. In addition to changes in corneal endothelium, increased central corneal thickness (CCT) has also been postulated.[2-6] When the reduction of endothelial cells is not detectable by cell density, then that may be detected by quantization of coefficient of variation, the percentage of hexagonal cells and CCT.[7]

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Corresponding Author:
Dr. Anubhav Baveja,
Senior Resident,
Department of Ophthalmology,
Christian Medical College and Hospital,
Ludhiana, Punjab.
E-mail: anubhav_baveja@yahoo.com
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Aims and Objectives

1. To compare central corneal thickness and corneal endothelial changes in type 2 diabetic subjects and non-diabetic controls.
2. To assess the correlation of central corneal thickness and corneal endothelial changes with duration of diabetes since diagnosis and HbA1c levels.

MATERIALS AND METHODS

This prospective cross-sectional study was conducted in the Department of Ophthalmology, Christian Medical College, Ludhiana. The study was conducted over the period of one year and eight months. A total of 200 eyes of type 2 diabetes mellitus subjects were included in the study. A total of 200 eyes of non-diabetic, age and gender matched subjects were taken as controls. Informed consent was obtained from all participants. Following a detailed history, all cases underwent complete ophthalmological examination. Best corrected visual acuity (BCVA) was recorded and anterior segment examination was performed using a slit lamp biomicroscope. Specular microscopy was performed using a non-contact NIDEK CEM-530 (NIDEK co., LTD Hiroishi-CHO GAMGORI AICHI JAPAN) Microscope. It is a non-invasive and non-contact imaging technique. Corneal endothelial cell density, size, standard deviation, coefficient of variation, hexagonality as well as central corneal thickness was measured. Data was analysed using SPSS software version 21 using independent t-test, chi-square test and Spearmen correlation test.

RESULTS

In this prospective cross-sectional study, a total of 200 eyes of type 2 diabetic patients were included. This formed the study group. A total of 200 eyes of non-diabetic, age and gender matched subjects were taken as controls.

The study group was further divided into various sub groups according to age of the patients, duration of diabetes and HbA1c levels. The control group was also divided into various sub groups according to age of the patients.

The mean age of the study group was 58±6.98 years, whereas in the case of controls it was 57±7.22 years.

Central Corneal Thickness (CCT)

Central corneal thickness in type 2 diabetics was found to be more when compared to non-diabetic controls. A statistically significant difference was observed in the mean central corneal thickness between the two groups (p<0.001). (Figure 1)

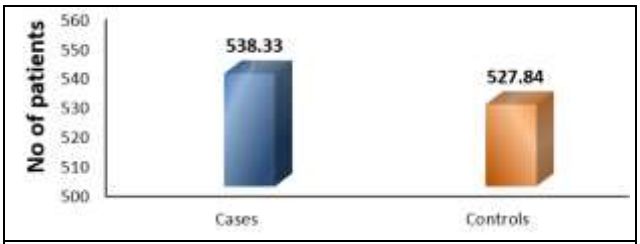

Figure 1. Comparison of Central Corneal Thickness (CCT) in Cases and Controls

Corneal Endothelial Parameters

On comparing corneal endothelial parameters between type 2 diabetics and non-diabetic subjects, corneal endothelial cell density and hexagonality were lower in type 2 diabetic subjects than non-diabetic controls. Whereas standard deviation corneal endothelial cell size and coefficient of variation were reported higher in study group. As shown in table 1. The result showed significant polymegathism and pleomorphism of corneal endothelium in type 2 diabetic subjects.

Characteristics	Total (n=400) Mean±S.D.	Cases (n=200) Mean±S.D.	Controls (n=200) Mean±S.D.	p-Value
Cell Density (CD)	2583.01±185.63	2507.62±194.05	2659.13±141.44	<0.001
Standard Deviation (SD)	104.31±16.02	110.98±17.52	97.31±9.73	<0.001
Coefficient of Variation (CV)	28.73±3.65	29.93±3.68	27.45±2.86	<0.001
Hexagonality	68.35±4.36	67.66±5.19	69.03±3.18	0.002

Table 1. Comparison of Corneal Endothelial Parameters in Cases and Controls

Correlation of Central Corneal Thickness and Corneal Endothelial Parameters with Duration of Diabetes Since Diagnosis

When the central corneal thickness and corneal endothelial parameters were correlated with the duration of diabetes, it was observed that all the outcomes had statistically significant correlation with the duration of diabetes mellitus. Cell density and hexagonality showed negative correlation (r=-0.274 and r=-0.228 respectively) with the duration of diabetes mellitus. However, central corneal thickness, standard deviation and coefficient of variation were positively correlated (r=0.223, r=0.210 and r= 0.160 respectively). As shown in table 2.

