The Effect of Mode of Delivery on Refractive Errors in Preschool Children

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ABSTRACT

Purpose: To evaluate the effect of mode of delivery (MOD) on refractive errors in preschool children.

Materials and Methods: Ophthalmological examination findings and cycloplegic refraction values of 92 preschool children aged 3 to 6 years were retrospectively evaluated. Children were divided into two groups: vaginal delivery (VD) and cesarean section (CS). Results were compared between groups.

Results: Of the 92 children with a mean age of 4.7 ± 1.0 included in the study, 50 (54.3%) had a history of VD and 42 (45.7%) had a history of CS. The prevalence of myopia (spherical equivalent (SE)-0.50 D or less), hyperopia (SE +2.00 D or more), astigmatism (cylindrical power -1.00 D or less) and significant astigmatism (cylindrical power -2.00 D or less) was 14 % (n=7), 42 % (n=21), 70 % (n=35) and 8 % (n=4) in the VD group, and 11.9 % (n=5), 2.4% (n=1), 76.2 % (n=32) and 2.4% (n=1) in the CS group, respectively. Hyperopia was significantly higher in children with a history of VD (p<0.005). Although children with a history of VD have lower rate of astigmatism and a higher rate of significant astigmatism and with-the-rule astigmatism compared to CS, there was no significant difference in severity or type of astigmatism between groups (p=0.506, p=0.236, and p=0.353).

Conclusion: Our findings have shown that refractive differences observed in preschool children related to MOD are associated with hyperopia rather than astigmatism. Further studies involving larger sample sizes and detailed ocular biometric measurements are needed to clarify these associations.

Keywords: Astigmatism, cesarean section, preschooler, vaginal delivery

INTRODUCTION

The preschool period holds unique importance in children's refractive development due to the ongoing development of visual systems and the risk of amblyopia due to uncorrected high ametropia or anisometropia.[1] Astigmatism, one of the common causes of vision impairment, is an optical defect resulting from the unequal curvature of the refractive surfaces of the eye, resulting in blurred images. If it is not corrected timely, it may present with a decrease in visual quality and regression in visual development. [2,3] Studies have shown that uncorrected astigmatism may increase the risk of refractive amblyopia and contribute to the development of myopia. [5-7] The prevalence of astigmatism can vary depending on different criteria, age, and ethnicity; it has been reported that the incidence of astigmatism in children aged 3-6 years from different ethnic backgrounds varies between 4.0% and 44% according to different criteria. [8-13] Although the cause of astigmatism in children is not known exactly, many factors including prenatal and birth-related factors such as birth weight (BW), gestational age (GA), mode of delivery (MOD) and maternal age at birth, and other factors such as genetic, nutrition, smoking,

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electronic screen exposure, body mass index (BMI), education and socioeconomic level can affect astigmatism in childhood. [3,8, 14-18] On the other hand, the distribution of hyperopia and myopia can also vary according to age groups; some studies report that similar to hyperopia, the incidence of myopia decreases with age in preschool children under the age of 5 and slightly increases at the ages of 5-6. [19-21]

To our knowledge, few studies have investigated the effect of prenatal and birth-related factors on refractive errors during this period. [3, 7, 9] The aim of our study was to evaluate the effect of MOD on refractive errors in preschool children.

MATERIAL AND METHOD

Study Design and Subjects

This cross-sectional study, adhered to the tenets of the Declaration of Helsinki for research involving human subjects, was approved by the Ethics Review Committee of Bilkent City Hospital and numbered TABED 1-25-1289. Informed consent was obtained from each child's parent. Preschool children aged 3 to 6 years with a history of term birth (37 to 42 weeks) between January 2022 to March 2022 were included in the study. Children with severe eye diseases, born prematurely (GA<37 week) and without cycloplegic examination were excluded. Also, we had no patients with strabismus, developmental delay, or neurological disorder. Child's gender, BW, GA, age at examination, delivery method (vaginal delivery (VD), cesarean section (CS)) and maternal age at birth were recorded based on detailed questions directed to the families. Children were divided into two groups: VD (Group 1) and CS (Group 2).

