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Original Research Article

Association of ocular biometric parameters with diabetic retinopathy

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ABSTRACT

Background: To study the association of ocular biometric parameters {Spherical equivalent (SE), Axial length (AL), Anterior chamber depth (ACD) and Corneal curvature (CC)} with diabetic retinopathy (DR) in subjects with Type 2 diabetes mellitus (DM).
Methods: This prospective observational study was conducted in the Outpatient Department of Ophthalmology of a tertiary care teaching hospital in North India. The study included 100 subjects having various grades of DR as cases and 100 diabetics without DR as controls. The SE was assessed using objective autorefraction, while AL, CC and ACD were measured using the NIDEK AL SCAN. International Clinical Diabetic Retinopathy Disease Severity Scale was used for grading of DR.
Results: A total of 181 eyes in the study group and 200 eyes in the control group were analysed. Progressive decrease in the mean AL was observed with the increasing severity of DR (p=0.017). Deeper ACD had a negative correlation with severity of DR (p=0.037). No statistically significant difference was observed for AL and ACD with the incidence of DR (p=0.147 and p=0.091 respectively). Likewise, there was no significant relation of DR with SE or CC.
Conclusions: Longer AL and deep ACD were protective against progression to the severe forms of DR. However, there was no correlation of AL and ACD with the incidence of DR. The SE and CC were not found to be significant determinants for either development or severity of DR.

Keywords: Anterior chamber depth, Axial length, Corneal curvature, Diabetes mellitus, Diabetic retinopathy, Myopia, Spherical equivalent

INTRODUCTION

Individuals with diabetes mellitus (DM) are 25 times more likely to become legally blind than others.[1] Visual loss is primarily the result of progressive diabetic retinopathy (DR) and clinically significant macular edema (CSME). Various studies have suggested that myopia, particularly of high degree, may have a protective effect on DR.[2] Myopia has two components: structural {Axial length (AL) and Anterior chamber depth (ACD)} and refractive {Corneal curvature (CC) and Spherical equivalent (SE)}.

It is unclear as to which component is the main contributor to the relationship of refractive errors with DR.[3] Among the components of myopia, AL has received the most attention.[4]

Since ACD is a part of AL, apparently the major protective effect may be related to the length of the vitreous chamber.[5] These relationships, however, have not been firmly established. This study has been carried out to evaluate the association between the various ocular biometric parameters and the presence as well as different grades of DR.

METHODS

This prospective observational study was conducted in the Outpatient Department of Ophthalmology of a tertiary care teaching hospital in North India. The study group included 100 subjects with type 2 DM and varying grades of DR. The control group consisted of 100 subjects having no DR.

Patients with history of previous retinal or cataract surgery, laser treatment, anti-VEGF treatment and patients with clinically significant macular edema (CSME) were excluded from the study. Patients with significant media opacities which hampered the recording of ocular biometric parameters were also excluded. Informed consent was taken from each patient. The study was duly approved by the Institutional Ethics Committee.

Assessment of ocular biometric parameters

All subjects underwent a complete ophthalmological examination including Best Corrected Visual Acuity (BCVA). Autorefractometer reading was taken and converted to spherical equivalent. SE was defined as the sum of sphere and half negative cylinder.

The refractive error was classified as Myopia, Hypermetropia or Emmetropia based on the SE as follows -

Myopia S.E. ≤-0.5 D
Emmetropia SE › -0.5 to ‹ +1.00 D
Hypermetropia S.E. ≥+1.00 D

As the ocular biometric parameters may be different between the two eyes of the same person, individual eyes of cases and controls were taken into study according to the inclusion and exclusion criteria. The parameters AL, CC and ACD were measured using NIDEK AL SCAN optical biometer. Three readings of AL and ACD were measured in mm for each eye and the arithmetic mean was taken for analysis. Three readings of CC were taken in diopters and the average was calculated using Average Keratometry Calculator V 1.1.

