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Evaluation of near accommodation in type 1 diabetic patients

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ABSTRACT

Aim: To evaluate accommodation in type 1 diabetic patients by PowerRef3 in our study. The PowerRef 3 can be used in studying the near triad of accommodation, vergence and pupil responses in healthy and clinical populations.

Method: The accommodation of 14 patients (mean age: 33.14 ± 10.27) with type 1 diabetes and 16 control subjects (mean age: 35.81 ± 5.88) were measured by PowerRef3 at 30 cm with a standard accommodation target. The metabolic status of the diabetic patients and accommodation were compared with those of control subjects.

Results: The mean accommodation, spherical equivalents and age was not significantly different between diabetic and control subjects. The mean duration of diabetes was 13 ± 5.7 years (min: 7, max: 27). The mean accommodation was not significantly correlated with duration of diabetes and glycated hemoglobin levels, but it was significantly correlated with the spherical equivalents (p<0.05) and weakly correlated other metabolic parameters (fasting plasma glucose, cholesterol, low density lipoprotein, high density lipoprotein and triglyceride levels).

Conclusion: The accommodation of type 1 diabetes patients at pre-presbyopic ages without diabetic retinopathy was similar to control subjects with PowerRef 3 measurements. This may reflect that good diabetes control, which will prevent retinopathy, may prevent the decrease in accommodation in type 1 diabetes patients.

Key words: Accommodation, type 1 diabetes, PowerRefractor 3, spherical equivalents.

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Introduction

The ability to accommodate for near is normally diminished with decreased elasticity of lens with age [1]. That is because of changing refractive status of the eye by altered shape of crystalline lens. Changes in accommodation have been previously reported in a wide range of age groups [2-4]. Most of these studies have used subjective methods to evaluate accommodation.

Diabetes mellitus is a group of metabolic diseases characterized by chronic hyperglycemia. It's classified into two types. Type 1 diabetes mellitus, which is characterized loss of insulin secretion by autoimmune destruction of pancreatic beta-cells. Type 2 diabetes mellitus, which is characterized by insufficient insulin production and associated

with obesity and insulin resistance. Type 2 is the most common (90%) form.

Diabetes mellitus can also cause a variety of ocular pathologies that affect nearly all tissues in the eye, especially if it's uncontrolled [5]. Decreased accommodation in patients with Diabetes reported several studies before [3,4,6,7].

The Plusoptix PowerRef 3 (http://www./plusoptix.com) measures gaze position, pupil size and refractive state binocularly at a sampling rate of 50 Hz over a wide dioptric range (+5 D to −7 D). PlusoptixSO9 PowerRef 3 (Plusoptix GmbH, Nuremberg, Germany) provides refraction measurements (50 measurements per second) reporting thus accommodative changes during fixation of designed targets. PowerRef 3 can measure highly sensitive changes in refraction helping us to evaluate changes in the ability of accommodation. This pilot study, we aimed to objectively evaluate accommodative function in pre-presbyopic patients with type 1 diabetes mellitus without retinopathy and compare them with age and sex matched heathy subjects.

Materials and Methods

The study included 14 type 1 diabetic patients without diabetic retinopathy and 16 control subjects matched for demographic characteristics. This prospective, cross-sectional study was performed in our hospital strabismus unit, department of ophthalmology from July 2018 to February 2019. The study was approved by our University Faculty of Medicine Clinical Research Ethics Committee (22.02.2017, Decree no: 38). The study was conducted according to the ethical standards stated in the 1964 Helsinki Declaration.

Full ophthalmological examination was performed for all patients; including visual function, slit lamp biomicroscopy, fundus examination. Blood samples were taken from the participants on the same day as eye examinations and analyzed for HbA_{1c} (glycated hemoglobin) levels and metabolic parameters [cholesterol, low density lipoprotein (LDL), high density lipoprotein (HDL), and triglyceride levels].

The accommodation response of diabetic patients and volunteers fixated on an accommodative target at 33 cm, 50 cm, and 1 m while their eyes' refractive state, gaze positions and accommodation were measured with PlusOptix PowerRef 3. The target consisted of a central letter 'E' surrounded by two rings of letters. The letters were scaled in size such that they each subtended 0.33 deg. The outer ring diameter was 4 deg. The letters are printed in black on white paper.