Refraction

After a complete ophthalmological examination, cycloplegia was achieved in the children included in the study by applying two drops of 1% cyclopentolate hydrochloride (Sikloplejin, Abdi İbrahim, Turkey) to each eye at 5-10 minute intervals. Cycloplegic refraction was performed using retinoscopy, automated refractometry (Welch Allyn SureSight Autorefractor, USA) and autokeratorefractometer (Zeiss Autoref keratometer, Germany). Examination results were recorded as diopters (D). According to the cycloplegic refraction results, myopia was recorded as -0.50 D or less; hyperopia as +2.00 D or more; astigmatism as -1.00 D or less and significant astigmatism as -2.00 D or less. Children with astigmatism were divided into three types according to the axis position including with-the-rule (WTR) astigmatism (plus cylinder axis 90 ± 30°), against-the rule (ATR) astigmatism (plus cylinder axis 180 ± 30°), and oblique (OBL) astigmatism (plus cylinder axis 30° to 60° or 120° to 150°).

Statistical Analysis

Statistical Package for the Social Sciences (SPSS Inc., Chicago, Illinois, USA) version 25.0 program was used for statistical analysis. Descriptive data were presented as mean ± standard deviation (SD), and categorical data were presented as number (n) and percentage (%). T test was used for normally distributed data, and Mann-Whitney U test was used for non-normally distributed data. Chi-square test was used to analyze categorical data. Statistical significance was accepted as a P value of 0.05 or less.

RESULTS

Characteristics of subjects

Among 92 children, 50 (54.3%) were born by VD and 42 (45.7%) were born by CS. The mean age of these children was 4.6 ± 1.1 years (3 to 6 years) in VD group and the BW of 98 % (n=49) of these children was over 2500 grams. In the group born CS, the mean age was 4.7 ± 1.0 years (3 to 6 years) and the BW of 92.9 % (n=39) of these children was over 2500 grams. Out of 92 children, 30 (60 %) in the VD group and 21 (50 %) in the CS group were female. Moreover, maternal birth age was over 30 in 9 (18 %) and 16 (38.1%) of the children in group 1 and group 2, respectively. There was no significant difference between the groups for age, gender distribution and BW (p=0.485, p=0.336, and p=0.228). Children with a history of VD were found to have a significantly lower maternal birth age than children with CS (p=0.031) (Table 1).

Refraction and the distribution of astigmatism types

The prevalence of myopia, hyperopia, astigmatism and significant astigmatism was 14 % (n=7), 42 % (n=21), 70 % (n=35) and 8 % (n=4) in the VD group, and 11.9 % (n=5), 2.4% (n=1), 76.2 % (n=32) and 2.4% (n=1) in the CS group, respectively. While no significant difference was observed between the groups in terms of myopic refraction, hyperopia was found to be significantly higher in children with a history of VD (p=0.000). Although children with a history of VD have lower rate of astigmatism and a higher rate of significant astigmatism compared to CS, there was no significant difference in astigmatism and significant astigmatism between children born with VD and CS (p=0.506 and p=0.236) (Table 1). The distribution of refractive errors according to the MOD is shown in Figure 1. The type of astigmatism in both groups was predominantly WTR, and no significant difference was found between the children with a history of VD and CS (p=0.353) (Table 1, Figure 2).

Moreover, logistic regression analysis revealed that risk factors such as gender, BW, maternal age at birth, and MOD were not associated with astigmatism (cylindrical power ≤ -1.00 D) (β= 1.098, p = 0.827; β= 2.077, p=0.534; β= 0.480, p=0.149; and β= 0.486, p=0.099) (Table 2).