Assessment of DR

Fundus examination was done using a +90 diopter lens and DR was graded according to the International Clinical Diabetic Retinopathy Disease Severity Scale into five levels, viz. none, mild, moderate, severe and proliferative.[6]

No apparent retinopathy: No abnormalities, Mild NPDR: Microaneurysms only, Moderate NPDR: More than just microaneurysms but less than severe NPDR, Severe NPDR- any of the following: Twenty intra-retinal hemorrhages in each of four quadrants, Definite venous beading in two or more quadrants, Prominent IRMA in one or more quadrants, No signs of PDR, PDR: Neovascularization, Vitreous/preretinal hemorrhage.

Statistical analysis

The data was evaluated using frequency distribution and descriptive analysis. Chi-square test was used for categorical variables. T-test and Mann-Whitney's test was used to find the significant difference of continuous variables. The p value <0.05 was considered significant. All statistical analysis was performed using SPSS (Statistical Package for Social Sciences) version 22.0 Armonk, NY; IBM Corp.

RESULTS

Mean age of the patients in the study group was 57.98±7.12 years (range 37-83 years), while it was 56.58±9.22 (range 37-70 years) in the control group. There was no statistically significant difference between the two groups (p=0.231). The maximum number of subjects in both the groups were in the age group of <59 years (53 in study group and 67 in control group) and minimum number of subjects were in >70 years age group (nine in both study and control group).

Among the 200 eyes of 100 subjects in the study group, 19 eyes fell under the exclusion criteria and only 181 eyes were included for further analysis. In the control group, both the eyes of the patients were included (200 eyes).

Of the 181 eyes in the study group, 76 had Mild NPDR, 41 Moderate NPDR, 42 Severe NPDR and the remaining 22 eyes had PDR.

There was a statistically significant difference observed in the mean duration of DM as well as in glycated hemoglobin levels in the study and control groups (Table 1).

Table 1: Demographic profile of cases and controls.

	Case	Control	P value
Age (years) (Mean±SD)	57.98±7.12	56.58±9.22	0.231
Gender (number) Males Females	 56 44	 50 50	0.395
Duration (years) (Mean±SD)	14.32±7.09	7.45±7.11	<0.0001
HbA1c (%) (Mean±SD)	10.05±2.31	8.8±2.58	<0.0001

SD: Standard deviation.

The mean SE in cases with myopia, emmetropia and hypermetropia were statistically not significant in the

study and control group. Thus, SE was not a significant determinant for development of DR. The mean AL was found to be statistically not significant (p=0.147). This could be because Mild NPDR formed a major component of the DR group (76/100) which led to the overall non-significance of difference between AL of the study and control groups. Similarly, the mean ACD and CC in both the groups were also not found to be statistically significant (p=0.091) (Table 2).

Table 2: Ocular biometric parameters in cases and controls.

	Cases	Control	P value
Spherical equivalent (mean ± sd)			
Myopia	-1.42±1.02	-1.17±0.97	0.102
Emmetropia	0.33±0.38	0.24±0.36	0.074
Hypermetropia	1.65±0.59	1.71±0.69	0.875
Axial length (mean ± sd)	22.95±0.84	23.07±0.91	0.147
Anterior chamber depth (mean ± sd)	3.0±0.38	3.08±0.35	0.091
Corneal curvature (average k) (d)	44.29±1.43	44.24±1.57	0.742

SD: Standard deviation, D: Diopter.

Table 3 shows the association of ocular biometric parameters in various subgroups of DR.

The SE was comparable in all the four subgroups of patients with DR. There was no significant difference in the severity of retinopathy with respect to spherical equivalent in all the three categories of myopia, hypermetropia and emmetropia.

The mean AL in the Mild NPDR subgroup was very similar to the mean AL in the control group. This suggests that longer AL was more commonly encountered in the milder forms of DR which also implies that longer AL may be protective against the more severe forms of DR. A progressive decrease in the mean AL was observed with the increasing severity of DR and this difference was statistically significant.

As in the case of AL, it was observed that the ACD was shorter in eyes with severe NPDR and PDR as compared to the mild NPDR group (p=0.037). The explanation for this observation is that the overall mean in the DR group is heavily tilted towards the milder forms, with maximum number of eyes in the Mild NPDR group. It is only on subcategorization that the impact of ACD on the severity of DR is obvious.

The CC in the various DR subgroups is shown in Table 3. This distribution was not statistically significant (p= 0.754). This shows that CC does not have any relation with the severity of DR.

