RETINAL NERVE FIBER LAYER THICKNESS IN NON-GLAUCOMATOUS PAKISTANI CHILDREN

Irfan Ullah, Sorath Noorani, Yousaf Jamal Mahsood, Sumaira Altaf

[1,2,4] Department of Pediatric Ophthalmology and Strabismus, Al-Shifa Trust Eye Hospital, Rawalpindi - Pakistan.
[3] Department of Ophthalmology, Khyber Girls Medical College, Hayatabad Medical Complex, Peshawar - Pakistan.
Address for correspondence:
Dr. Irfan Ullah
Registrar,
Department of Pediatric Ophthalmology and Strabismus,
Al-Shifa Trust Eye Hospital,
Rawalpindi - Pakistan.
Email: drirfankhattak85@gmail.com
Date Received:
November 11, 2018
Date Revised:
October 08, 2019
Date Accepted:
October 16, 2019

ABSTRACT

Objective: To find out the normal retinal nerve fiber layer thickness in Pakistani children and create a normative data.

Methodology: This descriptive cross sectional study was carried out at the Department of Pediatric Ophthalmology and Strabismus, Al-Shifa Trust Eye Hospital, Rawalpindi. The subjects were thoroughly examined by consultant pediatric ophthalmologist including slit-lamp examination, intraocular pressure (IOP) measurement, central corneal thickness (CCT) by handheld pachymeter and cycloplegic refraction. Those subjects who fulfilled the inclusion criteria were then sent for peripapillary retinal nerve fiber layer (RNFL) analysis by using spectral domain optical coherence tomography. RNFL thickness of 4 sectors were recorded and used for analysis which were temporal (T), nasal (N), superior (S) and inferior (I). Global (G), temporal superior (TS), temporal inferior (TI), nasal superior (NS) and nasal inferior (NI) were also included.

Results: A total of 106 eyes of 53 subjects were included in the study. Male were 28 (52.8%); mean age, IOP and CCT were 10.78± 2.61 years, 13.11 ±2.3 mm Hg and 542.31 ±43.9 microns respectively. Mean RNFL-Global was 101.25 microns with male having more thickness as compared to females (103.7 ±10.15 versus 99.87 ±8.47), p =0.17.

Conclusion: Mean RNFL-Global was 101.25 microns with male having more thickness as compared to females but not significant. These results can be used as reference when evaluating the normal values of RNFL in our pediatric population.

Key Words: Retinal nerve fiber layer, Glaucoma, Intraocular pressure, Normative values

This article may be cited as: **Ullah I, Noorani S, Mahsood YJ, Altaf S. Retinal nerve fiber layer thickness in non-glaucomatous Pakistani children. J Postgrad Med Inst 2019; 33(2): 251-5.**

INTRODUCTION

Glaucoma is the disease of optic nerve, in which there is accelerated death of retinal ganglion cells (RGCs)[1]. The diagnosis of this blinding condition is based on measurement of IOP, appearance of optic disc, visual fields and retinal nerve fiber layer (RNFL) thickness. The former examinations except RNFL thickness measurement are not able to detect early damage to the optic nerve. Visual field examination can detect damage when there is substantial loss to RNFL[2,3].

Optical coherence tomography (OCT) is an objective method of RNFL thickness measurement. OCT is a noncontact, noninvasive and painless method of RNFL measurement by using low coherence interferometry principle. OCT has well established role in the diagnosis and monitoring of glaucoma in adult patient but with the advent of new spectral domain (SD) OCT, the role of OCT in the diagnosis and monitoring of pediatric glaucoma has also increased. Unfortunately, the normative data for comparison with age matched population is currently for individuals of 18 years or older[4,5].

There are published studies in different regions regarding normal RNFL thickness in children by using SD-OCT[1,2,6,7]. Until recently there is no published data in Pakistani population regarding RNFL thickness in normal children. Our study was aimed to find out the normal retinal nerve fiber layer thickness in Pakistani children and create a normative data, so that it will help in the diagnosis as well as monitoring of pediatric glaucoma.

METHODOLOGY

This observational cross-sectional study was conducted at the Department of Pediatric Ophthalmology and Strabismus, Al-Shifa Trust Eye Hospital, Rawalpindi.

The study was approved from institute's ethical review committee. Total 53 children were included in the study, who visit the hospital from school screening service or routine checkup. Consent was taken for their inclusion in the study after their parents or guardians were fully informed about the purpose of this research. Inclusion criteria were children with age 6 to 17 years, IOP ≤21 mmHg, cup-disc ratio ≤0.5 and any refractive error but best corrected visual acuity (BCVA) of 6/6 on Snellen's chart. Children having glaucoma, congenital ocular abnormalities, amblyopia, past history of ocular surgery/ trauma and family history of congenital/juvenile glaucoma were excluded from the study.

