Is Prematurity a Risk Factor for Refractive Errors in Children? Results from School Vision Screening Program

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ABSTRACT

BACKGROUND

The prevalence of refractive errors is reported to be higher in children born preterm. Factors like gestational age, birth weight and retinopathy of prematurity status have a significant impact on the refractive development in preterm infants. Population based long term follow up studies on the refractive status in preterm infants are limited. We designed this study to assess whether prematurity is a risk factor for refractive errors in children.

METHODS

This study was conducted among children aged 5 - 16 years who participated in the school vision screening program over a period of one year. All children underwent detailed ocular examination including measurement of best corrected visual acuity, cycloplegic refraction and fundoscopy. Visual acuity was assessed using an internally illuminated Snellen's chart at 6 meters. Objective refraction by streak retinoscopy after instilling 1 % cyclopentolate eye drops was done in all children with visual acuity ≤ 6 / 9. Children were divided into two groups based on their gestational age at birth - preterm group and full-term group. Preterm birth was defined as childbirth before 37 completed weeks of gestation. Children were enrolled in the study only if the hospital birth document showing gestational age and birth weight was available. Children with co-existing organic disease affecting the eye contributing to the diminished visual acuity such as congenital cataract, glaucoma, and corneal opacities were excluded from the study. Those who had undergone any ocular surgery were also excluded.

RESULTS

One thousand two hundred and ninety-five children were enrolled in the study of which 700 (54.1 %) were boys and 595 (45.9 %) were girls. Median age of the enrolled children was 12 years. The number of pre-term births was 287 (22.2 %). Of the 1295 students screened, 273 (21 %) had refractive errors. Among the children with refractive errors, astigmatism was the most common refractive error (10.6 %), followed by myopia (8.5 %) and hypermetropia (1.9 %). Refractive errors were statistically more prevalent in preterm group (34.1 %), when compared with term born children (17.3 %), p = < 0.001. Compared to the term born children, preterm group had significantly higher prevalence of myopia; 16.4 % vs 6.3 % (p = < 0.001) and astigmatism; 15.3 % vs 9.3% (p = 0.003). There was no statistically significant difference in the prevalence of hypermetropia among the two groups; 2.4 vs. 1.8 (p = 0.477).

CONCLUSIONS

There is strong association between prematurity and refractive errors. These findings prompt long term monitoring of the refractive and visual outcome in preterm infants for diagnosing refractive errors at the earliest. This helps to prevent the consequent amblyopia and the ensuing permanent visual function deficits.

KEYWORDS

Prematurity, Refractive Error, Myopia, Hypermetropia, Astigmatism

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BACKGROUND

Premature birth presents with a host of ophthalmic problems like retinopathy of prematurity (ROP), increased incidence of refractive errors, strabismus and cerebral visual impairment. With the increase in the survival rate of premature infants due to the advances in the field of neonatology, management of ocular morbidity in this expanding group is relevant. Various studies in preterm infants have shown a significant association between prematurity and refractive errors [1-5], although disputed by a few.[6] Fledelius HC investigated the refractive status of preterm infants by follow up for 10 years and demonstrated that preterm infants were likely to develop myopia due to arrested development of the ocular anterior segment.[3] This myopic status in preterm infants may persist into adulthood. A higher prevalence of myopia and astigmatism among preterm infants compared to term babies was first reported by Fletcher and Brandon in 1955[8] and they considered it a complication of retrolental fibroplasia. Retinopathy of prematurity (ROP) certainly increases the risk of myopia, but various studies have shown that, prematurity per se is a risk factor for the development of refractive errors.[2] A. R. Fielder had elucidated the association between prematurity, ROP and myopia.[7]

Three types of myopia have been described in association with prematurity. First is the physiological myopia secondary to a flat anterior chamber, increased corneal curvature and a spherical lens associated with prematurity. The second type is Myopia of prematurity (MOP), which is a form of refractive error related to alterations in the development of the anterior segment that occur in individuals born preterm.[8] The hallmark of MOP is arrested development of the ocular anterior segment and is characterized by a shallow anterior chamber, axial length shorter than expected for the dioptric value, high refractive power of lens and a steep corneal curvature.[9] The third type of myopia associated with prematurity is the one secondary to retinopathy of prematurity and its treatment.

Only very few population based long term follow up studies on the refractive status in preterm infants have been reported. We designed this study to assess whether prematurity is a risk factor for refractive errors in children.

METHODS

This was a community based, observational study among children aged 5 - 16 years who participated in the school vision screening program conducted by SUT Medical College Hospital (a tertiary care teaching hospital in South India), between 1st October 2018 and 31st September 2019. This study was approved by the Ethics Committee of the study center and was conducted in accordance with the declaration of Helsinki. Informed written consent was obtained from the parents of all children.