	Mean ± S.D.	Correlation Coefficient (r)	p-Value
CCT	538.33 ± 29.26	0.223	0.001
CD	2507.62 ± 194.05	-0.274	<0.001
SD	110.98 ± 17.52	0.210	0.003
CV	29.93 ± 3.68	0.160	0.023
Hexagonality	67.66 ± 5.19	-0.228	0.001

Table 2. Correlation Between Outcomes and Duration of Diabetes Mellitus

Correlation of Central Corneal Thickness and Corneal Endothelial Parameters with HbA1c

In this study the mean HbA1c levels recorded in diabetic subjects was 8.90±1.77 (Range 5.9 - 16.4). On correlating central corneal thickness and corneal endothelial parameters with HbA1c, central corneal thickness (CCT), standard deviation (SD) and coefficient of variation (CV) showed positive correlation (r= 0.144, r= 0.104, r= 0.238 respectively), whereas cell density (CD) and hexagonality were negatively correlated (r=-0.013, r=-0.126 respectively). There was no statistically significant correlation between the CD, SD and Hexagonality of the corneal endothelium of the study group subjects when correlated with HbA1c. However, the CCT and CV had a statistically significant correlation (p=0.041 and p=0.001 respectively) with HbA1c. As shown in table 3.

	Mean ± S.D.	Correlation Coefficient (r)	p-Value
CCT	538.33 ± 29.26	0.144	0.041
CD	2507.62 ± 194.05	-0.013	0.851
SD	110.98 ± 17.52	0.104	0.145
CV	29.93 ± 3.68	0.238	0.001
Hexagonality	67.66 ± 5.19	-0.126	0.076
HbA1c	8.90 ± 1.77		

Table 3. Correlation Between Outcomes and HbA1c

DISCUSSION

The corneal endothelium plays an important role in the maintenance of corneal transparency. Hence the evaluation of corneal endothelial cell density and CCT is important in a wide range of disorders such as contact lens related complications, glaucoma, dry eye and diabetes as in these condition corneal endothelial cells tend to decrease faster as compared to normal. Thus, with an increase in diabetic population, it becomes important to evaluate the effect of diabetes on corneal endothelium and CCT.[7]

Central Corneal Thickness (CCT)

According to our study, it was found that the mean CCT in diabetics (538.33±29.26 microns) was more than in controls (527.84±27.38 microns) and the difference was statistically significant (p<0.001). Our results were similar to those observed in previous studies done by Busted et al and Larsson et al.[8,9] Larsson et al, in their study, found a significant increase in CCT in diabetic subjects when compared with non-diabetic subjects.[9] In contrast, Inoue et al, Choo et al and Sudhir et al have found no difference in central corneal thickness between diabetics and non-diabetic subjects.[4,10,11]

Corneal Endothelial Parameters

The results of the present study showed that the mean endothelial cell density and hexagonality were significantly lower in patients with type 2 diabetes mellitus when compared with the controls. Our results are similar to the results observed in the previous study done by Inoue et al and Shenoy et al showing the mean endothelial cell density and hexagonality was significantly lower in the diabetic group than in the control group.[2,4] A study done by Sudhir et al also found similar results.[11] Choo et al in their study observed that in diabetic corneas there was a significant reduction in hexagonality of corneal endothelium when compared with the controls (58.2%±43.0% vs 67.2%±47.2%, p<0.01).[10] However, studies done by Larsson et al, Schultz et al, Matsuda et al and Itoi at al showed limited or no effect on endothelial cell density and hexagonality in subjects with type 2 diabetes.[9,12-14]

There was an increase in the standard deviation of cell size and mean CV in our study group, which was statistically significant. This is in accordance with other studies. Inoue et al and Choo et al in their study found that type 2 diabetic patients showed a statistically significant increase in standard deviation of corneal endothelial cell size and CV.[4,10] Whereas in the study conducted by Sudhir et al, there was no statistical difference in endothelial cell size and CV between the diabetics and controls.[11]

In our study group, we found that there was an increased rate of polymegethism and pleomorphism when compared to controls. Inoue et al in their study found that there was increased rate of polymegethism in diabetics when compared with non-diabetics.[4] A study conducted by Choo et al observed that there was significant increase in polymegethism and pleomorphism in diabetic subjects. Shenoy et al and Matsuda et al also found the similar results.[2,13]

We observed that CCT in the study group was positively correlated (r=0.223) with the duration of diabetes, and the correlation was statistically significant (p=0.001). This finding was comparable with the study done by Parekh et al who found that there was an increase in the corneal thickness with duration of diabetes (p<0.001).[7] Lee et al also concluded that the cornea is thicker in eyes with longer duration of diabetes when compared with controls.[3]

