ORIGINAL ARTICLE

Retinal Nerve Fibre Layer Thickness Among Children with Refractive Errors Using Spectralis Optical Coherence Tomography

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Abstract:
Objective: To determine mean RNFL thickness among the pediatric population with refractive errors using Spectralis optical coherence tomography.
Methodology: The study was conducted in a tertiary eye care hospital located in Rawalpindi, Pakistan between March 14, 2018, and September 14, 2018. The research included children aged 4-12 years who had refractive errors and received a complete basic ophthalmologic examination, including VA, cycloplegic refraction, slit lamp examination of anterior and posterior segment examination after pupillary dilatation, and intraocular pressure measurement. The spherical equivalent was determined in diopters and taken as a quantitative measure. Axial length was calculated by non-contact optical biometry and recorded in millimeters.
Results: A total of 165 individuals were recruited with a mean age (years) in the study of 9.07+2.43 years. There were 114 (69.1%) male and 51 (30.9%) female patients who were included in the study. Mean spherical equivalent was 1.25+4.21 whereas mean RNFL thickness was 102.99+5.86 among children with refractive errors using Spectralis optical coherence tomography among the participants.
Conclusion: The study has found that there is a notable connection between the average thickness of the retinal nerve fiber layer (RNFL) in children with refractive errors using Spectralis optical coherence tomography in the Pakistani community. Further studies are needed in various settings to investigate the factors that affect RNFL reserve in childhood. This information would be beneficial in diagnosing and keeping an eye on optic nerve diseases. *Al-Shifa Journal of Ophthalmology 2023; 19(3): 100-105. © Al-Shifa Trust Eye Hospital, Rawalpindi, Pakistan.*

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Originally Received: 20 April 2023
Revised: 10 May 2023
Accepted: 13 May 2023

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Introduction:

According to WHO statistics, over 150 million people globally have optical disability secondary to uncorrected refractive errors.[1] In East Asian countries 40% of children suffer from visual impairment due to refractive errors, especially Myopia.[2-4]
Retinal nerve fiber layer is formed by expansion of optic nerve fibers. In the phase of embryonic development, there are known to be 2.85 million nerve fibers.[1] RNFL thickness in adults and children follows ISNT[5] rule with maximum thickness present inferiorly (126+/-16.13)

and thinnest temporally (70.6+/-13.9).[6] Mean global RNFL thickness among children with refractive errors after age adjustments are 94.1 +/- 12.2 in myopic group,102.5 +/- 7.8 in emmetropic group and 107.8+/- 11.[6] in hypermetropic group(1). The myopic group was considerably older than other two groups. Average age in myopic group was 9.6+/- 3.9, emmetropic 6.9+/- 2.7, hypermetropic 6.5+/- 1.9 years.[1] Other studies are also present that show a similar pattern.[4]

Pakistan is an underdeveloped country accompanied with limited resources which causes poor socio economic status and low quality infrastructure particularly in providing healthcare facilities. It is a dilemma that so far, such studies have not done to document RNFL thickness accompanied with various ocular conditions and refractive errors.[7,8]

The loss of nerve fibers in the peripapillary retina is a hallmark of glaucoma (RNFL). Imaging the retinal nerve fiber layer (RNFL) thickness is an effective diagnostic and monitoring tool for glaucoma. The peripapillary RNFL may not be as helpful for those with optic nerve head abnormalities, slanted discs, peripapillary atrophy, and extreme myopia because these conditions are not accounted for in the normative database of most imaging tools. Myopia is more common in some groups than others; nonetheless, it is disproportionately prevalent in East Asian countries[2]. Approximately 50% of all retinal ganglion cells are located in the macula. According to previous research, there are substantial positive connections between macular thickness and peripapillary RNFL thickness in adults. It was also proposed that measuring macular thickness could help with spotting glaucoma in its early stages. Noninvasive optical coherence tomography (OCT) can objectively measure macular and peripapillary RNFL thickness in youngsters as young as 3 years old.[2]

It is also of importance to perform study in children as understanding the factors that affect RNFL reserve in childhood would be helpful in diagnosing and monitoring optic nerve disease. To determine mean RNFL thickness among children with refractive errors using Spectralis optical coherence tomography.