Table 1. *Demographic data and cycloplegic refraction results of the children*

		Vaginal Delivery (Group 1) (n=50)	Cesarean section (Group 2) (n=42)	*P* - value
Age at examination (weeks)	Mean ± SD (Range)	4.6 ± 1.1 (3-6)	4.7 ± 1.0 (3-6)	0.485*
Gender	Female (n, %) Male (n, %)	30 (60 %) 20 (40 %)	21 (50 %) 21 (50 %)	0.336 *
Birth weight (BW) (g) < 2500 g ≥ 2500 g	 n, % n, %	 1 (2 %) 49 (98 %)	 3 (7.1 %) 39 (92.9 %)	0.228*
Maternal age at birth (years) < 30 years ≥ 30 years	 n, % n, %	 41 (82 %) 9 (18 %)	 26 (61.9 %) 16 (38.1 %)	0.031*
Myopia (SE ≤ -0.50 D)	n, %	7 (14 %)	5 (11.9 %)	0.766*
Hyperopia (SE ≥ +2.00 D)	n, %	21 (42 %)	1 (2.4%)	0.000*
Astigmatism (cylindrical power ≤ -1.00 D)	n, %	35 (70 %)	32 (76.2 %)	0.506*
Significant astigmatism (cylindrical power ≤ -2.00 D)	n, %	4 (8%)	1 (2.4%)	0.236*
Type of Astigmatism With-the-rule (WTR) Against-the rule (ATR) Oblique (OBL)	 n, % n, % n, %	 46 (92 %) 3 (6 %) 1 (2 %)	 38 (90.5 %) 1 (2.4 %) 3 (7.1 %)	0.353*

SE, spherical equivalent; Bold, statistically significant values are highlighted
*Chi-square test

Table 2. *Logistic regression analysis of risk factors associated with astigmatism (Cylindrical value ≤ -1.00 D)*		
β (95 CI)	Univariable regression analysis	
	β (95 CI)	p value
Gender	1.098	0.827
Birth weight (g) < 2500 g ≥ 2500 g	2.077	0.534
Maternal age at birth (years) < 30 years ≥ 30 years	0.480	0.149
Mode of Delivery Vaginal Delivery Caesarean section	0.486	0.099

