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Accommodative Ability in Pre-presbyopic Diabetic Patients

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ABSTRACT

Introduction: To compare various accommodative parameters in pre-presbyopic diabetic patients with age-matched healthy individuals.

Materials and Methods: Study population consisted of 32 younger-onset diabetic patients (30-40 years of age) and 28 age-matched healthy normal individuals. Using the best correction for distance visual acuity (20.20 by Snellen chart), multiple accommodative ability tests such as near point of accommodation, accommodative amplitude, negative or positive accommodative facility and near point of convergence were measured in both groups.

Results: Mean near point of accommodation in diabetic patients was significantly greater than the control group (18.5±4.4 centimeters [cm] versus 9.5±2 centimeters, p= 0.000). Mean accommodative amplitude was (5.93±1.75) Diopter (D) and (10.95±2.16) Diopter in diabetics and normal individuals, respectively (p=0.000). Mean accommodation facility was (3.19±3.04) cycle/minute [cyl/min] in patients and 10.01±5.09 cycle/minute in the control group (p= 0.000). Mean positive relative accommodation was (–3.37±1.19) D in diabetic and (-2.11±0.99) D in healthy participants (p=0.000). Mean negative relative accommodation was lower in diabetic patients compared with the control group, however, this difference did not reach statistical significance (2.61±0.65) D versus (2.61±0.60) D, p= 0.23). Mean near point of convergence was (8.23±1.43) cm and (7.13±0.67) cm in normal and diabetic groups, respectively which had insignificant difference (p= 0.45).

Conclusion: Majority of accommodative ability functions decreased in Pre-presbyopic diabetic patients. Early detection and rehabilitation of such patients with corrective near spectacles are strongly recommended.

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Introduction

Accommodation is the mechanism by which the eye changes its refractive power by altering the shape of the crystalline lens (1). During accommodation, ciliary muscles contract, allowing the zonular fiber to relax and the crystalline lens become more convex, far point moves closer to the eye to focus on near objects (1, 2).

If crystalline lens elasticity decreases (due to aging process or a systemic condition like diabetes mellitus), accommodative response reduce (2).These patients require additional spectacle lens power to see near objects clearly. Few studies were performed on young diabetic patients to evaluate only accommodation amplitude and/or convergence.ETDRS group in 1995 compared Amplitude of Accommodation(AA) in white Pre-presbyopic diabetic and normal subjects. They used spherical lens power for AA measurement. They found that AA was lower in diabetic patients and the mean AA for a 35-year-old diabetic patient was about four diopters(3).In this study, for first time we performed multiple accommodative ability tests in Pre-presbyopic (less than 40 years of age) diabetic patients to compare their accommodation characteristics with those normal individuals.

Materials and Methods

This cross-sectional case-control study was performed on patients who were referred to one of the teaching hospitals of Mashhad University of Medical Sciences. Informed consent was obtained in accordance with the Declaration of Helsinki. There were two groups of young adult subjects,one group(n=32) with young – onset diabetes and control group(n=28)

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without diabetes.Inclusion criteria for diabetic group were individuals ages ranged between 30 and 40 years, detected diabetes by endocrinologist, history of glucose lowering drugs, no diabetic retinopathy in fundus examination, fasting blood sugar less than 180 mg/dl and HbA1c les than (7%) immediately before accommodative tests. Inclusion criteria for control group were healthy individuals in same age range without diabetes. Exclusion criteria were evidence of diabetic retinopathy (proliferative or nonproliftrative) in diabetes group, previous ocular surgery, systemic disease, history of anticholinergic drug use for both groups. Demographic data including age, gender, type of diabetes (insulin-dependent or non-insulin-dependent) and duration of disease were recorded.

Detailed ocular examination including best corrected visual acuity for distance under cycloplegia, movement including alternate cover test for detection of any phoria or tropia, biomicroscopic and fundus examination were performed on both groups. Fasting blood sugar was measured and in case of being less than 180 mg/dl, accommodation ability tests were performed.Accommodation ability tests consisted of multiple experiments which was performed by single optometrist and rechecked by an expert ophthalmologist. The study was double-blinded and intraobserver and interobserver variability were controlled by another examiner. These means, examiners were blinded for both group in which the subjects belonged and measurements obtained by the optometrist and ophthalmologist. Each test was performed two times in individuals by observer and average of result considered for statistical analysis. All tests were run binoculary and instruction set was similar to cases and controls. These accommodative tests include:

Near Point of Accommodation (NPA):

It was measured by the push-up method. While the participant wearing his/her best distance correction, a (20.20-20.40) size target on the ruler moves slowly toward the nose until the observer reported the first blur. The distance from ruler was read and expressed as centimeter. Accommodative Amplitude defined as the reciprocal of near point of accommodation and expressed as diopter.

Accommodation Facility (AF):

With proper distance correction, accommodative target (20.20-20.40 sizes) was viewed at near distance (40 cm). ±2.00 D lens pairs mounted in a handheld flipper frame were repeatedly introduced over both eyes and the time needed to see the target clearly was measured. Test duration was one minute and expressed as Cycle (times to see the target clearly) Per Minute (CPM).

Relative Accommodation (RA):

With proper refractive correction for distance, accommodative target was viewed. Minus or plus sphere with (0.25)D interval in power incrementally replaced until the observer could not see the target clearly. The strongest power which causes blurring was recorded and expressed as diopter (negative value for positive relative accommodation and positive value for negative relative accommodation).