According to our study, it was observed that all the corneal endothelial parameters had statistically significant correlation with the duration of diabetes mellitus. Cell density and hexagonality were negatively correlated (r=-0.274 and r=-0.228 respectively), whereas standard deviation and coefficient of variation were positively correlated (r=0.210 and r= 0.160 respectively) with the duration of diabetes mellitus. These findings were comparable with the study done by Sudhir et al who concluded that with longer duration of diabetes, there was a decrease in the endothelial cell density and hexagonality. They also found that with increasing duration of diabetes, there was an increase in the standard deviation of endothelial cell size and the coefficient of variation when compared with the controls.[11]

In our study on correlating central corneal thickness with HbA1c, positive correlation was observed (r=0.144), which was statistically significant (p=0.041). This was in accordance with the results observed by Sudhir et al who reported that there was an increase in central corneal thickness in patients who did not have good control of diabetes.[11]

When corneal endothelial parameters were correlated with HbA1c, standard deviation (SD) and coefficient of variation (CV) showed positive correlation (r= 0.104, r= 0.238 respectively), whereas cell density (CD) and hexagonality were negatively correlated (r=-0.013, r=-0.126 respectively). There was no statistically significant correlation of the CD, SD and Hexagonality of corneal endothelium of the study group subjects when correlated with HbA1c. However, CV had a statistically significant correlation (p=0.001) with HbA1c. But in the study conducted by Choo et al, it was observed that there was no statistical correlation between the control of diabetes and any of the corneal endothelial parameters.[10]

CONCLUSION

Diabetics have thicker corneas, less corneal endothelial cell density and hexagonality, and more irregular cell size. It may therefore be suggested that routine assessment of central corneal thickness and corneal endothelial structure may be beneficial in all diabetic patients along with their usual retinopathy assessment. It is important to monitor diabetic individuals closely as they are more prone to corneal decompensation after intraocular surgeries.

REFERENCES

[1] Kaveeshwar SA, Cornwall J. The current state of diabetes mellitus in India. Australas Med J 2014;7(1):45-48.

[2] Shenoy R, Khandekar R, Bialasiewicz A, et al. Corneal endothelium in patients with diabetes mellitus: a historical cohort study. Eur J Ophthalmol 2009;19(3):369-375.

[3] Lee JS, Oum BS, Choi HY, et al. Differences in corneal thickness and corneal endothelium related to duration in diabetes. Eye (Lond) 2006;20(3):315-318.

[4] Inoue K, Kato S, Inoue Y, et al. The corneal endothelium and thickness in type II diabetes mellitus. Jpn J Ophthalmol 2002;46(1):65-69.

[5] Siribunkum J, Kosrirukvongs P, Singalavanija A. Corneal abnormalities in diabetes. J Med Assoc Thai 2001;84(8):1075-1083.

[6] Storr-Paulsen A, Singh A, Jeppesen H, et al. Corneal endothelial morphology and central thickness in patients with type II diabetes mellitus. Acta Ophthalmol 2014;92(2):158-160.

[7] Parekh R, Ranganath KN, Suresh KP, et al. Corneal endothelium count and thickness in diabetes mellitus. Int J Diab Dev Ctries 2006;26(1):24-26.

[8] Busted N, Olsen T, Schmitz O. Clinical observations on the corneal thickness and the corneal endothelium in diabetes mellitus. Br J Ophthalmol 1981;65(10):687-690.

[9] Larsson LI, Bourne WM, Pach JM, et al. Structure and function of the corneal endothelium in diabetes mellitus type I and type II. Arch Ophthalmol 1996;114(1):9-14.

[10] Choo M, Prakash K, Samsudin A, et al. Corneal changes in type II diabetes mellitus in Malaysia. Int J Ophthalmol 2010;3(3):234-236.

[11] Sudhir RR, Raman R, Sharma T. Changes in the corneal endothelial cell density and morphology in patients with type 2 diabetes mellitus: a population-based study, Sankara Nethralaya Diabetic Retinopathy and Molecular Genetics Study (SN-DREAMS, Report 23). Cornea 2012;31(10):1119-1122.

[12] Schultz RO, Matsuda M, Yee RW, et al. Corneal endothelial changes in type I and type II diabetes mellitus. Am J Ophthalmol 1984;98(4):401-410.

[13] Matsuda M, Ohguro N, Ishimoto I, et al. Relationship of corneal endothelial morphology to diabetic retinopathy, duration of diabetes and glycemic control. Jpn J Ophthalmol 1990;34(1):53-56.

[14] Itoi M, Nakamura T, Mizobe K, et al. Specular microscopic studies of the corneal endothelia of Japanese diabetics. Cornea 1989;8(1):2-6.