

OCT Based Analysis of RNFL Thickness in Normal Indian Paediatric Population

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ABSTRACT

AIM: Cirrus Optical coherence tomography (OCT) provides high resolution cross-sectional images of retina, vitreous and optic nerve head with an axial resolution of 6 μm and a reproducibility of 1.6 μm . There is an availability of integrated normative database only for adult subjects >18 years but the normal reference ranges of (retinal nerve fibre layer) RNFL thickness in paediatric population for comparison is lacking. With this background in mind the present study was undertaken.

MATERIALS AND METHODS: 340 eyes of 170 children between 5 to 17 years of age were recruited for study. Full ophthalmic examination was done including visual acuity, cycloplegic refraction, fundus, intraocular pressure, ocular motility and alignment. RNFL measurements were obtained through dilated pupils using Cirrus HD OCT.

RESULT: Of 170 children between the age of 5-17 years who were enrolled for the study the mean RNFL thickness was 110.81 ± 13.74 in RE and 110.77 ± 12.39 in LE ($P = 0.954$). Further mean RNFL thickness of the two eyes was assessed in the 4 quadrants and the difference of RNFL thickness in 4 quadrants was statistically significant in BE ($P = 0.0001$).

CONCLUSION: The normative data values of RNFL thickness in children was assessed as it will be helpful while interpreting the RNFL thickness of children having glaucoma or other Retinal or Optic nerve diseases.

Key words: Paediatric population; OCT; RNFL

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INTRODUCTION

OCT is a non-invasive, non-contact, transpupillary imaging method that performs objective high resolution cross-sectional images of retinal tissue. Spectral domain OCT is currently the most advanced commercially available application of OCT technology. Cirrus HD-OCT is a spectral domain OCT with a speed of 27,000 A scans/sec and a resolution of 5 $\mu\text{m}^{\text{[1]}}$. It allows faster scanning and higher resolution images than the time domain OCT technology. Cirrus HD-OCT 4000 scans the optic disc and peripapillary RNFL in a 6 mm^2 area consisting of 200 \times 200 scanning grid. Due to its greater acquisition speed and high image resolution, it is very useful for the examination of children.

All OCT devices have an integrated normative database only for adult subjects >18 years. The reported normative values of RNFL thickness in children using time domain OCT devices are available but very limited. Using SD-OCT, normal reference values of RNFL thickness are needed in paediatric population as the software in Cirrus SD OCT has no paediatric normogram for comparison.

The primary objective of this study is to provide a normative

paediatric database for RNFL thickness in healthy Indian children using Cirrus SD OCT. The secondary objectives are to analyse the effects of age and gender on RNFL thickness. The development of reference standards may allow for better investigation and detection of various ocular diseases in children.

MATERIALS AND METHODS

217 children between 5-17 years of age who attended the paediatric OPD, were then counselled by our resident doctors. The entire procedure as well as the type of study was explained to their guardians. All those children’s parents who gave their informed and written consent were enrolled for the study. The selection of the children was done randomly ensuring that the children were not suffering from any serious systemic illness and were healthy.

Out of the 217 children, 22 were uncooperative; most of them showed difficulty while measuring IOP and conducting OCT, and so were excluded 25 more children were excluded on following the exclusion criteria. We were thus left with 170 children whose eyes were finally analysed.

Exclusion criteria were any kind of refractive error, any ocular pathology like Retinitis pigmentosa, posterior staphyloma, strabismus or amblyopia any abnormality of optic disc or retinal nerve fiber layer; family history of glaucoma or any other hereditary eye disease; history of any ocular injury or intraocular surgery or any kind of laser therapy and children with any systemic disease probably affecting the eye.

All subjects underwent full ophthalmic examination including vision assessment by Snellen’s drum both with or without pinhole, cycloplegic refraction, fundus examination by indirect ophthalmoscope, intraocular pressure measurement and assessment of ocular motility and alignment.

After thorough ophthalmic and systemic history and examination RNFL measurements were obtained through dilated pupils using Cirrus OCT.

The scan with the best signal strength among the three OCT volume scans (200 × 200 axial scans) which were taken centered on the optic disc were selected. RNFL data were evaluated automatically by Cirrus OCT system software (version 3.0 software; Carl Zeiss Meditec). The RNFL parameters evaluated were the RNFL average (in micrometers) and RNFL thickness in four quadrants i.e superior, inferior, nasal, and temporal. Only the scans with signal strength of 6 or higher were included in the analysis.

This study was undertaken for 6 months duration, during which all the children who were fulfilling the study criteria were enrolled.

The results were analysed using descriptive statistics and making comparison about the RNFL thickness among various quadrants. Discrete categorical data were summarized as in proportions and percentage and continuous data were summarized as Mean +/- SD.

The p value was calculated by Gaussian Z Test.

RESULTS

Of 170 children between the age of 5-17 years who were enrolled for the study mean age was 10.4 (± 2.7). There were 100 (59%) males and 70 (41%) females, with the M: F ratio of 1.42:1.

We looked for the average RNFL thickness in the two eyes of all the children together and found the values to be 110.81 ± 13.74 in RE and 110.77 ± 12.39 in LE but the difference was statistically insignificant (p = 0.954).

The normal RNFL thickness in males was 110.8 (SD 13.52) and in females was 113.8 (SD 13.95) with P value of 0.138. Thus no gender

discrimination was found between normal average RNFL thickness.

Further, mean RNFL thickness of different quadrants was assessed in children of different age groups. In the age group of 5-9 years and 10-13 years both maximum thickness was seen in the inferior quadrant, followed by superior, temporal and nasal quadrant. The difference of RNFL thickness in these quadrants was statistically significant (p < 0.0001).

