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Original Research Article

Comparison of proportional macular thinning in normal and diabetic patients without diabetic retinopathy in tertiary hospital, Bhavnagar – An observational comparative study

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ABSTRACT

Background: Patients with diabetes mellitus are found to exhibit decreasing thickness in the macula with progression of disease severity and consistent elevation in the HbA1C levels. The study compares the thinning of macula in diabetic patients without retinopathy and non-diabetic patients using Optical Coherence Tomography (OCT).

Materials and Methods: This observational cross-sectional design was conducted on 200 eyes of 100 patients, who reported to the tertiary care centre OPD in Bhavnagar. The study group included 50 diabetic individuals without retinopathy and 50 were non diabetic patients as controls. The macular thickness between groups was assessed using OCT. The correlation of CMT values with HbA1C levels were also evaluated in patients with diabetes.

Results: The macula thickness in patients with diabetes was found to be thinner when compared to non-diabetic patients (P<0.05), and the thickness of macula increased with a consistent increase in the HbA1C levels in diabetic patients without diabetic retinopathy (P<0.05).

Conclusion: OCT remains a promising diagnostic imaging tool in evaluating accurately the thickness of macula in patients with diabetes. According to the study's findings, diabetic individuals without retinopathy at a tertiary care facility in Bhavnagar had thinner macula.

1. Introduction

Diabetes is the most prevalent metabolic disorder with a risk factor of causing multiple organ damage affecting humans worldwide.[1] Combination of diabetic retinopathy and diabetic maculopathy may cause serious sight threatening disturbances, leading to blindness.[2] It is necessary to understand the concept of macular thickness in normal individuals because of the occurrence of multiple systemic and ocular diseases.[3] The risk factors that increase macular thickness are longer duration of diabetes,[4] under the use of insulin,[5] HbA1C levels,[6] ocular hypertension,[7] macular oedema,[8] diabetic retinopathy[9] and hyperlipidaemia.[10] Apart from these obvious signs, numerous authors[11–13] have emphasized that individuals with diabetes mellitus have altered blood-retinal barrier which may be the inciting factor for macular thickness. However, this statement was not clearly dealt in the literature.[14]

Conventional methods in measuring the retinal thickness are slit lamp bio-microscopy and stereo fundus photography,[3] which are imprecise in assessing the thickness of the retina. Other imaging modalities include conventional fundus photography and fluorescein angiography provides detailed cross sectional information on the retinal thickness.[3,15] OCT is an advanced method of imaging that deals with both cross sectional and

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tomographic imaging of the tissues at micrometre resolution.[16] OCT significantly evaluates the early changes in the base macular thickness as well as it helps to assess the underlying disease and the disease progression in the selection of the correct treatment plan.[17]

The study rationale was to assess the thinning of macula in patients with diabetes without retinopathy and healthy patients in Indian population. Also, to understand the correlation of macular thickness with increasing HbA1C levels in patients with diabetes.

2. Materials and Methods

2.1. Study plan

This cross-sectional, comparative hospital based study was performed on 100 patients who reported to the Tertiary Health Centre OPD, Department of Ophthalmology, Sir T Hospital, Bhavnagar. The study protocol was evaluated, and ethical committee approval was obtained from Government Medical College, Bhavnagar. All of the study participants received written informed permission once the study's methodology was explained to them.

2.2. Selection criteria

The study inclusions are patients between 30-60 years of age, Diabetic and non-diabetic patients. Those patients with signs and symptoms of Retinopathy, Glaucoma and Corneal opacities, previous history of surgeries related to the retina. Any further retinal disorders, including vitreous haemorrhages, retinal detachment, and macular holes were excluded from our study.

2.3. Groups

This study included 100 patients were segregated into 2 groups. The study group comprised of 50 patients with diabetes without retinopathy, and a control group consisted of 50 non-diabetic patients. All the study patients were subjected to OCT in both the eyes.

2.4. Measurement of macula thickness

The OCT (APPA OCT 2018) uses 840 ± 10 nm light with a 750 μW pupillary power. The resolution at transverse plane was 15 μm, while the depth of resolution was 5 μm. Three circles were localized in the central fovea of the nine areas that collectively make up the macular thickness map. The innermost ring of the fovea was 1mm in diameter. The inner ring's diameter was 3mm, while the outer ring's diameter was 6mm. The average thickness of macula was analysed with OCT machines.

2.5. Study assessments

Using OCT, the macula thickness in each patient's right and left eyes was examined and the association of macula thickness to HbA1C level was correlated based on the level of HbA1C in diabetic patients.

2.6. Data analysis

Data observed were collected, compiled and tabulated in an excel sheet. Quantitative data such as the thickness of macula between groups were represented by descriptive variables. The recorded data was statistically analysed through SPSS 26.0 version software using Chi-square test. For the current investigation, a P value of less than 0.05 was deemed statistically significant.

3. Results

A 100 patients, with an average age of diabetic patients was 50.78±5.40 years and, the average age of healthy patients was 49.94±5.53 years with P=0.4440 were recruited for the present study. Among 100 patients, 46 were males and 54 were females. The mean HbA1C level in diabetic patient was 6.77±1.18 and 4.43±0.47 in non-diabetic patients which showed a statistical significance of P<0.0001 respectively (Table 1).

Table 1: The mean HbA1C values between groups

	Diabetic	Non Diabetic	P value
HbAIC	6.77 ± 1.18	4.43 ± 0.41	0.0001

The mean CMT value in the right eye for diabetic patients was found to be thinner (202.04±35.65) when compared to non-diabetic patients (220.04±70.04) which showed a statistical significance of P=0.0427 respectively. The mean CMT value in the left eye for diabetic patients was also found to be thinner (205.68±42.64) when compared to non-diabetic patients (222.26 ±90.10) which showed a statistical significance of P=0.0215 respectively (Table 2).