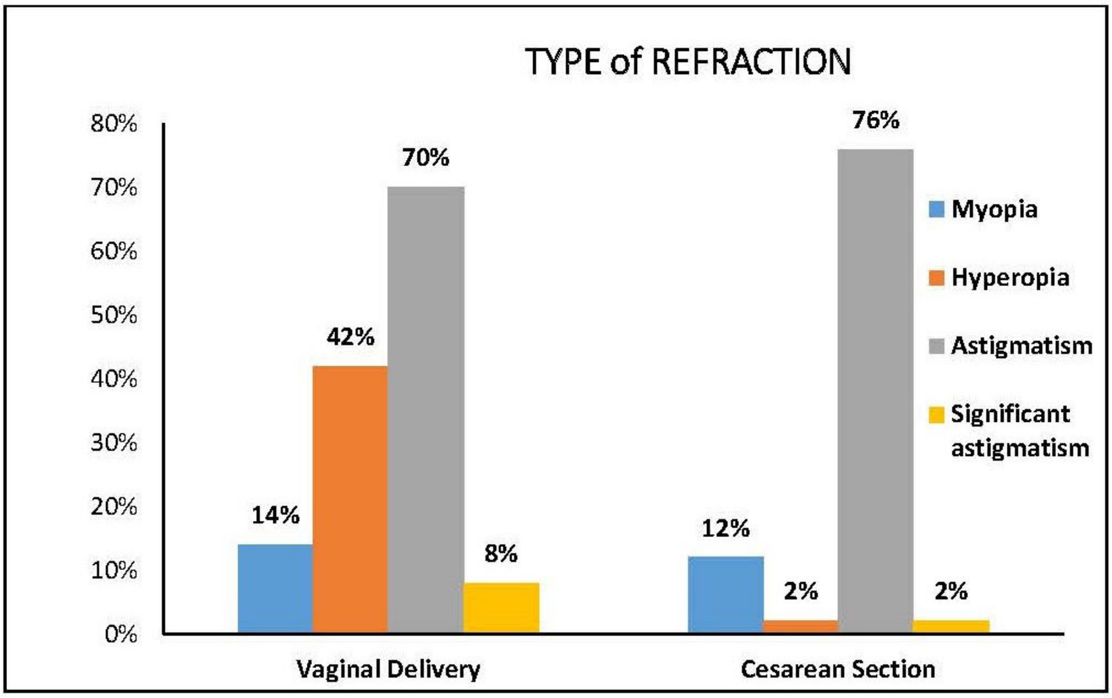

Figure 1. *The distribution of refractive errors according to the mode of delivery. Myopia was defined as spherical equivalent (SE) ≤ -0.50 D, hyperopia as SE ≥ +2.00 D, astigmatism as cylindrical power ≤ -1.00 D and significant astigmatism as cylindrical power ≤ -2.00 D, which was determined by cycloplegic refraction.*

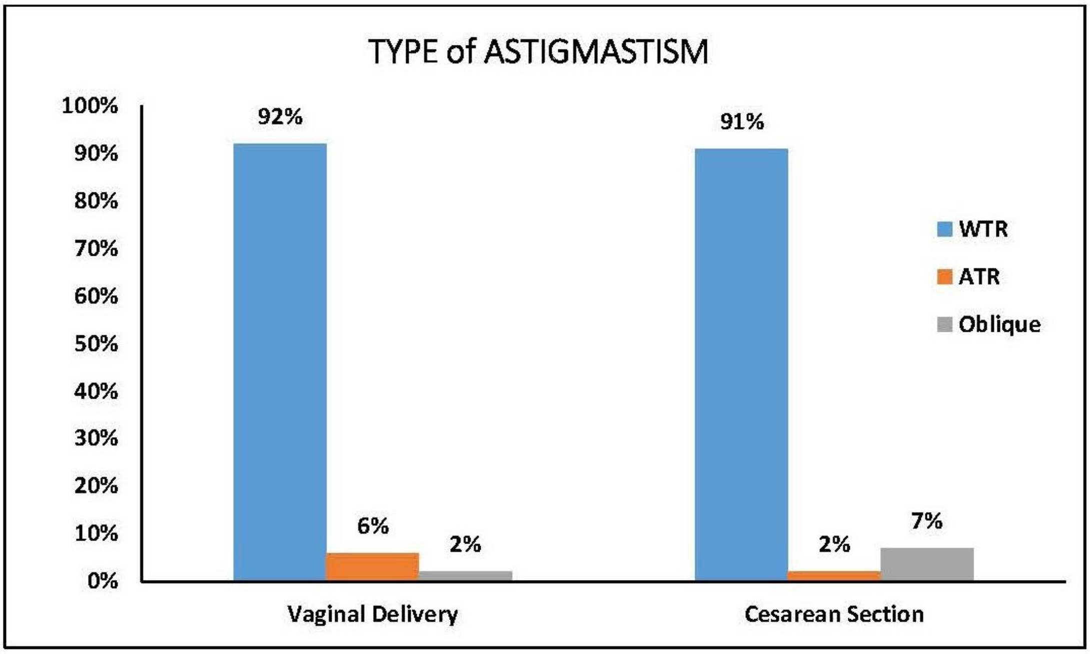

Figure 2. *The distribution of astigmatism type according to the mode of delivery. Astigmatism was divided into three types according to the axis position: With-the-rule (WTR) astigmatism (plus cylinder axis 90 ± 30°), against-the rule (ATR) astigmatism (plus cylinder axis 180 ± 30°), and oblique (OBL) astigmatism (plus cylinder axis 30° to 60° or 120° to 150°).*