All subjects underwent vision testing (Snellen's chart), subjective/cycloplegic refraction (by an experienced optometrist). IOP measurement (Goldmann applanation Tonometer), pachymetery (Handy pachymeter SP-100, Tomey Corporation, Japan), slit lamp examination and fundus examination with 78D lens were taken by the primary author.

Optical coherence tomography (OCT) of peripapillary RNFL (3.4 diameter) was done by an experienced technician using internal fixation method while directly observing the fundus through screen (Spectralis, Heidelberg GmbH, Heidelberg Germany) using software version 6.0.9. Satisfactory quality of scan was defined with good centration and signal strength of 20 or more. The peripapillary RNFL measurement were taken automatically by SD-OCT and recorded as global (G); also its 6 sectors i.e. nasal (N), nasal superior (NS), nasal inferior (NI), temporal (T), temporal superior (TS) and temporal inferior (TI) were measured for average thickness.

RESULTS

There were 106 eyes from 53 subjects in our study. Figure 1 shows normal distribution curve of G-RNFL thickness in our study population.

Mean age in our study was 10.78± 2.61 years with male representation as 28 (52.8%) and females were 25 (47.2%). Mean IOP, CCT & CDR were 13.11 ±2.3 mm Hg, 542.31 ±43.9 microns and 0.17 ±0.09 respectively, as shown in Table 1.

When analyzed for RNFL thickness in different quadrants; inferior was thickest 128.19 ±19.32 followed by superior 125.92 ±16.05, nasal 75.81 ±15.24 and temporal 70.08 ±11.39 microns respectively, as shown in Table 2.

The mean Global thickness including both genders was 101.25 ±9.59 microns with males having thicker G-RNFL as compared to females; 103.7 ±10.15 versus 99.87 ±8.47; however when it was compared gender-wise, it was statistically non-significant (p = 0.17).

Figure 1: Distribution curve of RNFL Global thickness

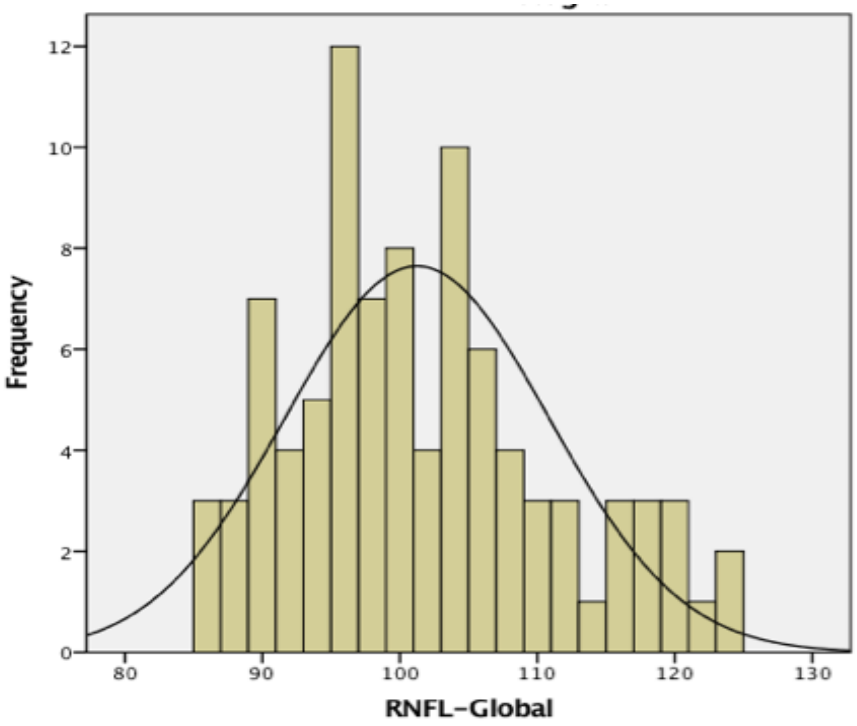

Table 1: Baseline characteristics

Age Range (years)	Minimum	Maximum	Mean	Std. Deviation
Age in Years	6	16	10.78	2.6
Intraocular Pressure in mm of Hg	9	21	13.11	2.3
Central Corneal Thickness (CCT) microns	459	654	542.31	43.9
Cup to Disc Ratio (CDR)	0.1	0.5	0.18	0.09

