Research Article

Optic Disc Parameters by Spectral Domain Optical Coherence Tomography: Normative Values and Associations in Adult Emmetropic, Myopic and

Nadia Akhtar[1], **Ayisha Kausar**[2]

[1]*Assistant Professor of Ophthalmology, Federal Medical and Dental College Islamabad, Federal General Hospital Islamabad*[1,2]*Associate Professor of Ophthalmology, Shifa College of Medicine Islamabad, Shifa Tameer e Millat University Islamabad. Shifa International Hospital.*

Abstract

Objectives: To study the optic disc parameters in adult emmetropic, myopic and hypermetropic Pakistani population eyes using Topcon spectral domain optical coherence tomography (SD-OCT) and its variation with refractive error and axial length.

Methods: This cross sectional study was carried out in Ophthalmology Department of Shifa Foundation Falahee Clinic after approval from Ethical Committee and IRB, over a period of one year starting from January 2016. A total of 93 eyes (including 35 myopes 29 emmetropes and 29 hypermetropes) of 93 patients were enrolled, and autorefraction, axial length measurements and optic disc analysis done. Various optic disc parameters were obtained using Topcon SD OCT. A definable optic cup was absent in 9.68% (n=9) of the patients so they were excluded. One-way ANOVA was applied to compare the variables amongst three groups after adjustment for ocular magnification by using Littman's formula. Pearson correlation coe cients (r) were measured to establish the relationship of the optic disc parameters with axial length and disc area.

Results: The study included 51.2% males (n=43) and 48.8% (n=41) females. Mean age was 30.82±8.01years. Mean±SD of cup-disc ratio was 0.33±0.14 and disc area was 2.24±0.44mm^2. Statistically significant di erence was found among the three groups in disc area (p=0.001). No correlation was observed between disc parameters and axial length except for the linear and vertical CDR. Positive correlation was observed between disc area and various disc parameters.

Conclusions: This study provides normal values for the optic disc parameters in healthy adult Pakistani eyes as measured by OCT. We also report that optic disc parameters are significantly associated with refractive error, axial length and disc area.

Received | 27-04-2018: **Accepted** | 15-02-2019

Corresponding Author | Dr. Nadia Akhtar, Assistant Professor of Ophthalmology, Federal Medical and Dental College Islamabad, Federal General Hospital Islamabad., FANA Global Consultancy and Business Limited (UK)

Email: drnadiaakhter@yahoo.com

Keywords | Optical coherence tomography, Refractive errors, Optic disc, Glaucoma, Axial length

Introduction

The importance of optic disc assessment in diagnosis of optic neuropathies cannot be overlooked. The quantitative parameters of optic disc including cup-disc ratio, area and volume of cup and disc are valuable for early detection of glaucoma thus helping us to identify diseased nerves and those at risk of disease.[1]

Optical coherence tomography (OCT) is an imaging modality whose value for diagnosing and monitoring the diseases related to optic nerve and retina cannot be under estimated [2]. With newer spectral domain SD-

OCT, it is now possible to get rapid and reproducible measurements of the optic disc.[3,4] However it is known that certain factors related to ocular structure and demographic factors can a ect the ability of OCT to quantify disc parameters.[5,6]

Optic disc parameters measured in various groups have shown racial di erences.[7,8] However, there is limited information of these parameters in Pakistani population and variations with refraction and axial length of the eye have not been studied as yet. Influence of refractive status and axial length on optic disc may be relevant for managing di erent optic nerve pathologies including glaucoma.

We aim to find out the normal values of optic disc parameters in a healthy non-glaucomatous Pakistani population and their variation with refractive state and axial length using Topcon SD 1-maestro OCT in our clinical setting.

Methods

This cross sectional study was started after approval from Institutional Review board and Ethics Committee. Patients were recruited from eye clinic of Shifa Falahee Community Health Centre over a period of 1 year from January to December 2016 using convenience sampling technique. A total of 93 eyes of 93 patients (including 29 emmetropes, 29 hypermetropes and 35 myopes) older than 18 years of age, both males and females and having best corrected vision 6/6 were included. Eyes having astigmatism >2.00 dioptre, amblyopia, strabismus, corneal, retinal and optic nerve pathologies (including glaucoma and ocular hypertension) and prior history of ocular surgery or trauma were excluded. Verbal Informed consent was taken from all the patients. After detailed history, visual acuity, auto refraction, applanation tonometry and complete examination of anterior and posterior segment (using slit lamp) was done.

