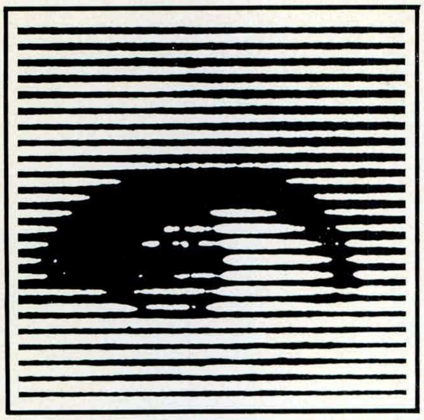

Ocular Accommodation in Juvenile Diabetics: A Preliminary Report

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Abstract

This paper discusses aspects of Ocular Accommodation measured by the push-up to blur out and minus lens to blur out methods in a sample population of juvenile diabetics. The data suggest an accelerated age-related trend to loss of accommodation. Since as many as 2/3 of this sample failed to reach Duane's minimum norms of accommodation careful measurement of ocular accommodation in young persons between 6 and 18 years of age may provide a means of early detection of diabetes mellitus, particularly when considered in conjunction with a tear glucose test and case history. Since this is a preliminary report the authors ask speculative questions on causative mechanisms.

Abrégé

Ce travail présente les résultats de deux mesures de l'accommodation déterminées dans une population de jeunes diabétiques. Les données suggèrent une tendance à une baisse prématurée de cette fonction. Deux tiers des sujets ne rencontrent pas les normes de Duane. Les auteurs proposent donc qu'une évaluation minutieuse de l'accommodation dans les âges de six à dix-huit ans pourrait servir à dépister la diabète surtout si on ajoute le test de glucose lacrymal et porte attention à l'histoire du cas. En marge de cette enquête préliminaire, les auteurs spéculent sur la cause de ce phénomène.

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INTRODUCTION

Diabetes is a disorder of carbohydrate metabolism resulting from insufficient action or production of insulin. The disease leads to various systemic disorders such as hyperglycemia, polyuria, muscular weakness and weight loss. This disease is often detected only when a routine urine analysis is done because of secondary complications arising from the underlying metabolic disorder. A definitive diagnosis of diabetes requires blood glucose tolerance determination. Diabetes has two forms; "adult onset" which is usually due to an hormonal imbalance affecting the regulation of insulin production and "insulin deficiency" form which is thought to be produced by viral infection of the pancreatic cells. The insulin deficiency form of the disease has a strong hereditary component and is termed juvenile or "Brittle" diabetes. The onset of this form of the disease usually occurs before 30 years of age, often much younger. Ten percent of diabetics fall into the juvenile diabetic classification[1-4] and thus a substantial number of cases are apt to appear in optometric practices making early detection and continuing vision care a necessity.

In addition to these metabolic changes there are also ocular changes that occur in diabetes. For example, there may be variations in refractive error and intraocular pressure, as well as structural changes in the extra ocular muscles, iris, cornea, conjunctiva and retina. The most serious ocular complications of diabetes are those resulting from vascular changes in the retina. Diabetic retinopathy[5-7] can be divided into three phases; the first, termed "background retinopathy" exhibits the development of microaneurysms, lipid deposits, hard exudates, macular edema and cystoid macular edema. A "preproliferative" phase follows, and is characterized by cotton wool spots, intraretinal microvascular anomalies cenrally and peripherally, venous beading, papillary closure and anteriole abnormalities. The "proliferation" phase consists of neovascularization of the disc (NVD), neovascularization elsewhere in the retina (NVE), and proliferation of fiberous tissue over areas of the retina. This latter change results in a high risk of tractional retinal detachment. This proliferative phase presents serious consequences to both central vision and the visual fields which can lead to blindness.

In July, 1980, one of us (MEW) began a clinical program of photographic documentation of the ocular fundus of juvenile diabetic patients at the Kitchener-Waterloo Hospital in response to the medical advisor of the Diabetic Day Care Center.

Before using a cycloplegic agent to dilate the pupil of the eye preparatory to refraction and photography, the status of vision and ocular health of each patient was assessed. The initial objective of the project was to establish baseline data of the status of vision and the ocular fundus at a point in time, and to compare this baseline data with visual findings and subsequent fundus photographs taken under similar conditions.

As part of the oculo-visual assessment prior to fundus photography, the ocular accommodative ability of each eye was measured by the push up to blur out method commonly used in clinical optometrical practice. Interocular differences in accommodative ability as well as reduced accommodative amplitudes were noted in a number of the juvenile diabetics. These unexpected and unusual variations occurred with sufficient frequency to need exploration and correlation with various parameters of the physiological status and medical conditions of the patients.

