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The clinical features and concomitant diseases in preschool high myopia

Leyla NİYAZ[1,*], Ayşe İdil ÇAKMAK[2], Özlem TERZİ [3], İnci GÜNGÖR[1]

[1]Department of Opthalmology, Faculty of Medicine, Ondokuz Mayıs University, Samsun, Türkiye
[2]Department of Opthalmology, Faculty of Medicine, Mustafa Kemal University, Hatay, Türkiye
[3]Department of Public Health, Faculty of Medicine, Ondokuz Mayıs Univesity, Samsun, Türkiye

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Abstract

The aim of this study was to summarize the clinical and demographic findings of preschool children presenting to the ophthalmology clinic with high myopia and to compare them with controls. A retrospective chart review was performed in patients with myopia of -6D or higher before the age of 4 years. The control group of similar age and sex was created from the patients presenting to the ophthalmology department for routine eye examination without any apparent complaint. Child and parent characteristics, concomitant ocular and systemic pathologies were recorded and analyzed. Seventy patients (35 cases with high myopia and 35 controls) were included in the study. Compared to controls, the cases in the study group had significantly higher rate of birth in spring (37.1% vs 8.6%), higher rate of strabismus (57.1% vs 14.3%) and paternal smoking (54.3% vs 37.1%), higher parental consanguinity (34.3% vs 11.4%) and higher rate of concomitant diseases (51.4% vs 17.1%). Birth season, paternal smoking and consanguinity were found to correlate with high myopia in children under the age of 4. High rates of ocular and systemic comorbidities should be considered in patients with high myopia at preschool age.

Keywords: high myopia, preschool myopia, strabismus, consanguinity, birth season

1. Introduction

Myopia is a disorder which can be corrected with glasses or contact lenses. However the rapid increase in prevalence in recent years and the increased risk of potentially blinding complications makes myopia a major public health concern (1). Myopia usually occurs due to the elongation of the axial length of the eye. Controlling the axial elongation during the eye development may prevent myopia and may result in normal vision. However routinely used optical correction just makes the object to focus on the macula and has no impact on the axial length. Understanding the biological basis for the myopia development and exploring the causes are the major target points for prevention. Recent studies have shown that the myopia is not just genetic, but has a heterogeneous etiology. Intensive near work, decreased amounts of time outdoors are found to be strong environmental factors for the myopia development and progression (2,3). Myopia prevalence is high in school age children and low in preschool children. Preschool myopia also differs from school age myopia in terms of risk factors and clinical course; however it is less discussed in the literatüre (4-6). Given that myopia is a risk factor for amblyopia and strabismus, the early detection and treatment of refractive errors in infancy is crucial. The aim of this study was to determine the clinical features and associated co-morbidities in preschool children with high myopia.

2. Materials and Methods

This study was approved by the Ethics Committee of the University and conducted in accordance with the Declaration of Helsinki. The charts of patients admitting to the Ondokuz Mayis University ophthalmology clinic between 2013 and 2021 were reviewed. The clinical records of children diagnosed with myopia before the age of 4 years were retrospectively analyzed. The patients with high myopia were included in the study. High myopia was defined as a spherical equivalent refraction of > -6D in cycloplegic refraction measurement in at least one eye. Age, gender, prematurity, mother's age at delivery, presence of any other ocular or systemic diseases, visual acuities, cycloplegic refractions, anterior and posterior segment findings were recorded. The parents were asked about time spent outdoors (sun exposure) and time spent in front of screen devices (mobile phones and tablets), as well as maternal and paternal myopia or history of smoking. The causes of high myopia were determined if present. The exclusion criteria were as follows: patients receiving the myopia diagnosis at or over 5years of age, infants with myopia <-6D, and patients with inadequate or missing data. The control group was chosen from patients presenting to the ophthalmology department for routine eye examination without any apparent complaint. The control group consisted of patients of similar age and sex with the study group.

*Correspondence: niyazleyla@gmail.com

Cycloplegic refraction was obtained at each visit. Refractions were measured at least 30 minutes after the two consecutive administrations of 1% cyclopentolate 20 minutes apart, which is a routine procedure in the outpatient clinic. A handheld authorefractor Retinomax Plus (Nicon Inc., Japan) was used to obtain the refraction. However, all refractive values were rechecked with retinoscopy. Axial length measurement of the globe was performed in some patients.

The patients were analyzed in terms of risk factors such as maternal or paternal myopia, smoking, prematurity and birth season. The possible causes like treatment for retinopathy of prematurity (ROP), systemic diseases, microspherophakia were recorded. The patients without an eligible cause were evaluated as isolated high myopia or pathological myopia.