Table 3: Ocular biometric parameters in different subgroups of DR.

	Mild NPDR	Moderate NPDR	Severe NPDR	PDR	P value
Spherical equivalent (mean ± sd)					
Myopia	-1.38±1.12	-1.72±1.23	-1.12±0.74	-1.23±0.56	0.469
Emmetropia	0.28±0.4	0.41±0.35	0.36±0.37	0.38±0.38	0.748
Hypermetropia	1.52±0.54	2.04±0.86	1.5±0.35	1.6±0.44	0.368
Axial length (mean ± sd)	23.20±0.82	23.07±0.97	22.69±0.66	22.60±0.8	0.017
Anterior chamber depth (mean ± sd)	3.11±0.41	3.03±0.34	2.94±0.32	2.84±0.39	0.037
Corneal curvature (average k) (d)	44.23±1.55	44.26±1.22	44.5±1.44	44.18±1.36	0.754

SD: Standard deviation, D: Diopter.

DISCUSSION

The incidence of retinopathy worsened as the duration of DM increased although the difference between the duration of DM in the various subgroups of the study group was not found to be statistically significant. These findings were in agreement with several other studies that have established that on assessment of variables associated with significantly increased risk of DR, in age and gender adjusted prevalence studies, the main factor was longer duration of diabetes.[7-9] Since DR is the result of poor control of diabetes and the resultant relentless hyperglycemia, it is expected that DR is associated with high HbA1c levels.[10,11] Similar results were seen in this study.

Myopia, particularly high myopia, has been suggested in some studies to have a protective effect against DR.[12,13] It has been reported that more myopic eyes with longer AL and deeper ACD were less likely to have any DR,

particularly vision-threatening DR, but it is unclear whether these associations are related to axial myopia or to other refractive components.[14] In the present study SE was not a significant determinant for development and progression of DR. The protective role of a more myopic SE in DR is not established in other studies also and a large multicentric study may be necessary to come to some conclusion.[5,15]

A progressive decrease in the mean AL was observed with the increasing severity of DR.[3,5,16] Though no correlation was found between AL and mere presence of DR, there was a statistically significant negative correlation with the severity of DR. Several mechanisms underlying the protective effects of globe elongation have been proposed in literature. Firstly, the decrease in blood flow with increasing AL may play a major role in the protective effect against DR. The decreased blood flow reduces the leakage of blood components that act as a stimuli for proliferation.[14] Secondly, there is decreased retinal function in the outer retina in higher axial length which reduces the metabolic demand as well as the production of inflammatory or proangiogenic cytokines.[5] Thirdly, posterior vitreous detachment noted in many myopic eyes helps in removal of the vitreous scaffold for neovascular proliferation and improved oxygen diffusion across the liquefied vitreous.[13]

Various studies state that myopia per se is not an isolated entity but is dependent on various components of ocular structure of which AL remains the primary determinant. This parameter represents the combination of three components of the eye, namely depth of the anterior chamber, thickness of the lens and depth of the vitreous chamber. The association of myopia with DR may in effect be a reflection of AL and ACD.

In the present study, the ACD was shorter in eyes with severe NPDR and PDR. Like AL, deeper ACD had a negative correlation with severity of DR. This result was in line with other studies.[14] The explanation for this observation is that the overall mean in the DR group is heavily tilted towards the milder forms. It is only on subcategorization that the impact of ACD on the severity of DR is obvious.

The study also revealed that CC was not significantly associated with incidence or severity of DR as seen in many other studies.[5]

The strength of the study is that it is a comprehensive rather than selective analysis of the various ocular biometric parameters with DR. These associations may vary in different subset of population and have not been well established in North India. The limitation of the study is that the majority of the cases were in Mild DR group. Also, the impact of these parameters on diabetic macular edema (DME) have not been evaluated.

CONCLUSION

In conclusion, no association of spherical equivalent and corneal curvature was observed with the prevalence and severity of diabetic retinopathy. Axial length and anterior chamber depth do not appear to affect the development of diabetic retinopathy per se, but do protect against progression to the severe forms of diabetic retinopathy, particularly PDR.

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