Vision literature has a number of general references to loss of accommodation[8,9] in diabetes but few of these references are related to the loss of ocular accommodation in juvenile diabetes. In two recent ophthalmological[9,10] texts there is little or no documentation as to the extent of the reduction in accommodation or to the temporal aspects of accommodative loss in either juvenile or adult onset diabetes. The relationship of accommodative loss to the duration of the disease has not been quantified, nor is the response of the accommodative function to diabetic treatment documented. The effect of accommodative reduction on the association between ocular accommodation and the related convergence has not been explored. While the authors have been able to find references to loss of accommodative function in young persons[11-13], no papers in western vision literature reported detailed cross sectional or longitudinal studies of ocular accommodation in populations of juveniles who had diabetes mellitus. In Russian vision literature[14,15], we did identify two papers, one on ocular accommodation and a second on aspects of the extraocular muscles used in mediating convergence. These papers reported only a single cross-sectional study and left uninvestigated many of the areas and relationships related above.

Methods

Accommodative Amplitudes were taken by the push up to blur out method using Prince's Rule for all 49 subjects during the initial vision assessment at the K-W Hospital Diabetic Day Care Clinic. Two of us, MEW and JL made all of these measurements.

Subsequently 32 patients were seen in the University of Waterloo Optometry Clinic for a complete assessment of visual structures and functions including an electroretinogram and visually evoked cortical response work-up. At this visit amplitudes of accommodation were measured by the minus lens to blur out method. The majority of these measures of accommodation were made by one of the investigators MMS.

The amplitude measurement was taken using a standard near point reading card with a surface reflectance of 85%. The stimulus used was the 0.5M paragraph. Illumination was 15 ft.L, the luminance standard used for accommodative amplitude measurement at the School of Optometry.

RESULTS

Amplitudes of accommodation ranged from 15.0D to 7.0D with a mean of 10.0D (SD+/-2.96D).

The push up to blur out amplitude for each eye is displayed as a scatter plot on a replot of curves of Duane's normals[3], Figure 1. Duane's median amplitude and the range of high and low amplitudes are displayed in this figure as a solid line and shaded areas above and below the line. Fifty two of the 98 (53.1%) eyes comprising the sample did not attain Duane's minimum amplitude when measured by the push up to blur out method. Since magnification of the fixation target occurs as it is moved in a ramplike way closer to the eye, we assumed that this contributed a maximum of one diopter of measurement error to the push up to blur out findings. If this latter assumption is made, 32.7% of eyes fail to meet the minimum values of Duane's normal range of accommodation amplitude.

The minus lens to blur out amplitude data for each eye of 32 patients are shown in Figure 2. This figure shows that 67.2% of eyes failed to reach Duane's minimum amplitude. If it is assumed that a 0.50D measurement error was induced by the subjective judgement of the patient in responding to the steplike accommodation stimulus through minus lenses, the number of persons failing to meet Duane's minimum range of normality is 59.4%.

Figures 1 and 2 also contain insets which show the regression lines for both Duane's median amplitudes and the respective regression lines for push up to blur out and the minus lens to blur out amplitudes of accommodation. These figures show an accelerated decline of accommodative amplitude with age. The calculated regression coefficients represent the slope of these regression lines and indicate the change in amplitude per year of age. The rate of decline of amplitude per year, for the push up to blur out amplitudes was -0.37 D/year and the rate for minus lens to blur out amplitude was -0.35 D/year.

This sample of juvenile diabetics lacks representative number of subjects in some age groups. While, our data suggest the existence of an accelerated rate of loss of accommodative amplitude among juvenile diabetics, it will require additions to the sample in these groups to confirm or deny the validity of the indicated trend. Accommodative amplitudes derived by the push up to blur out method were equal between the two eyes of 30 of 49 (61.2%) patients; 10 of 49 (20.4%) had a difference of 0.5D, while 9 of 49 (18.4%) had differences of 1.0 to 2.00D between the accommodative amplitude of the two eyes.

The minus lens to blur out amplitudes of accommodation were equal or showed a 0.25D difference in 11 of 32 patients (34.4%), and 0.50D to 0.75D difference in 13 of 32 (40.6%) patients. The remaining 8 of 32 patients (25%) had accommodative amplitudes varying between 1 to 2 diopters, except for one of these eight who showed an 8.5D difference between the two eyes.