2.1. Statistical analysis

Data were analyzed with SPSS (Version 22 for Windows, SPSS Inc, Chicago, IL, USA).The Shapiro–Wilk test was applied to examine whether the measurements in the study were normally distributed. Normally distributed continuous variables were presented as mean ± standard deviation and compared between the study groups using independent t- test. Continuous variables that were not normally distributed were presented as median with the minimum and maximum values and statistically analyzed using the Mann-Whitney U test. Paired t tests or Wilcoxon tests were used to assess within-group changes over the intervention period. Categorical variables, presented in counts or as percentages, were analyzed using the chi-square or Fisher exact test when appropriate. P values lower than 0.05 were considered statistically significant.

3. Results

Seventy children were included in the study (35 high myopes and 35 controls). The refraction in the right and left eyes in the study group were -8.46±3.20 and -8.35±3.37 respectively. The refraction in the right and left eyes in the control group were +2.00±1.65 and +2.16±1.75 respectively. There was a significant difference between the groups($p<0.001$).

Table 1. Demographic factors of patients

	High myopia (n=35)	Control group (n=35)	p
Age (years)	1.64±1.09	1.76±1.29	0.673
Gender (F/M)	19/16	19/16	1
Maternal age at birth (years)	28.29±4.93	27.70±4.13	0.613
Follow-up time (months)	26.5±29.30	4.14±10.04	**<0.001**
Screen devices (hr/day)	0.74±1.11	1.10±2.49	**<0.001**
Sun exposure (hr/day)	2.48±2.06	1.49±1.67	**<0.001**

Nineteen (54.3%) females were present in both groups. The mean maternal age at birth, mean age of the patients at the diagnosis, gender, follow-up time, time spent with screen devices and time spent outdoors (sun exposure) are presented in Table 1. The age and gender of the patients and maternal age at delivery were similar in the study and the control groups ($p>0.05$). The study group had a higher rate of sun exposure, while the control group had a longer time spent in front of the screen devices ($p<0.001$).

The distribution of prematurity, maternal and paternal myopia/ smoking, season of birth, strabismus and consanguinity are given in Table 2. Paternal smoking and parental consanguinity were significantly higher in the study group compared to controls (p: 0.035, p: 0.023 respectively). The higher rate of birth was observed in spring for the study group (37.1%, p: 0.016). The rate of strabismus was higher in the study group with 13 cases of esotropia and 7 cases of exotropia (57.7%). In the control group, there was one case of esotropia, 3 cases of exotropia, and one case with oblique dysfunction ($p<0.001$).

Table 2. Clinical and parental features of patients

		High myopia (%)	Control group (%)	p
Premature delivery		6 (17.1)	4 (11.4)	0.495
ROP treatment		4 (11.4)	1 (2.9)	0.164
Birth season	Winter	5 (14.3)	9 (25.7)	0.23
	Spring	13 (37.1)	3 (8.6)	**0.004**
	Summer	14 (40.0)	14 (40.0)	1
	Autumn	3 (8.6)	9 (25.7)	0.057
Maternal myopia		6 (17.1)	10 (28.6)	0.424
Paternal myopia		3 (8.6)	8 (22.9)	0.168
Maternal smoking		2 (5.7)	4 (11.4)	0.508
Paternal smoking		19 (54.3)	13 (37.1)	**0.035**
Strabismus		20 (57.1)	5 (14.3)	**<0.001**
Consanguinity		12 (34.3)	4 (11.4)	**0.023**
Concomitant disease		18 (51.4)	6 (17.1)	**0.003**

Myopia was associated with ROP in 4, microspherophakia in 1, microcornea and foveal agenesis in 1, microcornea and chorioretinal coloboma in 2, congenital glaucoma in 1, persistant hyaloid artery on the disc in 1. Degenerative myopia was diagnosed in 4 (one unilateral and three bilateral cases), and isolated high myopia in 21 cases (two had myelinated nerve fibers).

Concomitant diseases were present in 18 cases (51.4%) with high myopia and included the followings: Sturge-Weber syndrome, atrial septal defect, patent foramen ovale, tetralogy of fallot, lung disease, asthma, iron deficiency anemia, developmental defects, cerebral palsy, mental retardation, hypospadias, enuresis, stuttering and partial trisomy 29 with congenital glaucoma, hypothyroidism, vesicoureteral reflux and incontinence. Concomitant diseases in the control group were present in 6 cases (17.1%) and included intracranial hemorrhage with ventriculoperitoneal shunt, asthma, epilepsy, developmental defect, hydrocephalus and hyperactivity.

4. Discussion

Cases with high myopia at preschool age presenting to the ophthalmology department may have various causes and concomitant ocular or systemic pathologies. Most studies in

the literature focus on high myopia at school age. In this study, we analyzed thirty-five preschool children with high myopia. Compared to the control group, high myopia cases were followed for a longer period, were mostly born in spring, and had a higher rate of paternal smoking, strabismus, parental consanguinity and concomitant disease.