Materials and Methods:

A cross-sectional study was conducted at the Pediatrics Ophthalmology outpatient department (OPD) of Al Shifa Trust Eye Hospital in Rawalpindi from 14th March, 2018 to 14th September, 2018. The study was approved after the synopsis was approved and was completed in a duration of 6 months. The sample size of 165 was calculated using the WHO calculator with a confidence level of 95%, a population mean RNFL thickness of 94.11 in the myopic group, and a population standard deviation of 12.21. Participants were recruited using a non-probability consecutive sampling technique. The inclusion criteria for the study included children aged 4-12 years, patients with refractive error and post-cycloplegic spherical equivalent of <-1 D calculated after cycloplegic refraction for myopia, patients with refractive error and post-cycloplegic spherical equivalent of >+1 D calculated after cycloplegic refraction for hypermetropia, and patients with emmetropia/post-cycloplegic spherical equivalent of >-1D to <+1D for emmetropia. Avoidance of specific eye conditions is necessary before LASIK: congenital cataract, nystagmus, microphthalmos, optic nerve/retinal disease, active corneal infection, or corneal scars. Patients who met the inclusion criteria were recruited from the Pediatrics Department at Al-Shifa Trust Eye Hospital, after receiving approval from the appropriate hospital authorities. These patients provided their informed written consent. The mean thickness of the Retinal Nerve Fiber Layer (RNFL) was measured in micrometers using Spectralis optical coherence tomography. The patients' names, ages, genders, addresses, and contact numbers were recorded with their

OPD registration numbers. After dilation of the pupils, a full basic ophthalmologic examination was performed, including visual acuity testing, cycloplegic refraction, and anterior and posterior segment slit lamp examinations. The Goldmann Applanation Tonometer was used to gauge the pressure inside the eye. All subjects received cycloplegic refraction. Post cycloplegic refraction was done after 30 minutes. The spherical equivalent was calculated in diopters and taken as a quantitative measure. Axial length was calculated by non-contact optical biometry and recorded in millimeters. OCT was performed on each subject after cycloplegic refraction. The RNFL thickness was measured using fovea-to-disc technology and the RNFL examination report. Measurements of the RNFL thickness were made in millimeters. It was done with the use of SPSS version 16. Gender and refractive status were taken as Qualitative variables. Quantitative variables such as Age, Spherical equivalent, and retinal nerve fiber layer thickness were analyzed by calculating frequencies and percentages.

Mean Standard Deviation (SD) was calculated as well. In order to compare RNFL thickness with myopia, hyperopia, and emmetropia, stratification was performed for age-matched children. The results were then analyzed using post-stratification ANOVA. A P-value less than 0.05 was considered significant.

Results:

A total of 165 patients were included with a mean age of 9.07 ± 2.43 years. The mean retinal nerve fiber layer was 149.13 ± 14.28 mm and the mean RNFL thickness was 102.99 ± 5.86 mm. Type of refractive errors was assessed in terms of myopia, hypermetropia and emmetropia.

Spherical equivalent thickness was found to be 1.25 ± 4.21 mm. Majority of the cases presented with emmetropia 71 (43.0), followed by hypermetropia 70 (42.4) and myopia 24 (14.5) respectively.

Table 1. Sociodemographic and Clinical Characteristics of Study participants

Characteristics	Parameters
Age (years)	9.07 ± 2.43
Retinal Nerve Fiber layer Thickness (mm)	149.13 ± 14.28
Mean RNFL Thickness (mm)	102.99 ± 5.86
Spherical Equivalent Thickness	1.25 ± 4.21
Gender	
Male	114 (69.1%)
Female	51 (30.9%)
Type of Refractive Errors	
Myopia	24 (14.5%)
Hypermetropia	70 (42.4%)
Emmetropia	71 (43%)

The study examined the relationship between age, refractive errors, and the thickness of the retinal nerve fiber layer (RNFL) among children. The researchers used Spectralis optical coherence tomography to measure the RNFL thickness in children with refractive errors. The results showed that for children aged 4-10 years, there was a statistically significant difference in mean RNFL thickness between those with myopia (96.00), hyperopia (104.00), and emmetropia (102.88). The p-value was 0.000, indicating that the difference was not due to chance.

The findings are summarized in Table No. 02.

Discussion:

In our study, the mean age (years) in the study was 9.07+2.43. Similarly, in a study conducted in 2015, 1 mean age in years was 7.6±3.3 years. In a study by Lee et al,[1] frequency of male and female patients was 103 and 8 respectively. Likewise, in our study, there were 114 (69.1) male and 51 (30.9) female patients. In our study, mean RNFL thickness with refractive error in terms of myopia, hypermetropia and emmetropia was 96, 104.00±2.29 and emmetropia 102.88±4.19 respectively was statistically significant (p<0.0001). Similarly, in a study conducted by Lee et al,[1] average age in myopic group was 9.6+3.9, emmetropic was 6.9+ 2.7 and hypermetropic was6.5+ 1.9 years.

