

Investigate the Relationship between Central Corneal Thickness and the Severity of Diabetic Retinopathy, as Well as HbA1c Levels, in Individuals with Type 2 Diabetes Mellitus

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Abstract

Aim: Investigate the relationship between central corneal thickness and the severity of diabetic retinopathy, as well as HbA1c levels, in individuals with type 2 diabetes mellitus.

Material and Methods: This retrospective study was done in the Department of Ophthalmology, JLNMCH, Bhagalpur, Bihar, India for one year. 100 patients diagnosed with T2DM who attended the ophthalmology clinic of a tertiary care hospital. The inclusion criteria were: patients aged 40-70 years with a confirmed diagnosis of T2DM for at least 5 years. Exclusion criteria included patients with a history of ocular surgery, corneal pathology, or other systemic diseases affecting the eye. Patients underwent a comprehensive ophthalmic examination, including visual acuity assessment, slit-lamp biomicroscope, intraocular pressure measurement, fundus examination, and optical coherence tomography (OCT). Central corneal thickness was measured using a specular microscope. The severity of diabetic retinopathy was graded based on the Early Treatment Diabetic Retinopathy Study (ETDRS) classification. Blood samples were taken to determine HbA1c levels using high-performance liquid chromatography (HPLC). The patients were divided into three groups based on the severity of diabetic retinopathy: no DR, non-proliferative diabetic retinopathy (NPDR), and proliferative diabetic retinopathy (PDR).

Results: In the No DR group, 25 participants had IOP less than 15 mmHg, 10 had IOP between 15-20 mmHg, and 5 had IOP greater than 20 mmHg. In the NPDR group, 20 participants had IOP less than 15 mmHg, 10 had IOP between 15-20 mmHg, and 5 had IOP greater than 20 mmHg. In the PDR group, 15 participants had IOP less than 15 mmHg, 8 had IOP between 15-20 mmHg, and 2 had IOP greater than 20 mmHg. This data suggests that IOP does not vary significantly with the severity of DR. In the No DR group, 35 participants had no abnormalities, and 5 had microaneurysms. In the NPDR group, 25 participants had microaneurysms, and 10 had cotton wool spots. In the PDR group, 5 participants had microaneurysms, 10 had cotton wool spots, and 10 had neovascularization. These findings highlight the progressive nature of DR, with increasing severity associated with more advanced fundus abnormalities, such as cotton wool spots and neovascularization.

Conclusion: The study findings indicate a clear correlation between central corneal thickness, HbA1c levels, and the severity of diabetic retinopathy. As the severity of diabetic retinopathy increases, central corneal thickness and HbA1c levels also tend to increase, while visual acuity decreases. Intraocular pressure does not significantly vary with DR severity, but fundus examination findings clearly show the progression from early to advanced stages of DR.

Keywords: Central corneal thickness, diabetic retinopathy, HbA1c levels, type 2 diabetes mellitus

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Introduction

Diabetic retinopathy (DR) is a prevalent and severe complication of type 2 diabetes mellitus (T2DM), often leading to vision impairment and blindness if not adequately managed. This condition arises from prolonged hyperglycaemia, which damages the retinal blood vessels, causing them to leak, swell, or close off, ultimately leading to retinal tissue damage. The severity of diabetic retinopathy is typically

classified into stages ranging from non-proliferative diabetic retinopathy (NPDR) to the more advanced proliferative diabetic retinopathy (PDR), which involves the growth of new, fragile blood vessels that can bleed and cause severe vision loss. [1-4] Central corneal thickness (CCT) is a vital parameter in ophthalmology, serving as an indicator of corneal health and integrity. It has been suggested that CCT

may correlate with systemic conditions, including diabetes and its complications. Monitoring CCT can provide insights into the ocular effects of diabetes and potentially serve as an indicator for the severity of diabetic retinopathy. [5-9] Glycaemic control, commonly assessed through HbA1c levels, is crucial in managing diabetes and preventing its complications. HbA1c reflects the average blood glucose levels over the past two to three months, providing a long-term gauge of glucose control. Poor glycaemic control, indicated by higher HbA1c levels, is strongly associated with the progression of diabetic retinopathy. This study aims to explore the relationship between central corneal thickness, the severity of diabetic retinopathy, and HbA1c levels in patients with type 2 diabetes mellitus. By examining these correlations, we seek to enhance the understanding of how systemic diabetic control and corneal health may interplay with the progression of diabetic retinopathy. This knowledge could contribute to better management strategies for preventing vision loss in diabetic patients. [10-12]

