OCULAR REFRACTIVE STATUS IN CHILDREN AND ADOLESCENTS WITH TYPE 1 DIABETES

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INTRODUCTION

Diabetes mellitus is a worldwide public health problem, with a considerable impact on society not only due to its high prevalence, but also due to chronic complications and increased mortality [1,2]. Among the many complications of diabetes, visual impairment takes center stage in its devastating long-term effect, with diabetic patients at greater risk of vision loss than those without diabetes[2, 26-39].

Diabetic disease can cause changes in all ocular structures, both vascular and non-vascular. Although these complications are not common in children and adolescents with diabetes, intensive surveillance and correct treatment during this period can prevent or delay the onset of severe complications [3].

Among the nonvascular ocular structures, variations in the curvatures and thickness of the lens as well as its refractive index induced by acute or chronic hyperglycemia lead to changes in the refractive status of the ocular diopter, with a variable tendency toward hypermetropia or myopia, or fluctuations in refraction with visual instability. The studies in the specialized literature that follow the evolution of these changes are extremely numerous only with regard to the adult population but are almost non-existent in the pediatric population, probably due to the difficulties in retrieving the data.

Identifying these changes is important in all diabetic patients, but especially in children; prompt optical correction creates the prerequisites for optimal development of visual function and decreased risk of amblyopia in these patients with high life expectancy and increased risk of long-term visual function impairment.

MATERIAL AND METHOD

In order to analyze the variations of ocular refraction in children with type 1 diabetes, we conducted a study on a group of 100 patients with type 1 diabetes, aged

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between 3 and 18 years. The study was carried out with the approval of the Ethics Committee of the "Lower Danube" Galati University. For each child participating in the study, the parents or legal guardians signed an informed consent form, by which they agreed to the data obtained being processed and used for scientific purposes.

The children enrolled in the study were registered in the Diabetes and Nutrition Department of the Pediatric Clinical Section 2 of the Children's Emergency Clinical Hospital "St. John" from Galati. In order to compare the results, we also selected a group of 100 healthy children, without diabetic damage (control group), with ages in the same range, who presented themselves for consultations at the ophthalmology office of the Specialized Outpatient Clinic during the same period.

The determination of the objective ocular refraction was performed in all children by computerized refractometry, after performing the cycloplegia, in order to cancel the accommodation. Cycloplegia was performed by administering cyclopentolate 1% (Cyclogyl), instilled in each eye three times at 15-minute intervals, and refractometry was performed 35-40 minutes after the last administration.

To analyze the results of this study, we performed statistical interpretation with the help of SPSS (Statistical Package for the Social Sciences) medical statistics programs, using "One Sample Test", "Paired Samples Test" and "Independent Samples Test", and reported the results obtained in the control batch.

RESULT

Through the One Sample Test, we performed the analysis of the average value of the ocular refraction (RO) for the patients of both groups (study and control) with the specified value 0 (which characterizes the state of emmetropia) of this parameter. It is found that in the study group, the average spherical equivalent of the ocular refraction was 0.56 for the right eye and 0.60 for the left eye, which places the ocular refraction in the hypermetropia zone, and in the control group, the average spherical equivalent was of 0.05 for the right eye and 0.07 for the left eye, so we are talking about emmetropia.

This finding was graphically represented in figure 1.

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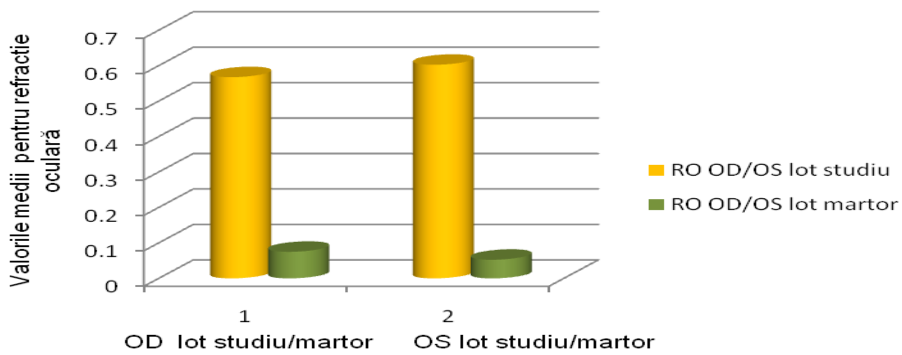