Table 2: Retinal nerve fiber layer (RNFL) thickness analyses

RNFL	Minimum	Maximum	Mean	Std. Deviation
RNFL-Inferior	77	191	128.19	19.3
RNFL-Inferotemporal	93	199	143.43	22.2
RNFL-Inferonasal	70	189	114.63	25.9
RNFL-Superior	82	163	125.92	16.1
RNFL-Superotemporal	91	193	136.52	20.6
RNFL-Superonasal	64	183	116.74	20.6
RNFL-Nasal	49	116	75.81	15.2
RNFL-Temporal	44	111	70.08	11.4
RNFL-Global	86	124	101.25	9.6

Table 3: Retinal nerve fiber layer (RNFL) thickness in healthy children in different populations

Study	Machine	Population	Mean Age in Years (SD)	Average RNFL in Microns (SD)
Zhu et al[7]	iVue-100	Chinese	12.34 (0.58)	103.08 (9.0)
Ahn et al[2]	Stratus OCT	Korean	12.60 (2.13)	105.53 (10.33)
Samarawickrama et al[13]	Stratus OCT	White	6.7 (0.4)	102.99
El-Dairi et al[9]	Stratus OCT	Black	8.6 (3.1)	110.7 (8.84)
Salchow et a[l3]	Stratus OCT	Hispanic	9.7 (2.7)	107.0 (11.1)
Leung et al[10]	Stratus OCT	Hong Kong Chinese	9.7	113.5 (9.8)
Qian et al[14]	Stratus OCT	Chinese	10.4 (2.7)	112.36 (9.21)
Kee et al[15]	Stratus OCT	Korean	8.5	108.8 (11.3)
Gire et al[16]	Stratus OCT	French	9.68 (3.02)	104.33 (10.22)
Parikh et al[17]	Stratus OCT	Asian Indian	11.1 (3.9)	100.15 (10.8)

DISCUSSION

There is widespread knowledge about the normative database for adults who are suspected of glaucoma used by different OCT machines for RNFL thickness. However there is little evidence in the literature about the same for population less than 18 years of age. There are few reports which have tried to provide normative database of peripapillary RNFL in healthy children but most of them have used time domain OCT (TD-OCT)[8-10]. With the advancement in OCT technology, spectral domain (SD-OCT) has proven itself to be superior to TD-OCT. With the development of SD-OCT and automated real time (ART) gaze trackers, frequency of motion artifacts has decreased which is helpful in acquiring good quality images in children. To the best of our knowledge, our study is the first one to publish normative data on RNFL thickness using SD-OCT in Pakistani children.

We followed ISNT rule during RNFL analysis and found difference in G-RNFL between males and females; however it was statistically not significant. When comparing to different studies the mean G-RNFL thickness of our children is less as compared to Turkish children which may be because of difference in ethnicity[6]. A recent study by Bansal et al[11] reported comparison of RNFL thickness in Indian children with cataracts and controls. Their average RNFL of control group was less as compared to our population. Same was reported by Al-Haddad et al[12] from Beirut, Lebanon with average RNFL in their Pediatric population less as compared to our results. Our results were close to a report by Chinese investigators in their pediatric population with their average RNFL thickness as 103.08 microns[7]. Table 4 shows different reports of RNFL thickness in different populations using different machines[2,3,7,9,10,13-17]. This shows how much variation of single parameter can occur in different populations. So, it will be wise that every population should have their own normative database which should be incorporated in the machine. The only common finding of all these studies was that RNFL thickness in different genders was not statistically significant and our study also found the same.

LIMITATIONS

Smaller sample size and correlation with other factors like axial length and refractive status should be addressed in future.

CONCLUSION

This study concludes that mean RNFL-Global was 101.25 microns with male having more thickness as compared to females but not significant. These results can be used as reference when evaluating the normal values of RNFL in our pediatric population.

