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Research Article

RETINAL NERVE FIBER LAYER THICKNESS MEASUREMENTS VIA SD-OCT IN PEDIATRIC PATIENTS

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ABSTRACT

Purpose: To determine the normative values of the retinal nerve fiber layer thickness (RNFL) via spectral-domain optical coherence tomography (SD-OCT) in healthy pediatrics.

Methods: Sixty eyes of 30 healthy pediatric patients (20 females, 10 males) were included in this prospective study. After full ophthalmologic examination RNFL measurements were performed via Spectralis SD-OCT.

Results: The mean age was 10.8 ± 3.1 years (range 6 - 15). The mean central macular thickness was 261 ± 27 μm (range 223 - 434). The mean RNFL thickness was 127.9 ± 13.1 μm (range 109 - 160 μm) for superior quadrant; 76.7 ± 11.9 μm (range 15 - 93 μm) for temporal quadrant; 130.1 ± 10.5 μm (range 98 - 149 μm) for inferior quadrant and 84.5 ± 11.7 μm (range 59 - 107 μm) for nasal quadrant. The mean average RNFL thickness was 104.9 ± 6.7 μm (range 90 - 116 μm).

Conclusion: The means and normative reference ranges of RNFL thickness are provided for Spectralis OCT in healthy pediatrics, between 6-15 years old, and this values can be used as a standard to compare those of children suspected of having retinal or optic nerve abnormalities.

Keywords: Retinal Nerve Fiber Layer Thickness, RNFL, Optical Coherence Tomography, OCT, Normative Data.

INTRODUCTION

Optical coherence tomography (OCT) is a noninvasive, cross-sectional and reproducible imaging technique that can measure retinal nerve fiber layer thickness (RNFL) quantitatively¹. OCT has become a popular technique for diagnosing and determining progression of glaucoma². RNFL can evaluate with slit-lamp biomicroscopic examination. However, automated computerized devices can measure the RNFL quantitatively and objectively³. Beside of being a diagnostic tool, OCT also can be used for monitoring disease progression and the effectiveness of treatment.

The first description of OCT by Huang et al was in 1991⁴. OCT works similar way with ultrasound but it uses light waves instead of sound waves⁵. For measuring the light echoes, OCT uses a spectrometer⁵. Historically, the first systems were time-domain (TD-OCT) technologies. With recent advances in OCT technologies, spectral-domain (SD-OCT) is became available⁶. Because of SD-OCT has the advantage of improved image quality and resolution, smaller morphologic changes became identifiable⁷.

Retinal nerve fiber layer thickness may affect from many ocular and systemic disease. Physicians need normal databases to distinguish normal and abnormal RNFL measurements. Previous studies have proved the feasibility of OCT in the pediatric population^{8,9}. However all OCT devices have an integrated normative database only for adult subjects. Some earlier studies have reported normative values in children for time domain OCT devices¹⁰⁻¹²; similar reports using spectral domain OCT devices are much less available. This study, we used Spectralis SD-OCT (Heidelberg Engineering, Inc., Vista, CA) and we aim to present RNFL measurements in healthy pediatric subjects.

MATERIALS AND METHODS

Sixty eyes of 30 patients (20 female, 10 male) were included in this prospective cross-sectional study. The inclusion criteria were: age 6 to 15 years old, best-corrected visual acuity 20/20 or better, refractive error not exceeding ± 3 diopters spherical equivalent, no ophthalmic or systemic disease, no prior ocular surgery, no medical or family history of retinal diseases or glaucoma. Parents of all participants were volunteers and the study was performed according to the

Helsinki declaration. This study was approved by the local ethics committee. All subjects underwent a full ophthalmic examination, including SD-OCT examination. SD-OCT scanning was performed using Spectralis. This OCT system has a resolution of 7 μm and the light source used is SLD centered at a wavelength of 870 nm. Device has eye-tracking technology recognizes the presence of eye movement then repositions the scan pattern and discards scans with motion artifacts. Also high speed scanning eliminates chances of artifacts.

RNFL thickness measured with 16 averaged consecutive circular B-scans (diameter of 3.5 mm) via Spectralis OCT. The device has an online tracking system to compensate for eye movement. The RNFL thickness was automatically segmented using the Spectralis software ver. 4.0.0.0)¹³.

The results between genders compared with independent samples t test and $p < 0.05$ was considered statistically significant. SPSS 20 (SPSS Inc., Chicago, IL, USA) software was used.

RESULTS

The mean age was 10.8 ± 3.1 years (range 6 – 15 years). The mean refractive error was 0.22 ± 1.75 diopter spherical equivalents. The mean RNFL thickness was 127.9 ± 13.1 μm (range 109 – 160 μm) for superior quadrant; 76.7 ± 11.9 μm (range 15 – 93 μm) for temporal quadrant; 130.1 ± 10.5 μm (range 98 – 149 μm) for inferior quadrant and 84.5 ± 11.7 μm (range 59 – 107 μm) for nasal quadrant. The mean average RNFL thickness was 104.9 ± 6.7 μm (range 90 – 116 μm) (Table1).

Table 1: The RNFL thickness measurements (μm) in pediatrics

	S	T	I	N	Aver.
Female	127.9 ± 13.2 (109-160)	76.8 ± 9.0 (53-90)	128.4 ± 11.7 (98-149)	82.9 ± 11.7 (59-107)	104.1 ± 7.1 (90-116)
Male	128.0 ± 13.0 (109-155)	76.7 ± 16.6 (15-93)	133.6 ± 6.1 (123-148)	87.6 ± 11.4 (60-102)	106.5 ± 5.5 (98-115)
Total	127.9 ± 13.1 (109-160)	76.7 ± 11.9 (15-93)	130.1 ± 10.5 (98-149)	84.5 ± 11.7 (59-107)	104.9 ± 6.7 (90-116)

S: Superior, T: Temporal, I: Inferior, N: Nasal, Aver: Average

There was no difference between sex groups in any parameters. The order of RNFL was inferior quadrant>superior quadrant>nasal quadrant>temporal quadrant.

DISCUSSION

This study reported normative values for RNFL thickness in children 6–15 years of age using Spectralis SD-OCT. Correlations with biometric data showed that RNFL thickness values were not different in gender groups. Optical coherence tomography, being non-invasive and fast, is gaining more popularity in evaluating diseases of childhood including pediatric glaucoma. There is not enough studies published yet which reports normal values for children. Only a few studies reported, using Spectralis, normative RNFL datas for children^{14,15}. One of them in Turkish children and other one in North American children. Turk et al reported that the average peripapillary RNFL thickness was 106.45 ± 9.41 μm in healthy Turkish children and added that OCT measurements were not significantly correlated with age, SE, or AL values¹⁴. Yanni et al reported that the average peripapillary RNFL thickness was 107.6 ± 1.2 μm in healthy American children and they added that SD-OCT can be used to assess peripapillary RNFL thickness in children as young as 5 years. OCT is a powerful technology for the assessment of the RNFL. However, different OCT devices employ different acquisition technologies and data analysis software. It has been shown that significant variability in RNFL thickness can exist among different OCT devices¹⁶. Physician needs to know for normative datas for all devices and for all patients groups. Using an adult normative database for pediatrics patents is not agreeable.

CONCLUSION

This study adds an example of normal reference ranges for RNFL thickness measured via Spectralis SD-OCT in healthy Middle Eastern children 6–15 years of age. Other races, ethnicities should be studied in future research. Also a possible correlation of RNFL thickness with axial length, refractive status of the eye, corneal thickness should be studied.

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