DISCUSSION

While vision literature is replete with descriptions of the structural

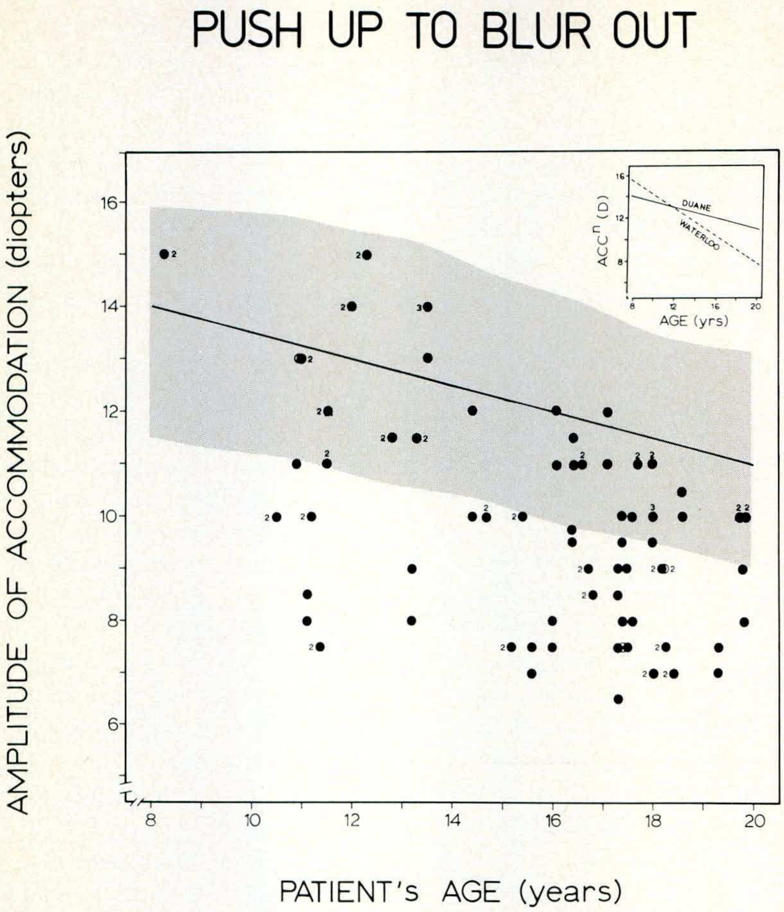

Figure 1

Graph showing the amplitude of accommodation as a function of the age of juvenile diabetics obtained by the push up to blur out method. Data points for accommodative amplitudes for 98 eyes are given by the small black points. The number beside some of the data points indicates the number of coincident values for accommodative amplitude. The solid line drawn through the shaded area represents Duane's median amplitude of accommodation while the upper and lower limits of the shaded area define the highest and lowest accommodation amplitudes reported by Duane. Note that a significant number of data points fall below Duane's minimum amplitude. The small figure inset compares the linear regression line (Slope = -0.25D/year) for Duane's median amplitude of accommodation values to the linear regression line (Slope = -0.37D/year) for the accommodative amplitudes obtained in the juvenile diabetic population in the Waterloo study. The data obtained to date suggests an accelerated loss of accommodation with age in juvenile diabetics.

damage which results from juvenile diabetes little attention has been paid to visual function of patients with this disease. Our studies show evident retinal structural damage to be minimal in most of the 49 patients discussed in this paper. Visual acuity which we will report on in detail at a later time is most frequently unaffected by the diabetic state and is either in the normal range or can be restored to normal levels when refractive errors exist. Thus if it were not known the children in this study were diabetics under treatment their eyes would generally be considered to be in a normal state of health until their accommodative amplitudes were measured. To further emphasize this point, both direct and consensual pupillary light refleses were normal, and only a few children exhibited any of the possible lenticular changes which relate to the presence of diabetes. Also, there were few abnormal phorias or ductions, and no convergence anomalies were found.

The possibility therefore exists that by accurately measuring amplitudes of accommodation routinely by both the push up to blur out and minus lens to blur out methods in persons under twenty years of age, diabetic onset might be detected at the earliest time. At the very least, juvenile diabetes must be ranked high among the differential diagnostic items to be considered when low amplitudes of accommodation are found to be below the ranges of eye norms in young persons. If optometric practitioners combine amplitude of accommodation measurements with in-office tests for elevated tear glucose[16] and a careful parental case history, they may well increase the rate of early detection of juvenile diabetics in clinical practice.

