Optic Disc Retinal Nerve Fiber Layer Thickness in Normal Paediatric Population of Central India

Ojha Sushil, Sharma Reena, Tandon Anupama, Shukla Dipendra, Jain Vaibhav, Singh Brijesh and Babbar Meenu

1Department of Ophthalmology, UPRIMS and R, Saifai, Etawah, UP, India.

Authors’ contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Purpose: Optic disc retinal nerve fiber layer thickness in normal paediatric population of central India.

Materials and Methods: It is a observational cross sectional study done at UPRIMS AND R (Uttar Pradesh Rural Institute of Medical Sciences and Research) Saifai, Etawah. The study was done to detect normative optical coherence tomography database for paediatric population in central Indian region. The total of 59 normal Indian children (117 eyes) after thorough ocular examination were enrolled from eye out patient department (OPD). The optic disc retinal nerve fiber thickness was measured using cirrus high definition optical coherence tomography (OCT).

Inclusion Criteria: Children with normal 6/6 visual acuity, any child of any age 5-17 years but cooperative for doing OCT.

Exclusion Criteria: Children with high refractive error (myopia more than -5 D or hypermetropia more than +3 D, astigmatism more than 2), amblyopia, vascular disorder, neurological disorder, metabolic disorder or corneal pathology and optic disc abnormality were excluded. Most of cases

*Corresponding author: E-mail: drsushilojha@gmail.com;
both eyes were examined by OCT and selected for normative database calculation. We also further tried to analyse the sex and different age subgroups has any significant difference or not.

**Results:** The mean global RNFL thickness in was 91.36±13.09 µm (range was from 48 µm-144 µm). The mean global retinal nerve fiber layer (RNFL) thickness in males was 92.75±15.107 µm (range 48-144 µm) and that in females was 89.98±11.080 µm (range 68-101 µm) and difference in RNFL thickness between males and females was not statistically significant (p=0.193). The retinal nerve fiber layer was thickest inferiorly (123.5±19.56 µm), superiorly (112.7±25.16 µm), thinner nasally (68.95±13.24 µm) and thinnest temporally (66.36±12.97 µm). In correlation analysis age is not found to have any statistically significant difference between age subgroups (p=0.07).

**Conclusion:** In conclusion we tried to analyse the normative database on OCT for RNFL thickness in paediatric age in rural population of central India. The average RNFL thickness noted in our study is less than reported in literature may be due to regional difference in RNFL or different OCT model or different software version or may be due to high likelihood of malnutrition in rural Indian children. The data obtained from the study would help in OCT evaluation for Optic disc pathologies, diagnosed glaucoma and glaucoma suspect. The Study would further help in characterising OCT scan to be normal or pathological if it lies outside the 2 standard deviation obtained in our study in children of central India.

**Keywords:** Indian children; normative database on OCT; retinal nerve fiber layer.

1. **INTRODUCTION**

Optical coherence tomography is a modality to detect in vivo cross sectional image of retina and nerve fiber layer around the disc. Its non-invasive and non-contact imaging modality for the retina and optic disc. It can detect ultra-structural view of all the 10 layers of retina and retinal nerve fiber layer thickness around disc with micrometre scale sensitivity [1].

OCT can be useful for the diagnosis and follow up of patients with retinal disorder and glaucoma [2,3,4]. The ability of OCT to diagnose the retinal disorders and disc abnormality has been proven in different studies [5,6]. The importance is further increased by giving repeated results without much interobserver variability [5,6].

The normative database already exist for retinal nerve fiber thickness across different age distributions, geographical locations and ocular disorders for adults more than 18 years of age [7-11]. Different studies have shown that RNFL thickness changes with age, geographical locations and race [9-11]. The normative database for RNFL in adults already been measured in different studies with OCT [7-8], but normative database for children still not yet established. The published studies on normative database for children are limited due to consideration of different age groups or different races.

The normative database of RNFL on OCT for children in India is not yet established. With this study we tried to find out normative database of RNFL in children which will help as ancillary investigation for detection of various childhood ocular disorders.

1.1 **Ethical Clearance**

Permission from the Institutional ethical committee was taken. Informed consent from parents or guardians was taken before the scans.