Material and Methods

This retrospective study was done in the Department of Ophthalmology, JLNMC, Bhagalpur, Bihar, India for one year. 100 patients diagnosed with T2DM who attended the ophthalmology clinic of a

tertiary care hospital. The inclusion criteria were: patients aged 40-70 years with a confirmed diagnosis of T2DM for at least 5 years. Exclusion criteria included patients with a history of ocular surgery, corneal pathology, or other systemic diseases affecting the eye. Patients underwent a comprehensive ophthalmic examination, including visual acuity assessment, slit-lamp biomicroscope, intraocular pressure measurement, fundus examination, and optical coherence tomography (OCT). Central corneal thickness was measured using a specular microscope. The severity of diabetic retinopathy was graded based on the Early Treatment Diabetic Retinopathy Study (ETDRS) classification. Blood samples were taken to determine HbA1c levels using high-performance liquid chromatography (HPLC). The patients were divided into three groups based on the severity of diabetic retinopathy: no DR, non-proliferative diabetic retinopathy (NPDR), and proliferative diabetic retinopathy (PDR). Statistical analysis was performed to assess the correlation between CCT, severity of DR, and HbA1c levels using Pearson's correlation coefficient. A p-value of <0.05 was considered statistically significant.

Results

Table 1: Baseline Characteristics of Study Participants

Characteristic	No DR (n=40) Mean ± SD	NPDR (n=35) Mean ± SD	PDR (n=25) Mean ± SD	p-value
Age (years)	56.2 ± 8.1	58.3 ± 7.9	57.8 ± 8.4	0.45
Duration of Diabetes (years)	8.3 ± 3.2	10.2 ± 3.5	11.5 ± 3.8	0.03
HbA1c (%)	7.2 ± 0.8	8.0 ± 1.0	8.5 ± 1.1	<0.01
CCT (µm)	535 ± 12.5	540 ± 14.3	548 ± 15.1	0.02

The baseline characteristics of the study participants showed that the mean age was similar across the three groups: 56.2 ± 8.1 years for the no diabetic retinopathy (No DR) group, 58.3 ± 7.9 years for the non-proliferative diabetic retinopathy (NPDR) group, and 57.8 ± 8.4 years for the proliferative diabetic retinopathy (PDR) group, with a p-value of 0.45, indicating no significant difference. The duration of diabetes was significantly longer in patients with more severe retinopathy: 8.3 ± 3.2 years in the No DR group, 10.2 ± 3.5 years in the

NPDR group, and 11.5 ± 3.8 years in the PDR group, with a p-value of 0.03. HbA1c levels were significantly higher in patients with DR, with means of 7.2 ± 0.8% in the No DR group, 8.0 ± 1.0% in the NPDR group, and 8.5 ± 1.1% in the PDR group, with a p-value of <0.01. Central corneal thickness (CCT) also increased with the severity of DR: 535 ± 12.5 µm in the No DR group, 540 ± 14.3 µm in the NPDR group, and 548 ± 15.1 µm in the PDR group, with a p-value of 0.02.

Table 2: Correlation between CCT, Severity of DR, and HbA1c Levels

Parameter	CCT (µm)	Severity of DR	HbA1c (%)
CCT (µm)	1	0.32*	0.28*
Severity of DR	0.32*	1	0.45**
HbA1c (%)	0.28*	0.45**	1

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

The correlation analysis revealed that CCT had a positive correlation with the severity of DR ($r = 0.32$, $p < 0.05$) and HbA1c levels ($r = 0.28$, $p < 0.05$). The severity of DR showed a stronger correlation with HbA1c levels ($r = 0.45$, $p < 0.01$). These correlations suggest that as CCT and HbA1c levels increase, the severity of DR also tends to increase.

Table 3: Visual Acuity in Study Participants

Visual Acuity	No DR (n=40)	NPDR (n=35)	PDR (n=25)
20/20 or better	20	15	10
20/40 to 20/60	15	15	10
Worse than 20/60	5	5	5

Visual acuity was distributed differently across the groups. In the No DR group, 20 participants had 20/20 or better vision, 15 had vision between 20/40 to 20/60, and 5 had vision worse than 20/60. In the NPDR group, 15 participants had 20/20 or better vision, 15 had vision between 20/40 to 20/60, and 5

had vision worse than 20/60. In the PDR group, 10 participants had 20/20 or better vision, 10 had vision between 20/40 to 20/60, and 5 had vision worse than 20/60. These results indicate that visual acuity tends to decrease as the severity of DR increases.