While in children of 14-17 years, maximum thickness was still in the inferior quadrant but it was followed by superior, nasal and then temporal quadrant, thus following the ISNT rule seen in adults. Here also the difference of RNFL thickness in 4 quadrants was statistically significant (p < 0.0001).

With increase in age, the RNFL thickness is increasing in superior quadrant and is decreasing in temporal quadrant, although it is statistically insignificant.

DISCUSSION

We examined 340 eyes of 170 children between 5 to 17 years of age. Their RNFL thickness around the optic nerve was analyzed using Spectral domain (Cirrus) OCT and then the mean RNFL thickness

Table 1 Demographic profile (n = 170).

Characteristic	Value
Age(years)	
Mean ± SD	10.4 ±(2.7)
Range	5 - 17
Gender (%)	
Male	100(59%)
Female	70 (41%), p value =0.071

Table 2 Variation of Normal Average RNFL thickness.

		MEAN	SD	P value
EYES	RE	110.81	SD 13.74	0.954
	LE	110.77	SD 12.39	
GENDER	MALES	110.8	SD 13.52	0.138
	FEMALES	113.8	SD 13.95	

Table 3a Quadrantic distribution of RNFL thickness in children of different age groups.

PARAMETER	AGE (years)					
	5-9 years		10-13 years		14-17 years	
QUADRANTS	RANGE	SD	RANGE	SD	RANGE	SD
SUPERIOR	95-150	10.65	97-184	18.44	100-181	21.9
INFERIOR	89-193	19.4	101-190	20.7	98-193	24.87
NASAL	57-135	16.93	51-135	21.29	48-132	25.83
TEMPORAL	33-166	40.73	37-166	38.36	32-170	39.25

Table 3 b Quadrantic retinal nerve fibre layer thickness (RNFL) (n=170) of children aged 5-17years.

QUADRANTS	AGE (years)					
	5-9 years		10-13 years		14-17 years	
	MEAN	MEDIAN	MEAN	MEDIAN	MEAN	MEDIAN
SUPERIOR	134.2	133.75	138.68	137	143.8	142
INFERIOR	144.45	142.25	145.8	145	146.4	144
NASAL	88.13	83	82	84.5	84.85	79.5
TEMPORAL	91.4	77	90.35	79	84.5	76

p-value (0.057) for the superior quadrants, p- value (0.611) for the temporal quadrants.

was calculated.

Spectral domain -OCT, the latest generation of the technology, provides higher resolution and decreased acquisition time, hence is more useful in the pediatric population compared to time domain OCT but the direct comparison of RNFL parameters between TD-OCT and SD-OCT is not possible due to different scanning algorithms.

The average RNFL thickness in our study was determined to be 110.81 μm (SD \pm 13.74 μm) which is consistent with the findings reported in literature as by Neelam Pawar *et al.*^[2], Salchow *et al.*^[3] and Rao *et al.*^[4]. While Bi Dan Zhu *et al.*^[5] examined 12 year old Chinese children and reported the mean RNFL thickness to be 103.08 μm and Christiane Al-Haddad *et al.*^[6] reported Mean RNFL thickness to be 95.6 \pm 8.7 μm using Cirrus OCT. The differences in the values could be because of the existence of variation between distinct geographic areas and ethnic groups. The disparity in values is also attributed to the use of different versions of the device which use different algorithm.

The average RNFL thickness in general is thicker in the inferior and superior quadrants than in the nasal and temporal quadrants. This characteristic, called a “double-hump” configuration of peripapillary RNFL thickness, has been reported in previous studies^[3,7-9] of adults and children. This is known as the “inferior superior nasal temporal” pattern^[10], which reflects the nerve fibers converging to the ONH from the superior and inferior arcuate bundles. In the present study the mean RNFL thickness of children of all the age groups=in Inferior quadrant was 145.8 μm and 144.37 μm , superior quadrant was 138.68 μm and 138.04 μm , nasal quadrant was 83.85 μm and 89 μm and temporal quadrant was 88.20 μm and 91.15 μm respectively in right eye and left eye. These values clearly shows that the distribution of RNFL thickness in our study is not in agreement with normal distribution of RNFL (I>S>N>T) around the optic nerve as has been previously reported by other authors in their study on normal children.

Therefore we divided the children into various age groups and determined the RNFL thickness. In them, we observed that in very young children, the rule is not followed strictly but in the older children, the thickness increased in both superior and temporal quadrant, finally following the ISNT rule seen in adults.

The possible explanation for that could be that ISNT rule is not applicable in children as the eyes are still developing by that age and also because RNFL thickness depends on axial length, age and optic disc area, all of which changes as the child grows. Bi-Dan Zhu *et al* also reported the similar findings as ours in 12 year old children of Chinese origin.

We also tried to look for the differences in the mean RNFL thicknesses of boys and girls, and it was found to be similar with no statistically significant difference and was in accordance with the study by Salchow *et al.*

In conclusion we would like to comment that although our study has several limitations like we did not consider the influential factors for RNFL measurements including axial length, refractive error

and optic disc size, but it surely throws some light on the normal values of retinal thickness and RNFL thickness in Indian paediatric age group. This data should definitely help in evaluation of OCT assessments performed in Indian children suspected or diagnosed to have glaucoma or other retinal or optic nerve diseases.

CONCLUSION

The normative data values of RNFL thickness in children is helpful in comparing the RNFL thickness of children having glaucoma or other Retinal or Optic nerve diseases.

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