Participants with corrected visual acuities ≥0.1 logMAR, equivalent spherical refraction ≤ ±3.5 D were included. Participants with glaucoma, uveitis, retinal diseases, ocular trauma or surgery, diabetic retinopathy, epilepsy, endocrine disorders (except diabetes), hypertension, neurologic or psychiatric disorders and cataract were excluded from the study. Patients using any drug other except insulin were also excluded from the study.

Statistical analyses were performed using SPSS for Windows 18.0 (Chicago, IL) software package. Descriptive statistics included mean ± standard deviation for normally distributed variables. Inter-group comparisons of the variables were performed using t-tests and Pearson correlation test. A p value <0.05 was considered to be statistically significant.

Results

Fourteen patients (3 male, 11 female) with Type 1 diabetes and 16 control (5 male, 11 female) subjects were examined. Mean age of diabetic group was 33.14 ± 10.27 years and 35.81 ± 5.88

years in control group. The two groups were similar in age and sex distribution.

Demographic properties, refractive errors and mean accommodation of diabetic and control subjects specified in table 1.The mean spherical equivalent in the diabetes group was -0.86 ± 0.91 in the right eye and -0.94 ± 0.96 in the left eye. And in control group mean spherical equivalent was -1.17 ± 1.80 in the right eye and -1.20 ± 1.90 in the left eye. There was no statistically significant difference in spherical equivalents between groups.

Mean accommodation was 0.91±0.64 (min: 5.10, max: 8.50) in type 1 diabetic group and 0.99±0.72 (min: 5.19, max: 5.36) in control group. There was no statistically significant difference in mean accommodation between diabetic and control subjects (*p*: 0.73) (Table 1).

Mean HbA_{1c} levels were 7.1±1.1 (min: 5.1, max: 8) in type 1 diabetic patients and 5.27±0.07 (min: 5.19, max: 5.36) in control group. Mean cholesterol levels were 160.10±34.09 (min: 106, max: 205) in type 1 diabetic patients and 201.22±34.32 (min: 142, max: 246) in control group. Mean LDL levels were 90.14±32.82 (min: 40, max: 143) in type 1 diabetic group and 118.40±30.34 (min: 62, max: 163) in control group. Mean HDL levels were 56.21±13.62 (min: 38, max: 79) in type 1 diabetic patients and 56.78±9.46 (min: 43, max: 74) in control group. And mean triglyceride levels were 89.50±65.09 (min: 34, max: 250) in type 1 diabetic patients and 129.96±70.68 (min: 66, max: 238) in control group. There wasn't statistically significant difference at LDL, HDL and triglyceride levels between two groups (*p*:

Table 1. Demographic and ophthalmological properties of the diabetic patients and control group.

Parameters	Diabetic patients	Control	*p* value
Age (years)	33.14±10.27	35.81±5.88	0.06
Gender (male/female)	3/11	5/11	0.56
Spherical equivalent OD (D)	-0.86±0.92	-1.18±1.80	0.84
Spherical equivalent OS (D)	-0.94±0.97	-1.20±1.90	0.66
Mean accommodation (D)	0.91±0.64	0.99±0.72	0,73

OD: oculus dexter, OS: oculus sinister, D: dioptre

Table 2. Comparison of metabolic parameters between the diabetic patients and the control group.

Parameters	Diabetic Patients	Control	*p* value
Fasting glucose (mg/dL)	205.91±99.31	87.91±14.96	0.001*
HbA1c	7.1±1.1	5.27±0.07	0.005*
Cholesterol (mg/dL)	160.10±34.09	201.22±34.32	0.02*
LDL (mg/dL)	90.14±32.82	118.40±30.34	0.69
HDL(mg/dL)	56.21±13.62	56.78±9.46	0.92
Triglyceride (mg/dL)	89.50±65.09	129.96±70.68	0.211

HbA1c: Glycated hemoglobin, HDL: High density lipoprotein, LDL: Low density lipoprotein * $p<0.05$

0.69, 0.92, and 0.211, respectively). Only cholesterol levels were statistically significant lower in diabetic patients (*p*: 0.02) (Table 2).