Figure 1. Mean values of the spherical equivalent of the ocular refraction (study/ control group)

So we can say that among the diabetic children included in this study there is a tendency towards hypermetropia more accentuated than among the other children, who are on average emmetropic.

The ametropic patients in the study group were divided into two subgroups, depending on the type of ametropia (myopia or hypermetropia) and the statistical analysis of the ocular refraction by types of ametropia (hypermetropia and myopia) was performed, using Levene's test of equality of variances (Levene's test for equality of variances).

It is found that in the right eye, out of 85 children with ametropia, 66 are hyperopic, with an average spherical equivalent of 1.18, and 18 are myopic, with an average spherical equivalent of -0.90. The value of Sig. of the Levene test is equal to 0.820 (>0.05), a fact that requires the analysis with common variances (Equal variances assumed). Thus it is found that the value of Sig. (2-tailed) is 0.000 so there are significant differences in the means of the spherical equivalent for the two ametropia groups of the patients in the study group (table I).

Table I. Statistical analysis of the right eye ocular refraction by types of ametropia

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Group Statistics

	REFRACȚIE OCULARĂ OD_S e	N	Mean
Refracție oculară OD_S	Hipermetropie	**66**	**1.1885**
	Miopie	**19**	**-.9079**

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means
		F	Sig.	t
Refracție oculară OD_S	Equal variances assumed	.052	**.820**	10.628
	Equal variances not assumed			11.754

Independent Samples Test

		t-test for Equality of Means		
		df	Sig. (2-tailed)	Mean Difference
Refracție oculară OD_S	Equal variances assumed	82	**.000**	2.09636
	Equal variances not assumed	34.652	.000	2.09636

Also, for the left eye there is a preponderance of hyperopic children (out of 80 children with ametropia, 61 are hyperopic, with an average spherical equivalent of 1.25, and 19 are myopic, with an average spherical equivalent of – 0.96), as it appears from table II.

Table II. Statistical analysis of left eye ocular refraction by types of ametropia

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Group Statistics

	REFRACȚIE OCULARĂ OS_S e	N	Mean
Refracție oculară OS_S	H	61	**1.2582**
	M	19	**-.9605**

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means
		F	Sig.	t
Refracție oculară OS_S	Equal variances assumed	.228	**.634**	10.147
	Equal variances not assumed			10.345

Independent Samples Test

		t-test for Equality of Means		
		df	Sig. (2-tailed)	Mean Difference
Refracție oculară OS_S	Equal variances assumed	78	**.000**	2.21872
	Equal variances not assumed	31.036	.000	2.21872

The value of Sig. of the Levene test is 0.634 for the objective refraction at OS (>0.05), a fact that requires the analysis with common variances (Equal variances assumed). Thus it is found that the value of Sig. (2-tailed) is 0.000 so there are significant differences in the averages of the ocular refraction in the left eye for the two types of ametropia of the patients in the study group.

DISCUSSIONS

There are numerous considerations in the specialized literature regarding chronic refractive errors reported in patients with diabetes; these refractive errors include both myopia and a tendency toward hypermetropia, or the absence of any ametropia. There are recent epidemiological studies that find that diabetes is an independent risk factor in the development of moderate (> -3 diopters) (59) or low (< -1 diopters) myopia [4]. A study of 1416 Danish patients aged 16 years and older concluded that diabetics in this population are predominantly myopic compared to non-diabetics [5,6]. Conversely, other population studies [7,8,9] find an increased incidence of hypermetropia, with no correlation between refractive errors and glycemic control or disease duration. But all this research looks at the adult population. Not so numerous are the reports about existing refractive changes in the pediatric population, although knowing and correcting them is at least as important.