Table 4: Intraocular Pressure in Study Participants

Intraocular Pressure (mmHg)	No DR (n=40)	NPDR (n=35)	PDR (n=25)
<15	25	20	15
15-20	10	10	8
>20	5	5	2

Intraocular pressure (IOP) was measured and categorized into three ranges. In the No DR group, 25 participants had IOP less than 15 mmHg, 10 had IOP between 15-20 mmHg, and 5 had IOP greater than 20 mmHg. In the NPDR group, 20 participants had IOP less than 15 mmHg, 10 had IOP between

15-20 mmHg, and 5 had IOP greater than 20 mmHg. In the PDR group, 15 participants had IOP less than 15 mmHg, 8 had IOP between 15-20 mmHg, and 2 had IOP greater than 20 mmHg. This data suggests that IOP does not vary significantly with the severity of DR.

Table 5: Fundus Examination Findings in Study Participants

Finding	No DR (n=40)	NPDR (n=35)	PDR (n=25)
No abnormalities	35	0	0
Microaneurysms	5	25	5
Cotton wool spots	0	10	10
Neovascularization	0	0	10

Fundus examination revealed significant differences in findings between the groups. In the No DR group, 35 participants had no abnormalities, and 5 had microaneurysms. In the NPDR group, 25 participants had microaneurysms, and 10 had cotton wool spots. In the PDR group, 5 participants had microaneurysms, 10 had cotton wool spots, and 10 had neovascularization. These findings highlight the progressive nature of DR, with increasing severity associated with more advanced fundus abnormalities, such as cotton wool spots and neovascularization.

Discussion

The baseline characteristics of the study participants indicate that age was not a significant factor affecting the severity of diabetic retinopathy (DR), as there was no statistically significant difference in age across the three groups. This finding is consistent with previous studies, such as those by Klein et al. (2012) and Yau et al. (2012), which also found no significant correlation between age and DR severity. However, the duration of diabetes showed a significant increase with the severity of DR, aligning with the general understanding that longer diabetes duration increases the risk of DR

development and progression.^{1,2} The HbA1c levels were significantly higher in patients with more severe DR, indicating poorer glycemic control in these patients. This supports the findings of the UKPDS (United Kingdom Prospective Diabetes Study), which demonstrated that higher HbA1c levels are associated with an increased risk of DR. Additionally, the central corneal thickness (CCT) was found to be significantly higher in patients with severe DR, suggesting that increased CCT may be a marker for more advanced DR. This is corroborated by a study by Zhu et al. (2015), which reported a similar association between increased CCT and DR severity.⁵ The correlation analysis revealed a positive correlation between CCT and DR severity ($r = 0.32, p < 0.05$) and between CCT and HbA1c levels ($r = 0.28, p < 0.05$). The strongest correlation was observed between DR severity and HbA1c levels ($r = 0.45, p < 0.01$). These findings suggest that as glycemic control worsens, reflected by higher HbA1c levels, both the severity of DR and CCT increase. This correlation has been observed in other studies, such as those by He et al. (2017) and Chua et al. (2012), who reported similar relationships between HbA1c, DR severity, and CCT.^[6,7] Visual acuity was found to decrease with the increasing

severity of DR. In the No DR group, half of the participants had 20/20 or better vision, while in the NPDR and PDR groups, this proportion decreased. These results are consistent with the findings of Early Treatment Diabetic Retinopathy Study (ETDRS), which also reported a decline in visual acuity with increasing DR severity. This decline in visual acuity with DR progression highlights the importance of early detection and management to preserve vision in diabetic patients. [8] Intraocular pressure (IOP) did not show significant variation across the different severity groups of DR. This finding is in line with the study by Jonas et al. (2003), which found no significant difference in IOP among diabetic patients with varying degrees of DR. This suggests that while IOP is an important parameter in ocular health, it may not be directly influenced by the severity of DR in the same way as other factors like HbA1c and CCT. [9] Fundus examination findings clearly demonstrated the progressive nature of DR. In the No DR group, most participants had no abnormalities, whereas in the NPDR and PDR groups, there were increasing numbers of microaneurysms, cotton wool spots, and neovascularization. These findings are consistent with the pathophysiological understanding of DR progression, where initial microvascular changes lead to more severe retinal damage and neovascularization in advanced stages. Studies by Cheung et al. (2010) and Antonetti et al. (2012) have similarly documented these progressive retinal changes in DR. [10-12]

Conclusion

The study findings indicate a clear correlation between central corneal thickness, HbA1c levels, and the severity of diabetic retinopathy. As the severity of diabetic retinopathy increases, central corneal thickness and HbA1c levels also tend to increase, while visual acuity decreases. Intraocular pressure does not significantly vary with DR severity, but fundus examination findings clearly show the progression from early to advanced stages of DR. These findings underscore the importance of regular monitoring and good glycemic control in preventing the progression of diabetic retinopathy and preserving visual function in patients with type 2 diabetes mellitus.

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