All children underwent detailed ocular examination including measurement of best corrected visual acuity (BCVA), cycloplegic refraction and fundoscopy. Visual acuity was assessed using an internally illuminated Snellen's chart at 6 meters. Ocular motility test and cover test were performed using torch light. Objective refraction by streak retinoscopy (Heine Beta 200 LED retinoscope) was performed by an experienced optometrist in children with uncorrected visual acuity of 6 / 9 or worse in either eye. Cycloplegic retinoscopy was performed after instilling 1 % cyclopentolate eye drops three times in each eye once every 10 min. Light reflex and pupil dilation were evaluated 20 minutes after the last instillation. Cycloplegia was defined as pupil size of 6 mm or more and absence of pupillary light reflex. Refraction was recorded as spherical equivalent refraction (SER); SER = spherical refraction + 1 / 2 cylindrical refraction. Based on the measured objective refraction, significant refractive error was defined as follows- myopia as SER ≤ - 1.00 D, hypermetropia as SER ≥ 3.00 D, astigmatism as absolute cylindrical refraction ≥ 1.00 DC in one or both eyes and anisometropia as a difference in SER ≥ 1.00 D between the two eyes.

A detailed slit lamp evaluation of anterior segment was done. Fundoscopy was done both with indirect ophthalmoscope and slit lamp biomicroscopic assessment with 78 D lens. Children with co-existing organic diseases contributing to the diminished visual acuity such as congenital cataract, glaucoma and corneal opacities were excluded from the study. Those who had undergone any ocular surgery were also excluded. Children were included only if hospital birth document showing gestational age and birth weight was available. All the children who attended the screening programme and satisfied the inclusion exclusion criteria and gave consent were enrolled in the study.

Children were divided into two groups based on their gestational age at birth: preterm group and full-term group. Preterm birth was defined as childbirth before 37 completed weeks of gestation.

Statistical Analysis

The data was analysed by SPSS 22.0 software. Quantitative data was expressed as Mean + / - SD and categorical variables as proportion. Comparison of categorical variables was done using Chi Square test and Fischer Exact test.

RESULTS

One thousand two hundred and ninety-five children were enrolled in the study of which 700 (54.1 %) were boys and 595 (45.9 %) were girls. Median age of the enrolled children was 12 years. Age distribution is detailed in Table 1. The number of pre term births was 287 (22.2 %). Of the 1295 students screened, 273 (21 %) had refractive errors (Figure 1). Among the children with refractive errors astigmatism was the most common refractive error (10.6 %), followed by myopia (8.5 %) and hypermetropia (1.9 %).

Prevalance of refractive errors in various gestational age groups is detailed in Table 2. An inverse relationship was observed between gestational age and prevalence of refractive errors. All the four children in the gestational age group of < 28 weeks had significant refractive errors. In the 28 - 30 weeks gestational group 32.8 % had significant

refractive errors, while the least prevalence (17.4 %) was in the term group (≥ 37 weeks).

Age Group	N (%)
5 - 7	116 (9)
8 - 10	233 (18)
11 - 13	428 (33)
14 - 16	518 (40)

Table 1. Age Distribution (N = 1295)

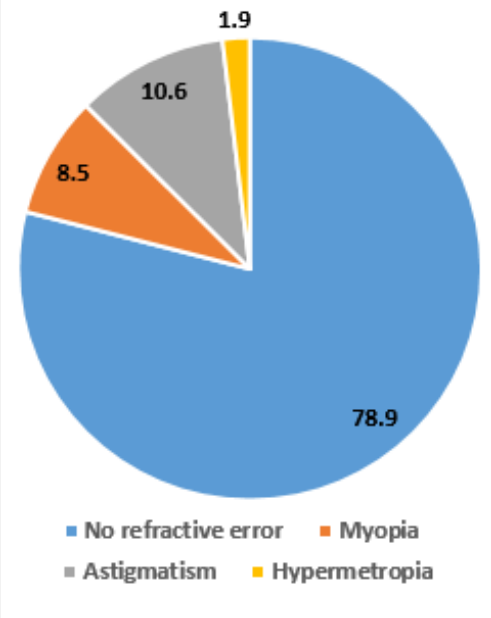

Figure 1. Prevalence of Refractive Errors Detected during School Vision Screening Program

Gestational Age (in Weeks)	Number of Patients	Emmetropia	Myopia	Hypermetropia	Astigmatism
	N (%)	N (%)	N (%)	N (%)	N (%)
< 28	4 (0.3)	0	3 (75)	0	1 (25)
28-30	51 (4.1)	27 (52.9)	12 (23.5)	1 (1.9)	11 (21.6)
31-33	82 (6.6)	55 (67)	15 (18.3)	2 (2.4)	10 (12.2)
34-36	150 (11.6)	107 (71.3)	17 (11.3)	4 (2.6)	22 (14.6)
≥37	1008 (77.8)	833 (82.6)	63 (6.3)	18 (1.8)	94 (9.3)

Table 2. Prevalence of Refractive Errors in Different Gestational Age Groups

Gestational Age	Refractive Error N (%)	Emmetropia N (%)	Chi - Square	P Value
Preterm (N = 287)	98 (34.1)	189 (65.8)	37.83	< 0.001
Term (N = 1008)	175 (17.3)	833 (82.6)		