Regarding the dynamic refractive variations, they are the consequence of changes in the lenticular status, i.e. the hydration or dehydration of the lens. The change in the water content of the lens occurs as a result of the variation in the osmolarity of the aqueous humor during the changes in

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blood sugar, or as a result of the change in the shape of the lens and/or its refractive index; this leads to refractive fluctuations and instability of vision. Transient hypermetropia is highly dependent on pretreatment glycated hemoglobin levels and the degree of glycemic compensation achieved by treatment. [10,11]. Fluctuations in blood glucose are known to affect visual acuity and ocular refraction in diabetic patients. Frequently, refractive fluctuations are the presenting symptom for a newly diagnosed diabetic person [7,12].

Some authors considered that acute hyperglycemia induces myopia, and after metabolic regulation the refraction changes to hypermetropia or lower myopia [13,14,15]. Myopia would be due to an increase in the thickness and curvature of the lens; these changes are measurable by ultrasonic biometry, Hartmann-Shack aberrometry or images obtained with the Scheimpflug camera and are reversible once glycemic control is achieved [16]. Poor metabolic control could be a risk factor for myopia [11]. This variability makes computerized topographic analysis of the anterior corneal surface extremely difficult for patients who choose to use orthokeratology hard night-wear contact lenses in order to stop the progression of myopia [17]. Also, for these patients, the increased risk of ocular surface infections while wearing these lenses can be controlled by using eye drops with disinfectant properties, such as those containing Aloe Barbadensis or Chamomilla Matricaria [18].

There are also numerous studies reporting that hyperopic changes during acute episodes of hyperglycemia or intensive treatment of metabolic imbalance are more common than myopic ones [19,20,21,22]. The incriminated mechanism is the variation (decrease) of the refractive indices of the various layers of the lens due to the influx of water, while maintaining a constant thickness of the lens.

This lack of consensus can be partly explained by the differences in approach in the aforementioned studies. Some investigators analyzed the components of the ocular refraction after normalization of blood glucose values, while others performed the measurements during maximal acute hyperglycemia, therefore it is important to define the exact moment of the refractive measurements.

Our study found an obvious predisposition towards hypermetropia, 66 (for the right eye) and 61 (for the left eye) of the children being included in this type of refractive error. The results could theoretically be framed in the natural tendency towards hypermetropia of young ages, but the statistical comparison with the study group having the same age distribution showed that patients without diabetic disease were predominantly emmetropes.

Another explanation for the variability of data in the literature regarding the variation of ocular refractive properties during hyperglycemia comes from the fact that both myopic and hyperopic variations are the consequence of complex morphological changes in the image-forming

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system in the eyeball. Any decrease in the refractive index of the lens or its radius of curvature can induce a hyperopic or myopic variation in the ocular refraction. In other words, there is a correlation between changes in the shape and the refractive equivalent of the lens, and these determine the global refractive result [23].

There are other optical errors (higher order aberrations), generally less taken into account, that can also contribute to variations in visual acuity [24]. In a 2004 study, Shahidi et al report increases in these higher order aberrations in patients with chronic diabetes, but the effect of acute hyperglycemia on them is not yet elucidated [25]. Most of the time, intensive insulin treatment leads to hypermetropia after the institution of therapy [11].

In most cases, refractive changes during acute hyperglycemia are reversible with normalization of blood glucose. That is why it is recommended to postpone the prescription of glasses for patients with newly diagnosed diabetes or those with insufficiently controlled blood sugar.

In **CONCLUSION,** the presented study addresses a little-studied problem and its results draw attention to the probability of the existence of a refractive error of the hyperopia type in children with insulin-dependent diabetes, which requires, within the periodic ophthalmological examinations performed in these children, the determination of the ocular refraction with rigorous cycloplegia, for the purpose of refractive correction to avoid amblyopia and create the conditions for the best possible visual acuity in these patients.

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