Specific geographical distribution of myopia may show that some populations might be genetically more susceptible to the environmental risk factors. However, families share environments, as well as genes (2,7). We observed a higher rate of parental consanguinity in high myopia group (34.3% vs 11.4%). Although this finding supports the evidence of genetic susceptibility at an early age, we did not find a significant effect of paternal or maternal myopia. One possible explanation for this is that preschool high myopia may have a recessive inheritance pattern. Hence, consanguineous parents may have a higher risk of having a myopic child. Myopia in parents has been shown to be a risk factor for the development of myopia in children in several studies. However, most studies focused on patients at an older age, so, it is difficult to extrapolate their findings to our study (8-10). In a study screening for myopia it was found that parental myopia significantly increased the risk of myopia in 11- and 15-year old children, but not in 7-year olds (10). It may be considered that high myopia at an early age and myopia at school age may have different risk factors.

Myopia at school age has been shown to increase with near work and decreased outdoor activities (8-10). In contrast to this evidence, we obtained that high myopic patients spend more time outdoors and less time in front of mobile phones and tablets compared to controls. We don't know exactly if this is the cause or the result of myopia. If we take into account the longer duration of follow-up of the patients with high myopia in our study; we may attribute these findings to the attention of parents, who follow the recommendations of physicians on prevention of myopia. We routinely and strictly advise the patients with myopia to stay away from mobile phones and tablets, and discuss the beneficial effects of sun exposure with parents.

Compared to control group, the majority of our cases with myopia were born in spring. This might support the findings in the literature. Studies conducted on adults and newborns showed that those born during months with longer daylight hours are at higher risk of myopia (3,11). Many other environmental factors may influence the development and progression of myopia, as well as light exposure that may affect emmetropization, thus influencing refraction.

The history of paternal smoking was higher among the patients with high myopia. The insignificant result regarding maternal smoking may be attributed to the low rate of maternal smoking in both the study and the control groups. Some studies reported that parental smoking is associated with a lower prevalence of myopia, lower myopic refraction and shorter axial length in children. The possible mechanism of ocular growth affected by the nicotine was proposed (12,13). However, there are also studies in the literature reporting either no association between parental smoking and myopia or an increased risk of myopia in smoking mothers (14,15). The study involving the Singapore Chinese children at a very young age (6-72 months) reported an 11% of myopia prevalence (refraction at least -0.5D), and found no association of paternal smoking with refractive error and an inverse relation of refraction with maternal smoking. There are some differences between this study and ours, as we only included the patients with high myopia (at least -6.0D) with a different ethnicity.[14] Such diversity in the results reflects the multifactorial nature of myopia.

There were no patients diagnosed with staphyloma in our study. Hsiang HW et al. found that posterior staphyloma is not common in children but its prevalence increases with age (16). Retinal detachment was not observed in any of cases. However lifelong observation is suggested as the risk of blinding complications increases as time progresses.

There were significantly higher rate of concomitant diseases in patients with high myopia compared to the control group. The frequency of strabismus among high myopes was 4 times higher than that in the control group. This association is consistent with the findings in the literature. Zhang et al analyzed the prevalence of strabismus and its risk factors in school aged children in Hong Kong. They observed a significant positive association between strabismus and myopia of >-1.0D (OR 1.72, p:0.012) (17). A meta-analysis involving 23.541 children showed that myopia (generally over -0.50D or -1.0D) resulted in an increased risk of developing concomitant strabismus (OR: 3.22, 95% CI: 1.84–5.65, $P < 0.0001$), and even more increased risk of exotropia specifically (OR: 5.23, 95% CI: 2.26–12.09, $P = 0.0001$). Decreased accommodative effort in patients with myopia is postulated as the main cause of strabismus (18). High myopia accompanied with anomalies in the eye, brain, heart or genitourinary system may be a part of the neurodegenerative disorders requiring genetic evaluation (19). Hence, such patients should be referred for detailed pediatric and genetic evaluation.

The major limitation of this study is the limited number of patients. Also, factors such as time spent outdoors or in front of mobile phones depended solely on the response of the parents that may be inaccurate, especially if the parents are working.

In conclusion, this is a summary of demographic and clinical findings in children presenting with high myopia before the age of 4 years. Preschool high myopia differs from teenage myopia in terms of genetic and environmental factors. Its rate increases in cases born in spring and in consanguineous parents. It is associated with a higher incidence of strabismus. Children with myopia presenting to the outpatient clinic have an increased risk of concomitant ocular and systemic diseases.

Detailed history taking and thorough physical examination should be performed for early detection and treatment of the disease to avoid life-long complications. Further studies with larger sample size are needed to identify the exact risk factors and to analyze the progression of high myopia at a very early age.

Conflict of interest

The authors declared no conflict of interest.

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Authors' contributions

Concept: M.U., T.A., Design: M.U., T.A., Data Collection or Processing: M.U., T.A., Analysis or Interpretation: M.U., T.A., Literature Search: M.U., T.A., Writing: M.U., T.A.

Ethical Statement

Approval was obtained from Ondokuz Mayıs University Clinical Research Ethics Committee, the study started. The ethics committee decision date is 27/02/2020 and the number of ethical committee decisions is 2020/93.

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