Table 3. Relation between Prevalence of Refractive Error and Gestational Age

Type of Refractive Error	Preterm N (%)	Term N (%)	Chi - Square	P Value
Myopia	47 (16.4)	63 (6.3)	29.47	< 0.001
Hypermetropia	7 (2.4)	18 (1.8)	0.50	0.477
Astigmatism	44 (15.3)	94 (9.3)	8.46	0.003

Table 4. Relation between Type of Refractive Error and Gestational Age

Significant refractive errors were statistically more prevalent in preterm born children (34.1 %) when compared with term born children (17.3 %), p = < 0. 001 (Table 3). Compared to the term born children, preterm group had significantly higher prevalence of myopia; 16.4 % vs 6. 3 % (p = < 0.001) and astigmatism; 15.3 % vs 9.3 % (p = 0.003). There was no statistically significant difference in the prevalence of hypermetropia among the two groups; 2.4 vs 1.8 (p = 0.477) (Table 4).

DISCUSSION

Relation between prematurity and refractive errors has been evaluated in various studies with contradictory results. In this study we found a positive association between prematurity and refractive errors. The prevalence of refractive errors in the preterm group was 34.1 % compared to 17.3 % in the full-term group. The findings are consistent with previous reports by Lennerstrand G. et al.[10] However, the study conducted by Saw SM et al showed no relationship between refractive errors and prematurity in children born without retinopathy of prematurity.[11] Shapiro A. et al found no difference in the refractive status of preterm children compared to children born full term.[6] Factors like different methods of refractive assessment, varying age of participant children, potential confounding variables like birth weight and epidemiological features of the study cohort may partly explain this discrepancy. We observed an inverse relation between gestational age and prevalence of refractive errors. Smaller the gestational age higher was the prevalence of refractive errors. Similar finding was also reported by Verma M. et al.[12]

In our study, the prevalence of myopia was 16.4 % in the preterm group and 6.2 % in the full-term group. Similar observation was made by Nissenkorn I. et al.[13] In a study conducted on preterm infants with birth weights less than 1251 g, Quinn GE et al. demonstrated a higher prevalence of myopia.[14] The prevalence of myopia in the preterm group in our study is higher than that reported by Quinn GE. et al (10 %). The reports from various studies about the prevalence of myopia in preterm children are conflicting. This may be due to the influence of other established risk factors for myopia including genetic factors, ethnicity, extended periods of near-work and limited outdoor activity.[15]

We also observed that astigmatism was significantly higher in the preterm (15.3 %) than in the full-term group (9.3 %). This is consistent with that reported by Larsson EK et al who analysed the development of astigmatism in preterm children during the first 10 years of life.[16] Larsson et al concluded that the presence of astigmatism of 1D or more at two and half years of age was the strongest risk factor for astigmatism at ten years of age. We did not find any significant association between prematurity and prevalence of hypermetropia though numerically hypermetropia was more common in preterm group. This could be due to under powering due to low number of children with hypermetropia. AR O'Connor et al reported that at the age of 10 – 12 years children born preterm have an increased prevalence of all refractive errors and that 20.5 % of preterm eyes became more hypermetropic between the ages of 6 months and 12 years.[5]

Full term infants tend to be hypermetropic at birth. This hypermetropia, which is primarily axial, rapidly reduces during the first year of life through the process of emmetropisation. Infants born preterm tend to be myopic at

birth despite the shorter axial length, which is proportional to their gestational age. Preterm eyes may fail to emmetropize due to an arrest in the development of the anterior segment resulting in increased risk for developing significant refractive errors, most commonly myopia. This myopic tendency may continue into adulthood, which is known as myopia of prematurity. AR O'Connor et al studied the anterior segment biometric profile and refractive status in a cohort of preterm children at 10 – 12 years of age and concluded that preterm birth have an impact on the process of emmetropisation through specific disturbance of ocular growth and arrested development of the anterior segment.[5] The exact pathogenesis of the association between prematurity and myopia is still not clear. Hypothesis proposed to explain these anterior segment aberrations include mechanical restriction of ocular growth, postnatal bone mineral deficiency, temperature deficit in preterm infants which impede corneal growth and retinal dysfunction.

Studies have shown that the prevalence of myopia in children born preterm correlates negatively with gestational age and birth weight. Berna Akova-Budak et al has concluded that birth weight and appropriateness for gestational age as birth parameters may have an impact on the development of all types of refractive errors.[17] The main limitation of our study would be that the confounding factor of birth weight was not taken into consideration. Further studies with larger sample size considering all these risk factors are necessary to understand more about the refractive status of preterm infants during adolescence & adulthood.

CONCLUSIONS

There is strong association between prematurity and refractive errors. We demonstrated an increased prevalence of myopia and astigmatism in school children born preterm. These findings prompt long term monitoring of the refractive and visual outcomes in preterm infants for diagnosing refractive errors at the earliest. This helps to prevent the consequent amblyopia and the ensuing permanent visual function deficits.

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