REFERENCES

1. 1- Budenz DL, Anderson DR, Varma R, Schuman J, Cantor L, Savell J, Greenfield DS, Patella VM, Quigley HA, and Tielsch J. Determinants of Normal Retinal Nerve Fiber Layer Thickness Measured by Stratus OCT. Ophthalmology 2007;114(6):1046–52.
2. 2- Ahn HC, Son HW, Kim JS and Lee JH. Quantitative Analysis of Retinal Nerve Fiber Layer Thickness of Children and Adolescents. Korean J Ophthalmol 2005;19(3):195-200.
3. 3- Salchow DJ, Oleynikov YS, Chiang MF, Kennedy-Salchow SE, Langton K, Tsai JC and Al-Aswad LA. Retinal Nerve Fiber Layer Thickness in Normal Children Measured with Optical Coherence Tomography. Ophthalmology 2006;113:786-91.
4. 4- Altemir I, Pueyo V, Elia N, Polo V, Larrosa JM and Oros D. Reproducibly of Optical Coherence Tomography Measurements in Children. Am J Ophthalmol 2013;155:171-6.
5. 5- Huynh SC, Wang XY, Rochtchina E and Mitchell P. Peripapillary Retinal Nerve Fiber Layer Thickness in a Population of 6 Year Old Children. Findings of Optical Coherence Tomography. Ophthalmology 2006;113:1583-92.
6. 6- Turk A, Ceylan OM, Arici C, Keskin S, Erdurman C, Durukan AH, Mutlu FM and Altinsoy HI. Evaluation of the Nerve Fiber Layer and macula in the Eyes of Healthy Children Using Spectral-Domain Optical Coherence Tomography. Am J Ophthalmol 2012;153:552-9.
7. 7- Zhu BD, Li SM, Li H, Liu LR, Wang Y, Yang Z, Li SY, Kang MT, Fu J, Qi YH, Zhan SY and Wang N; for the Anyang Childhood Eye Study Group. Retinal Nerve Fiber Layer Thickness in a Population of 12- Year-Old Children in Central China Measured by iVue-100 Spectral-Domain Optical Coherence Tomography: The Anyang Childhood Eye Study. Invest Ophthalmol Vis Sci 2013;54:8104-11.
8. 8- Eriksson U, Holmström G, Alm A, Larsson E. A population-based study of macular thickness in full-term children assessed with Stratus OCT: normative data and repeatability. Acta ophthalmologica. 2009 Nov;87(7):741-5.
9. 9- El-Dairi MA, Asrani SG, Enyedi LB, Freedman SF. Optical coherence tomography in the eyes of normal children. Archives of Ophthalmology. 2009 Jan 12;127(1):50-8.
10. 10- Leung MM, Huang RY, Lam AK. Retinal nerve fiber layer thickness in normal Hong Kong Chinese children measured with optical coherence tomography. Journal of glaucoma. 2010 Feb 1;19(2):95-9.
11. 11- Bansal P, Ram J, Sukhija J, Singh R, Gupta A. Retinal nerve fiber layer and macular thickness measurements in children after cataract surgery compared with age-

matched controls. American journal of ophthalmology. 2016 Jun 1;166:126-32.

12. 12- Al-Haddad C, Barikian A, Jaroudi M, Massoud V, Tamim H. Spectral domain optical coherence tomography in children: normative data and biometric correlations. BMC ophthalmology. 2014 Dec;14(1):53.

13. 13- Samarawickrama C, Wang JJ, Huynh SC, Pai A, Burlutsky G, Rose KA, Mitchell P. Ethnic differences in optic nerve head and retinal nerve fibre layer thickness parameters in children. British Journal of Ophthalmology. 2009 Oct 12:bjo-2009.

14. 14- Qian J, Wang W, Zhang X, Wang F, Jiang Y, Wang W, Xu S, Wu Y, Su Y, Xu X, Sun X. Optical coherence tomography measurements of retinal nerve fiber layer thickness in chinese children and teenagers. Journal of glaucoma. 2011 Oct 1;20(8):509-13.

15. 15- Kee SY, Lee SY, Lee YC. Thicknesses of the fovea and retinal nerve fiber layer in amblyopic and normal eyes in children. Korean Journal of Ophthalmology. 2006 Sep 1;20(3):177-81.

16. 16- Gire J, Cornand E, Fogliarini C, Benso C, Haouchine B, Denis D. Retinal nerve fiber layer in OCT 3: prospective study of 53 normal children. Journal francais d'ophtalmologie. 2010 Sep;33(7):444-9.

17. 17- Parikh RS, Parikh SR, Sekhar GC, Prabakaran S, Babu JG, Thomas R. Normal age-related decay of retinal nerve fiber layer thickness. Ophthalmology. 2007 May 1;114(5):921-6.

CONTRIBUTORS

IU conceived the idea, planned the study, wrote protocol and manuscript of the study. SN critically appraised the manuscript and helped collecting and analyzing the data. MTK appraised and approved the initial manuscript, supervised the data and carried out editing. YJM and SA carried out literature search after reading the proposal, helped in collection of data and correction of references. All authors contributed significantly to the submitted manuscript.