Table 2: Comparison of central macular thickness (CMT) measured in μm between groups

	Diabetic	Non Diabetic	P value
CMT (RE)(μm)	202.04 ± 35.65	220.38 ± 70.40	0.0427
CMT (LE)(μm)	205.68 ± 42.64	222.26 ± 90.10	0.0215

The average thickness of patient's macula with HbA1C level <5.7 was 172±23.69 in the right eye and 191.5±45.61 in the left eye which showed a statistical insignificant difference (P>0.05) respectively. The average thickness of macula with HbA1C level of 5.7-6.4 was 220.91±53.81 in the right eye and 204.91±62.77 in the left eye which showed a statistical insignificant difference of P>0.05

respectively. At HbA1C 6.5-8.5, the mean central thickness was 222.2±82.45 in the right eye and 231.85±111.01 in left eye, which revealed a statistical significance of P=0.0121 respectively. While, the HbA1C level >8.5 showed a mean CMT of 256.75±88.25 in right eye and, 300±83.15 in left eye, which expressed a statistical significance (P=0.0316) respectively (Table 3). This signifies that, higher the HbA1C levels greater the central macular thickness.

Table 3: HbA1C levels with macula thickness are correlated in diabetic individuals

HbA1C	Right Eye	Left Eye	P value
< 5.7	172 ± 23.69	191.5 ± 45.61	0.8621
5.7 – 6.4	220.91± 53.81	204.91 ± 62.77	0.4231
6.5 – 8.5	222.2± 82.45	231.85 ± 111.01	0.0121
>8.5	256.75 ± 88.25	300.5 ± 83.15	0.0316

4. Discussion

Diabetes mellitus is the significant determinant in causing visual impairment leading to retinopathy. The incidence of retinopathy increases with 10% at 3 years to 83% at 15 years in patients with a history of long term diabetes mellitus.[18] Various studies have reported the occurrence of central macular thickness with or without diabetic retinopathy.[19–21] Timely diagnosis and intervention may help to prevent the irreversible vision loss due to diabetic retinopathy. One such imaging modality in measuring the thickness of macula was OCT, which guides in achieving the right diagnosis with peculiar details of the progression of the disease and monitoring the efficacy of treatment planned for patients with or without retinopathy.[22]

In our study, with higher age groups, there was an improved thickness in the macula however, the findings lacked statistical significance when the macula thickness and age were compared between groups. This finding was consistent with Eriksson and Alm et al[23] who observed a negative connection between retinal thickness and age groups. On contrary, Khan et al[1] suggested that in his study, a significant correlation emerged on comparing the CMT values and, age in healthy subjects. Similarly, the author also had insignificant findings when comparing the CMT values and age with diabetic subjects.

In the present study, the average CMT value in the right eye for diabetic patients (202.04±35.65) was thinner when compared to non-diabetic patients (220.04±70.04) with P=0.0427. The average CMT value of patients with diabetes in left eye was also found to be thinner (205.68±42.64) when compared to non-diabetic patients (222.26±90.10) with P=0.0215. Our results are consistent with Demir et al,[20] Teberiek et al,[24] Murugesan et al[25] and Jiang Jing et al,[26] where the authors had found a thinning of macula in diabetic individuals than healthy subjects.

Biallosterski et al[27] had also suggested that there was some evidence of peri-central retinal thinning in patients with diabetes. Understanding the nature of retina, in diabetic patients, the nerve fibre thickness was reduced in the superior and other areas around the retina when compared to non-diabetic patients. Hence, any damage to the retina in diabetic patients, it predominantly affects the ganglionic and plexiform layers of the retina.[28,29]

Glycosylated hemoglobin is a compatible and well accepted marker for long term control of blood glucose levels in patients with diabetes. Our study found a thicker level of CMT in diabetic individuals with elevated HbA1c levels compared to those with normal HbA1c levels, presumably pointing to the impact of uncontrolled hyperglycemia. The present study findings were similar to a study performed by Tan O et al,[30] Prata TS et al,[31] Tekin K et al[32] and, Tadwalkar A et al.[33] On contrary, Demir et al,[20] found a lack of significance between the CMT values and, the duration of HbA1C levels.

Sugimoto M and colleagues[34] studied by correlating the HbA1c levels with retinal nerve fibre thickness in the region of macula at 4 months. The findings of their study confirmed that the control in HbA1C affects the retinal nerve fibres within 4 months. When the superior region was inspected at 4 months, the thickness of the nerve fibers had significantly decreased. Bronson-Castain KW and colleagues et al,[35] investigated and confirmed that the retinal thickness decreased in adolescents of type 2 diabetes with a typical length of diabetes of 2.1 years. The average time of subjects with diabetic history in our research was 5 years. Zaky et al.,[36] found a positive association between the peri-foveal thickness of the retina and HbA1C levels. According to Oshitari et al.,[37] ganglionic and axonal loss existed and deteriorated as the disease's severity accelerated when related to HbA1C and duration. Similarly, our study showed that there was an increase in the CMT in increasing HbA1C levels in diabetic patients.

Our study had few limitations

1. Although, the study compared CMT in diabetic and non-diabetic patients on a smaller sample size, further studies must be implemented on a larger study sample to analyse the CMT with changes in the degree of retinal nerve fibers in diabetic patients.
2. Since the typical history of diabetes in our study was only 5 years, future research must address on the long term diabetic history of >10 years.

5. Conclusion

The results of our research revealed that individuals with diabetes had substantially greater central macular thinning than non-diabetic patients, and that the corresponding CMT value elevated significantly as the patients' HbA1C levels increased.

6. Source of Funding

None.

7. Conflict of Interest

None.

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