In a study by Jody et al., the distribution of macular thickness and peripapillary retinal nerve fiber layer (RNFL) thickness was studied among the pediatric population with refractive errors.[9] The study revealed that the mean, superior, and inferior RNFL were 99 ± 11.5, 123 ± 25.8, and ± 22.2 micrometers, respectively.[9] Eslami Y et al., revealed that a total of 115 eyes were imaged. Approximately 51 (44.3%) of the cases were female children. The mean age was 12.44 ± 2.52 years. The SE of refractive error was 0.39 ± 1.38 diopters (range: −3.00 to +4.5 D). The RNFL thickness measurements in the superior, inferior, nasal, and temporal quadrants were 129.25 ± 14.52, 128.16 ± 13.46, 76.76 ± 10.58, and 69.58 ± 9.94 μm, respectively. The global RNFL thickness was 101.01 ± 7.74 μm. In both univariate and multiple regression analyses, SE was the only determinant of RNFL thickness (all P values < 0.05).[10] Bi-Dan Zhu et al., revealed that the mean (SD) RNFL thickness was 103.08 (9.01) μm, with the mean (SD) thickest RNFL in the inferior quadrant (129.34 [14.90] μm), followed by the superior (126.19 [15.24] μm), temporal (82.98 [10.57] μm), and nasal (73.82 [13.89] μm) quadrants. The RNFL was thicker with shorter axial length (β = −1.53, P < 0.0001) and with higher hyperopia (β= 0.90, P < 0.0001). Girls had slightly thicker average RNFL thickness than boys (P < 0.0001). The RNFL thickness had no significant correlation with age or BMI.[11] Both children and adults have been shown to have a thinner RNFL when they have myopia,[12,13,14] which has been widely established. Others, though, have said something different. For a sample of people between the ages of 7 and 18, Chen et al.[14] found no correlation between global RNFL and either age or spherical equivalent. Similarly, Tong et al.[15] used the Heidelberg Retinal Tomograph (Heidelberg Engineering, Heidelberg, Germany) to look at the eyes of 316 Singaporean children aged 11 to 12 years and found no correlation between RNFL thickness and axial length or myopia. In our analysis, a thinner global RNFL thickness was associated with increasing age (r=1/4 0.4, p=0.0001), increasing negative (myopic) spherical equivalent (r=1/4 0.5, P0.0001), and increasing axial length (r1/4 0.4, P0.0001). We corrected the data for age and re-compared the differences in RNFL thickness across the 3 groups to establish whether the thinning RNFL was mostly due to the physiological ganglion cell loss that comes with aging or the stretching of the RNFL that comes with the axial myopic shift. We discovered that there was no significant difference in RNFL thickness between the emmetropic and hyperopic groups (p>0.05), while the mean global RNFL in the myopic group was significantly thinner than the other 2 groups (p=0.0001). This indicated that both advanced age and refractive error contributed to the thinner RNFL in the myopic group. Children with variable refractive status have varying RNFL thickness in the periphery, with hyperopes having the thickest and myopes having the thinnest. Only myopic children showed noticeably thinner RNFLs after taking into account age. This suggests that age, not refractive state, is responsible for the observed RNFL disparities between emmetropic and hyperopic children. When looking at the children's cohort, a thinner RNFL was linked to increasing age, more myopia in terms of spherical equivalent, and greater axial length. RNFL thickness seems to be ethnic specific. [16-18] Samarawickrama et al. [16] reported that East Asian children generally had thicker RNFL than European Caucasian children at the ages of 6 years and 12 years. There were some limitations of our study. Firstly, we did not take into account the effect of optic disc size on RNFL thickness. Further studies should correct for magnification and add optic disc size as an influencing factor. Secondly, most children in this study were 8-10 years old. Therefore, the results cannot be applied to younger or older children.

Conclusion:

The study concluded that there was a significant relationship between mean RNFL thicknesses among children with refractive errors analyzed by using Spectralis optical coherence tomography. Our study showed thinner RNFL in myopes while there was no difference among other two groups (emmetropes and hyperopes).

It is necessary to conduct further studies in different setups to comprehend the factors that impact RNFL reserve during childhood. Therefore, data from other emerging countries will be presented, and future studies should focus on a wider range of racial and ethnic groups. The interpretation of Spectralis optical coherence tomography scans of the retinal nerve fiber layer (RNFL) in children with refractive defects should be approached carefully due to age and gender-related variations. This will help in evaluating and distinguishing OCT findings in children with optic pathologies, glaucoma, macular diseases, and refractive errors such as myopia. Conflict of Interests: None declared by the authors

Acknowledgements: Nil
Funding: Nil

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