Near Point of Convergence (NPC):

It was measured by the ruler and push-up method. In this technique (20.20-20.40) target size on ruler was moved toward to the observer. Nearest point when patient lose his/her fixation or developed diplopia is defined as the near point of convergence and expressed as centimeter.

Statistical analysis:

Statistical analysis was performed using SPSS Version $_{16}$ (SPSS Inc., Chicago, IL). The normality ofdatadistributionwascheckedwithKolmogorov–Smirnov test.

The differences in accommodation functions between groups were tested using student's T-test, Man Whitney and repeated measures analysis of variances. The level of significance was set at P-values<0.05.

Results

Case and control groups included 32 and 28 individuals, respectively. Male to female ratio was 2.3.

Mean age was 35±6 years in the case group and 31±4 in the control group (p=0.000). Mean Fasting Blood Glucose (FBS) was (170±8) mg/dl in the case and (85±16) mg/dl in the control group. Mean refractive error was (0.50±2.17) D in the case and (0.25±2.75) D in the control group which was not statistically significant (p=0.1). All subjects had orthophoria. Table shows various accommodation parameters measured in population study.

Table1: Measured accommodation parameters in population study

Mean	Diabetic	Control	P value
NPA(cm)	9.5±2	18.5±4.4	0.000
AA(D)	5.93±1.75	10.95±2.16	0.000
AF(cycle/minute)	3.19±3.04	10.01±5.09	0.000
Positive relative accommodation(D)	-3.37±1.19	-2.11±0.99	0.000
Negative relative accommodation(D)	2.61±0.65	2.61±0.60	0.23
NPC(cm)	8.23±1.43	7.13±0.67	0.45

Near Point of Accommodation (NPA), Centimeter (cm), Amplitude of Accommodation (AA), Diopter (D), Accommodative Facility (AF), Near Point of Convergence (NPC)

Mean NPA was (18.5±4.4) cm in the case and (9.5±2) cm in normal individuals; this difference was significantly different (p<0.001). In addition, the difference of mean AA was statistically significant between groups (+5.93±1.75) D in the case and (+10.95±2.16) D in the control group) (p<0.001).

Mean AF was (3.19±3.04) CPM in the case and (10.01±5.09) CPM in the control group; which the difference was statistically different (p<0.001). Mean positive RA was (-3.37±1.19) D in the case and (-2.11±0.99) D in the control group which had a significant difference (p<0.001). Mean negative RA was (+2.61±0.65) D in the case and (+2.61±0.60) D in control group which had no significant difference (p=0.235). Mean NPC was (7.13± 0.67) cm in the case and (8.23±1.43) cm in the control group; however, this different did not reach statistical significance (p=0.45).

Discussion

Accommodation insufficiency is the premature loss of accommodative amplitude (1).This problem may manifest itself by blurring the near visual objects or by inability to sustain accommodative effort. The onset may be heralded by the development of asthenopic symptoms, with ultimate development of the blurred near vision. Such premature presbyopia may indicate concurrent or past debilitating disorder such as diabetes mellitus or it may be induced by medication such as tranquilizing drugs or the parasympatholitic used in treating some gastrointestinal disorders. In both cases, the condition may be reversible, however, permanent accommodative insufficiency may be associated with neurologic disorders such as encephalitis or closed head trauma. These patients require reading addition for their near vision (1, 2).Diabetes mellitus is a major cause of blindness in 20-74 years age individuals in United State (4). Accommodative insufficiency is one of the problems which is usually neglected in these patients and may affect their quality of life if not treated properly. Few previous studies have investigated the accommodation changes in young diabetic patients. For example, in a study Duane in 1925 measured NPC and AA in healthy individuals,which has been considered a reference for further studies till today (5).In another investigation, Pawelski and Glien in 1971 compared accommodative amplitude between white American diabetic and healthy subjects in young age and measured AA by the push up technique. They found a decreased AA in diabetic group (6).Another study by Moss in 1988 on 61 subjects ages ranged 9-16 years in two groups (diabetic versus normal) showed lower AA in diabetic patients (9.9 versus 11.8 D)(7). The present study was performed on young Iranian diabetic and healthy subjects. The NPA and NPC measurements are more of less similar in terms of the technique. Yet, only the NPA deteriorates in diabetes while the NPC remains relatively unaffected. We have an explanation for why this might be the case. Logically it seems like the diabetic subjects should have seen the targets blurred for closer distance (distances closer than the NPA) in the NPC measurements and our subjects report this.

Ethnicity is important parameter that may influence the results of previous studies (8, 9, and 10). In contrast to the ETDRS study, due to small sample size, we did not evaluate the association between gender, type or duration of diabetes and accommodation parameters which were measured in ability tests. Similar to other studies, we found that most accommodation ability tests including AA were lower in diabetic patients. One advantage of the current study was quantification of multiple accommodation parameters in normal and diabetic patients which was not evaluated in other studies. Accommodative performance may be correlated with biochemical parameters measured in the experiment(i.e. HbA1c levels or FBS). We did not try to see these relations but it might provide more insights into why accommodative performance may be deteriorating in diabetic patients. A considerable problem of the tests employed is their subjective component since one has to rely on patient's perception.

Hence, we suggested using objective methods to measure accommodation.

Conclusion

Defective accommodation may develop in young diabetic patients. Early diagnosis and rehabilitation with proper corrective lenses may improve symptoms and probably improve quality of life in thesepatients.

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