2. **MATERIALS AND METHODS**

It is a observational cross sectional study done at UPRIMS AND R (Uttar Pradesh Rural Institute of Medical Sciences and Research) Saifai, Etawah. The study was done to detect normative optical coherence tomography database for paediatric population in central Indian region. The total of 59 normal Indian children (117 eyes) after normal ocular examination were enrolled from eye OPD.

The optic disc retinal nerve fiber thickness was measured using cirrus high definition optical coherence tomography (OCT).

2.1 **Inclusion Criteria**

Children with normal 6/6 visual acuity, any child of any age 5- 17 years but cooperative for doing OCT.

Cup disc ratio less than 0.7 and disc asymmetry between two eyes is less than 0.2.
2.2 Exclusion Criteria

- Children with strabismus or amblyopia
- Family history of glaucoma
- Any hereditary eye disease
- History of intraocular surgery or any kind of laser therapy,
- Mentally challenged children with neurological, metabolic, vascular disorders,
- Other systemic disease possibly affecting the eye, presence of a media opacity,
- Best corrected visual acuity of less than 6/9, hypermetropia more than + 3 D, myopia more than –5 D, or astigmatism more than 2 D were also excluded.

Most of cases both eyes were examined using OCT and selected for normative database calculation. We also further tried to analyse the sex and different age subgroups has any significant difference or not.

The subjects enrolled had no ocular visual problems. The children came for routine eye examination in Ophthalmology OPD or paediatrics OPD or brother of patient or cousin of patient were enrolled when they met the inclusion and exclusion criteria.

The complete Ophthalmological examination was done in all children’s. The complete ophthalmic examination included BCVA (Best Corrected Visual Acuity), IOP (Intraocular Pressure on Goldmann applanation tonometry), slit lamp anterior segment examination, assessment of squint by cover uncover and dilated posterior segment examination with slit lamp using 90 D or Indirect ophthalmoscopy.

Dilatation of pupil were done with tropicamide 1% for posterior segment examination. If required cycloplegia was done using homatropine or cyclopentolate (1% or 2%). The RNFL thickness measured with OCT after dilation of pupil with tropicamide 1%. The OCT machine used was Stratus OCT, software version 4.0.4, Carl Zeiss, Dublin, CA. The OCT uses partial coherence interferometry using wavelength of 840 nm to obtain for obtaining cross sectional image and achieves axial resolution of 5 µm and scanning rate of 27 kHz. OCT is the very good diagnostic tool which has very high intra-observer and inter-observer reproducibility [5,6]. OCT reading is not affected by pupillary diameter or optical aberrations, but in our study we used only dilated pupil for measurement on OCT scans, as children are not very cooperative for the examination [12]. The RNFL measurements were done using fast OCT scan protocol [3,4 protocol], this consist of a circular OCT scan pattern in which diameter taken is 3.46 mm for eyes with normal range axial length and refraction 0 diopter. Each OCT scan involves 256 A scans in a circular manner around optic disc. Three such circular OCT scan were performed around optic disc. The average RNFL obtained after the three reading is used for the final calculation.

All OCT scans were performed by the author himself. The internal fixation target was given in all children for scan and the proper centration was observed using inbuilt infrared sensitive live camera view before taking OCT scan on computer monitor. The OCT scan is taken only if they were not having any artefacts and signal strength more than or equal to 7. Mean RNFL thickness is measured in µm by a circle around the disc, mean RNFL for each quadrant, each clock hours is calculated by the OCT machine. The sectors were also defined in both eyes clockwise for the right eye and anticlockwise for the left eye:

The areas named as per the clock hours as below:

1- superior-nasal, 2- nasal-superior, 3- nasal, 4- nasal-inferior, 5- inferior-nasal, 6- inferior, 7- inferior-temporal, 8- temporal-inferior, 9- temporal, 10- temporal-superior, 11- superior temporal, and 12- superior.

Mean age of the children included in this study have been shown in Table 1.

2.3 Statistics

Both eyes of every subject were selected for statistical analysis. The Univariate and multivariate progression analysis were used to detect the effect of sex and progression of age in

<table>
<thead>
<tr>
<th>Sex</th>
<th>N</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>Std. error mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>M</td>
<td>71</td>
<td>11.21</td>
<td>2.762</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>46</td>
<td>9.48</td>
<td>2.795</td>
</tr>
</tbody>
</table>
different age subgroups. The right eye and left eye compared using paired t-test. Comparison between different eyes (right and left) were performed using paired t-test. The comparison of variability due to sex, unpaired t-test performed and chi-square test were conducted.