DISCUSSION

Factors influencing the development of astigmatism in children have been investigated, but only a few studies in recent years have evaluated the effect of MOD on astigmatism in the preschool period.[3,7-10] Furthermore, although the relationship between MOD and astigmatism is not clearly explained, it has been suggested that some mechanisms may contribute to it. These mechanisms can be listed as 1. children born with CS, face less stress than children born vaginally as a result of less exposure to uterine contractions, 2. due to the shortening of the transport time through the birth canal, children born with CS are exposed to less pressure compared to children born vaginally, and therefore the pressure applied on the eyes is different and 3. changes in the cornea and lens caused by hormonal fluctuations and the difference in the duration of hormonal exposure depending on the MOD. All these reasons may contribute to changes in corneal curvature. [3] Isenberg et al. [22] revealed that the mean corneal power and astigmatism values are high at birth, the frequency of WTR astigmatism is higher especially in those born vaginally (p=0.02), and the MOD may have an effect on the astigmatic axis. Liu et al.[3] found that the risk of severe astigmatism (≥2.50 D) in children born with CS was 85.28% higher than in children born vaginally, and this risk was especially more pronounced in elective CS. In a study from China, risk factors affecting astigmatic components were investigated and as a result, it was stated that while the MOD was not found to be associated with total astigmatism and internal compensation, CS increased the risk of anterior corneal astigmatism more than vaginal delivery.[7] Another study conducted in China revealed that the incidence of astigmatism in children born vaginally (34.5%) was lower than in children born via CS in the preschool period (37.8%) and there was no significant difference in the prevalence of astigmatism between birth types (p=0.320). In addition, they also stated that the most common type of astigmatism is WTR astigmatism, and that children with older maternal age (≥ 35 years) and no breastfeeding history are at higher risk of developing astigmatism.[9]

In the current study, although the rate of astigmatism was lower and the rate of significant astigmatism was higher in children with a history of VD, no statistically significant relationship was found between the MOD and the presence, severity, or type of astigmatism in preschool children. The inconsistencies between the studies may be explained by differences in study design, age range, and outcome measures (definition and cutoff values used for astigmatism). Studies reporting a higher risk of astigmatism after CS have generally focused on severe or anterior corneal astigmatism and included ocular biometric parameters, which were not present in this study. Furthermore, while some reports emphasize neonatal or early infancy findings, our cohort evaluated cycloplegic refractive outcomes in children aged 3–6 years. Birth-related effects on corneal shape may be transient and may decrease with emmetropization in early childhood. Moreover, differences in diagnostic criteria, ethnicity, sample size, and unmeasured confounding factors such as genetic and environmental influences may have contributed to inconsistent results between studies. From this perspective, our study differs from reports suggesting an association between MOD and astigmatism. [3,7,22] In addition, similar to the literature [8-10], the type of astigmatism in both groups was predominantly WTR astigmatism.

Starting from the newborn period, physiologically hyperopia appears as a more pronounced refractive error. Considering that VD is a normal process, it may have contributed to the emergence of physiological hyperopia. On the other hand, although causal inferences cannot be made, several hypothetical mechanisms have been proposed to explain the higher prevalence of hyperopia in children born vaginally. Transient influences on early refractive development or timing of emmetropization can be suggested as potential contributing factors.[20] However, these mechanisms remain speculative and need to be confirmed by longitudinal studies involving ocular biometric parameters. In the current study, the strongest and most statistically significant finding was that hyperopia was significantly more common in children born by VD compared to those born by CS.

Logistic regression analysis demonstrated that MOD, maternal age, BW, and gender were not independent risk factors for astigmatism, highlighting the multifactorial nature of astigmatism development in early childhood. Furthermore, maternal age differed significantly among delivery groups and could be a potential confounding factor. Although maternal age was not found to be independently associated with astigmatism in regression analysis, its possible influence on refractive development warrants further investigation.

The major limitations of the study include the small sample size, the lack of power analysis, and the absence of ocular biometric data (e.g., axial length, keratometry), which restrict mechanistic interpretation. Retrospective design, the difficulty in interpreting the findings due to the limited number of risk factors included, and the inability to generalize the results due to it being a cross-sectional study are our other limitations.

CONCLUSION

In conclusion, our findings have shown that refractive differences observed in preschool children related to MOD are primarily associated with hyperopia rather than astigmatism. Although differences in the prevalence and severity of astigmatism were observed between children born by VD and CS, these differences did not reach statistical significance. Further studies with larger sample sizes and detailed ocular biometric measurements are needed to clarify these associations.

DISCLOSURE OF INTEREST INFORMATION

Conflict of interest: “The authors declare that they have no conflict of interest”

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