The results of our study show that the accommodative function must be carefully measured in the case of diagnosed juvenile diabetes since premature presbyopia occurs in such a large percentage of individuals with this disease. Many of the children of this sample require spectacle corrections for near work if they are to carry on their lives and education with usual efficiency and comfort.

Both sets of amplitude data for these juvenile diabetic patients appear to roughly divide the sample into three categories; 1) Patients who have amplitudes of accommodation which are in the normal range, 2) Patients with a moderate loss of accommodation and 3) Patients with a substantial loss of accommodation (32 eyes). We intend to use a blind technique to have our physician colleague assess whether or not the individuals in these three groups have significant difference in the medical aspects of their diabetic disease. We also intend to examine whether the duration since onset of the disease is a factor in the production of accommodative loss.

The above discussion begs the question as to why certain individuals loose varying amounts of accommodation while others do not. Is the adequacy of treatment a factor? If the trend to accelerated loss of accommodation with age displayed by our sample population exists even when the majority of patients are considered to have their disease well regulated, what is the condition that retards or prevents an accelerated loss of accommodation in some individuals while others of the same age group retain normal accommodative function?

We anticipate that through continuing research that these and other questions resulting from our work in the clinical optometrical care of this juvenile diabetic population will be answered.

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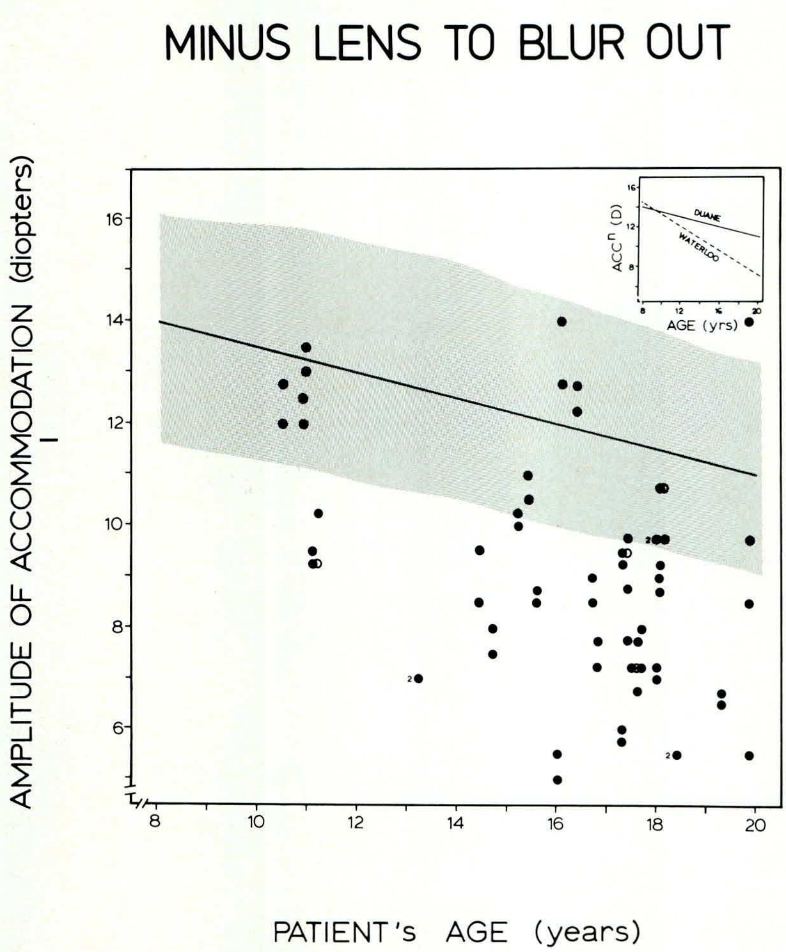

Figure 2
Graph illustrating the amplitude of accommodation as a function of the age of juvenile diabetics obtained by the minus lens to blur out method. Data points for accommodative amplitudes for 64 eyes are given by small black points. The number beside some data points indicates the number of coincident values for accommodative amplitude. The solid line and shaded area represent Duane's data as described in Figure 1. Note that a very significant number of data points fall below Duane's minimum amplitude of accommodation. The small figure inset compares the linear regression line (Slope = -0.25D/year) for Duane's median amplitude of accommodation values to the linear regression line (Slope = -0.35D/year) for the accommodative amplitudes obtained in the juvenile diabetic population in the Waterloo study. The data obtained to date by the minus lens to blur out method also suggests an accelerated loss of accommodation with age in juvenile diabetics.