3. RESULTS

3.1 Demographics

70 subjects consented for the study. Out of these 5 (7.1%) were uncooperative and scan could not be done in them. One (1) subject had leucomatous corneal opacity in the left eye. 12 (9.3%) scans out of 129 were excluded because of poor scan quality. So a total of 59 children (117 eyes) were included in statistical analysis. There was no statistically significant difference between male and female average RNFL, despite having higher male in the study (36 male and 23 female).

3.2 RNFL Thickness

The mean global RNFL thickness in was 91.36±13.09 µm (range was from 48 µm-144 µm). The mean global RNFL thickness in males was 92.75±15.107 µm (range 48-144 µm) and that in females was 89.98±11.080 µm (range 68-101 µm) and the difference was not statistically significant (p=0.193). This data has been shown in Fig. 1 (histogram). The average RNFL thickness measured on OCT was thickest inferiorly followed by superior, nasal and then temporal as seen in adults. RNFL was thickest inferiorly (123.5±19.56 µm) and superiorly (112.7±25.16 µm), thinner nasally (68.95±13.24 µm), and thinnest temporally (66.36±12.97 µm). In correlation analysis, age had no statistically significant (P =0.0702) effect on RNFL thickness.

The mean global RNFL thickness in was 91.36±13.09 µm (range was from 48 µm-144 µm). The mean RNFL reported by Neelam Pawar from south India was 106.11±9.50 µm. The lower mean RNFL reported may be because of regional difference in RNFL thickness or malnutrition in rural central India or difference in model of OCT machine or different version of software use. The Table 2 compares the mean RNFL thickness our study with different studies available in literature in paediatric age group.

4. DISCUSISION

OCT is a non-invasive and non-contact miraculous diagnostic modality based on principle of low-coherence interferometry which measures the intensity difference between backscattered, back reflected light and the echo time delay from the internal microstructure of biologic tissues.

It allows cross sectional high definition imaging of retina and optic disc. With the advent of this investigative procedure, we are able to diagnose many retinal and optic disc disorders. The major role is evolved only after having normative database of macula and optic disc from normal healthy individuals feeded in the machine. The optic disc and RNFL thickness measurement for normative database is reported in previous studies [13-15]. But there is very limited data available for paediatric age group. The reported studies done so far in healthy eyes of children cannot be generalised as they include single age subgroup or one race. Cheung CY et al. [16] reported that appropriate signal strength necessary for the evaluation of OCT scans. The OCT signal strength may be affected by obscuration in optical axis before retina like cataract, corneal opacity and vitreous opacity [16]. In our study we have not included any child with media opacities. During RNFL analysis we have excluded 12 eyes out of 129 eyes (9.3%) due to poor signal strength. So, we can conclude that even after following strict inclusion and exclusion criteria around 9.3% scan were of low signal strength proves that, getting a good quality OCT scan in children requires experience in dealing with children and optimized image before capturing OCT scan.

The normative database of OCT is normally feeded only for the individuals more than 18 years, which limits its widespread application in childhood disorders.

The mean global RNFL thickness in was 91.36±13.09 µm (range was from 48 µm-144 µm). The mean RNFL reported by Neelam Pawar from south India was 106.11±9.50 µm. The lower mean RNFL reported may be because of regional difference in RNFL thickness or malnutrition in rural central India or difference in model of OCT machine or different version of software use. The Table 2 compares the mean RNFL thickness our study with different studies available in literature in paediatric age group.

The mean RNFL thickness measured in present study in males was 92.75±15.107 µm (range 48-144 µm) and that in females was 89.98±11.080 µm (range 68-101 µm) which is lesser than that reported in other studies done for assessment of paediatric RNFL (Table 2). There was no statistically significant difference between male and female average RNFL, despite having higher male in the study (36 male and 23 female). This difference might be due to the higher prevalence of malnutrition in our subjects which is expected in rural Indian population and also the difference in the versions of devices used or due to different algorithms used for analysis.
The RNFL thickness in present study showed inferior rim to be thickest which is followed by superior, nasal and lastly temporal, which is in accordance with published reports in literature for children [17], and pattern of RNFL thickness is similar to that of adult [3,5].