The mean duration of diabetes was 13 ± 5.7 years (min: 7, max: 27). There was no statistically significant correlation between diabetes duration and accommodation (*p*: 0.245). The mean accommodation was negatively moderately correlated with mean spherical equivalent in right and left eye (*p*: 0.035, *p*: 0.043, respectively) while it was weakly correlated with other metabolic parameters in type 1 diabetic patients (Table 3).

Table 3. Correlation of the mean accommodation measured by PowerRef3 with the clinical parameters.

Parameters	**Correlation Coefficient r***	***p* value**
Spherical equivalent OD	0.498	0.035**
Spherical equivalent OS	0.482	0.043**
Fasting plasma glucose	0.326	0.769
HbA1c	0.126	0.354
Cholesterol	0.198	0.432
LDL	0.147	0.808
HDL	0.135	0.266
Triglyceride	0.222	0.223
Diabetes duration	0.187	0.245

HbA1c: Glycated hemoglobin, HDL: High density lipoprotein, LDL: Low density lipoprotein, OD: oculus dexter, OS: oculus sinister. *Pearson correlation coefficient. *$p<0.05$.

Discussion

Accommodation reduces as a normal part of aging and presbyopia occurs approximately at the age of 40 years. Decreased accommodation in diabetic patients in pre-presbyopic ages has been reported in several subjective studies [3,4,6,7]. Fisher et al observed that the lens capsule and lens substance lost elasticity in diabetic patients, which consequently impaired their accommodative function [8].

Also it is shown that there are considerable differences in the biometry and optics of lenses between people with and without diabetes by several studies. These studies indicating that the lens is mainly responsible for loss of amplitude in diabetes [9-11]. Razavi et al who subjectively investigated pre-presbyopic patients between 30 and 40 years of age could only find significant changes in accommodation facility [6]. Mantyaryi and Nousiainen used monocular push-up method, a subjective method for measuring accommodation, and found that children with type 1 diabetes have approximately 1.9 D less accommodation amplitude than non-diabetic children [12]. Sırakaya et al involved younger (mean age: 25.0 ± 3.3 years) type 1 diabetic patients in their study, they used minus lens method for measuring of accommodation amplitude. They also found accommodation amplitude significantly lower among patients than healthy individuals and suggested that the former might experience presbyopia earlier in life than the general population [7].

We observed that there isn't a significant change in accommodation of diabetic patients objectively by PowerRef 3.

Cholesterol levels in the diabetic patient group were found to be significantly lower than in the healthy group. We attribute this to the fact that the use of insulin in diabetic patients reduces cholesterol levels. This finding is also compatible with the literature [13].

Adnan et al excluded the patients who had moderate to severe diabetic retinopathy from their study and used another objective amplitude of accommodation measure method, Complete Ophthalmic Assessment System high

definition wavefront aberrometer. They found the loss of accommodation affected strongly by duration of diabetes [2]. Leffler et al found that the preferred reading addition in a 43-71 year population was significantly related to the duration of diabetes. They reported that related to reduction in amplitude of accommodation, the addition was predicted to increase by 0.06 D/year of diabetes duration [14]. We didn't find correlation between diabetes duration and accommodation amplitude.

Moss et al said that younger-onset diabetes, who are insulin-taking, on the average have poorer accommodation than nondiabetic persons of similar age. And participants with longer duration of diabetes, more severe retinopathy and higher glycosylated hemoglobin levels (poorer metabolic control) have lower mean amplitude [4].

In this study, HbA_{1c} level, that is an indicator of long term blood glucose changes, was found to be negatively weakly correlated with mean accommodation level in diabetic patients.

The different results from several studies may be explained by several factors. The type 1 diabetes patients at pre-presbyopic ages in our study population may have better control of blood glucose and metabolic status. This may decrease the possible diabetic changes in the lens that may influence accommodation.

Although we used an objective sensitive method for measuring refractive changes the patients' attention level may also be a confounding factor.

Since this is a pilot study with PowerRef 3 an important limiting factor is the low number of patients. The results can be confirmed with studies of larger populations.

Conclusion

The accommodation of type 1 diabetes patients at prepresbyopic ages without diabetic retinopathy is similar to control subjects with PowerRef 3 measurements. This may reflect that good diabetes control, which will prevent retinopathy, may prevent the decrease in accommodation in type 1 diabetes patients.

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