Table 2. Showing various studies done for RNFL with OCT on normal subjects

<table>
<thead>
<tr>
<th>Author</th>
<th>Ethnicity</th>
<th>Number of subjects</th>
<th>Age (years) (mean±SD)</th>
<th>Mean RNFL thickness (Mean±SD)</th>
<th>OCT version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Our study</td>
<td>Rural central Indian</td>
<td>59</td>
<td>5-15</td>
<td>91.36±13.09</td>
<td>Cirrus hd OCT</td>
</tr>
<tr>
<td>Gupta et al. [20]</td>
<td></td>
<td>18</td>
<td>6-13</td>
<td>100±2.64</td>
<td>Not mentioned</td>
</tr>
<tr>
<td>Parikh et al. [11]</td>
<td>Asian Indian</td>
<td>59</td>
<td>5-20</td>
<td>100.15±10.8</td>
<td>Stratus oct</td>
</tr>
<tr>
<td>Ahn et al. [17]</td>
<td>Korean</td>
<td>72</td>
<td>9-18</td>
<td>105.53±0.33</td>
<td>Stratus oct</td>
</tr>
<tr>
<td>Turk et al. [19]</td>
<td>Turkish</td>
<td>107</td>
<td>6-16</td>
<td>106.45±9.41</td>
<td>Spectralis oct</td>
</tr>
<tr>
<td>Neelam Pawar et al. [21]</td>
<td>Indian</td>
<td>120</td>
<td>5-17</td>
<td>106.11±9.5</td>
<td>Stratus oct</td>
</tr>
<tr>
<td>Huynh et al. [6]</td>
<td>White and East Asian</td>
<td>1765</td>
<td>6</td>
<td>103.7±11.4</td>
<td>Stratus oct</td>
</tr>
<tr>
<td>Leung et al. [22]</td>
<td>Hong kong</td>
<td>97</td>
<td>9.75</td>
<td>113±9.8 RE 113.1 LE</td>
<td>Stratus oct</td>
</tr>
</tbody>
</table>

The mean RNFL thickness measured in present study is not affected by different age groups. The mean RNFL for males was slightly greater than that for females. Age had no statistically significant (P =0.0702) effect on RNFL thickness.
The mean RNFL thickness measured from different OCT models can also vary as reported by Seibold LK [18]. The difference can also be seen in different models of spectral domain OCT [18-19]. Hence, we can conclude that use of different technologies in different models may be responsible for the difference in our results and that published in literature on mean RNFL thickness before. The proposed hypothesis for the difference in the mean RNFL between different models may be due to different software algorithms for measurement of RNFL.

The RNFL can be correlated with increasing age and change in axial length. However, in the present study we have excluded higher refractive errors, so we did not consider effect of refraction, axial length and optic disc size [15]. In literature its reported that for the every 1 mm increase in axial length the average RNFL decreases by 2.2 µm and for every 10 year increase in age causes decrease in average RNFL thickness by 2 µm [10].

5. LIMITATION

The study is conducted in children of rural India only. So, its not representation of general population. So, generalised use of normative database is questionable. But it can be useful for the rural children and making gross evaluation of RNFL in Indian children.

Another limitation was axial lengths were not calculated in the children.

As per our inclusion criteria, higher refractive error children (hypermetropia > +3 D, myopia >-5 D and astigmatism >2 D) were excluded, so its application in all children cannot be extrapolated.

6. CONCLUSION

In conclusion tried to analyse the normative database on OCT for RNFL thickness in paediatric age in rural population of central India.

The average RNFL thickness noted in our study is less than reported in literature may be due to regional difference in RNFL or different OCT model or different software version or may be due to high likelihood of malnutrition in rural Indian children.

The data obtained from the study would help in OCT evaluation for Optic disc pathologies, diagnosed glaucoma and glaucoma suspect.

The Study would further help in characterising OCT scan to be normal or pathological if it lies outside the 2 standard deviation obtained in our study in children of central India.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES


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