Refractive errors were measured by spherical equivalent (SE) via autorefraction. Axial lengths were noted using A-scan (Quantal medical axis-11). An average of 3 measurements was taken. Various optic disc parameters like area of disc, cup and rim , cup to disc area ratio (CDR), vertical and horizontal CDR, cup and rim volume, vertical and horizontal disc diameter were obtained using Topcon SD OCT. All OCT examinations were performed by single examiner. We used Littmann's formula[9,10] to correct ocular magnification induced by refractive error.

Statistical analysis was done using SPSS 20.0. Frequency and percentage was calculated for gender and was compared by Chi square test. After applying Kolmogorov-Smirnov test for normal distribution, mean ±SD was calculated for age, SE, axial length and parameters of disc. Levene's test was applied to evaluate the homogeneity of the variances. One-way ANOVA was applied to compare the variables amongst three groups. A p-value of <0.05 was taken as statistically significant. Pearson correlation coe - cients (r) were measured to establish associations of disc parameters with axial length and area of the disc.

Results

A total of 93 eyes of 93 patients were enrolled in the study, 9.68% (n=9) of the patients were excluded as a definable optic cup was absent in these patients. Remaining 84 eyes [42(50%) right & 42(50%) left eyes] were analysed. The study population included 36.9 %(n=31) myopes, 29.8% (n=25) hypermetropes and 33.3% (n=28) emmetropes.

Mean age of study population was 30.82±8.01years (range 17-47years). The mean age in the emmetropic group was significantly younger than the other 2 groups. The di erence of age between the myopic and hypermetropic group is not significant (p=0.397).

Table 1 shows the demographic and clinical variables of the groups.

Mean value of axial length was 23.15±1.13mm.

Table 1: *Demographic and Clinical Variables of the Groups (Mean±SD and Percentages)*

Characteristic	Myopic eyes (n=31)	Hypermetropic eyes (n=25)	Emmetropic eyes (n=28)
Age (years)	31.87±7.01	33.80±9.86	27.00±5.61
Gender Male 51.2%(n=43)	45.2%(n=14)	32.0%(n=8)	75.0%(n=21)
Female 48.8%(n=41)	54.8%(n=17)	68.0%(n=17)	25.0%(n=07)
SE (diopters)	-3.58±1.86	2.37±2.28	-0.17±0.23
Axial length(mm)	24.48±0.85	22.71±1.01	23.16±0.66
Intraocular pressure IOP (mmHg)	12.45±1.43	11.92±1.78	12.14±1.33

Table 2: *The Mean Values of the Optic Disc Parameters of the Groups (Mean±SD) (After Applying Littmann'sFormula)*

Optic Disc Parameters	Total (n=94)	Myopia (n=31)	Hyperopia (n=25)	Emetropia (n=28)	p-value
Disc area (mm^2)	2.24±0.44	2.05±0.37	2.23±0.37	2.47±0.44	0.001
Cup area (mm^2)	0.81±0.50	0.77±0.58	0.67±0.35	0.98±0.49	0.060
Rim area (mm^2)	1.53±0.69	1.55±1.03	1.56±0.38	1.48±0.37	0.894
Cup to disc area ratio(CDR)	0.33±0.14	0.33±0.15	0.28±0.12	0.37±0.14	0.072
Linear CDR	0.56±0.14	0.57±0.14	0.51±0.13	0.59±0.13	0.062
Vertical CDR	0.56±0.14	0.58±0.12	0.51±0.13	0.59±0.15	0.068
Cup volume (mm^3)	0.16±0.13	0.15±0.15	0.13±0.11	0.20±0.13	0.118
Rim volume (mm^3)	0.47±0.26	0.46±0.30	0.53±0.24	0.43±0.22	0.379
Horizontal disc diameter (mm)	1.61±0.31	1.62±0.46	1.57±0.20	1.64±0.17	0.655
Vertical disc diameter (mm)	1.80±0.26	1.78±0.37	1.76±0.19	1.87±0.16	0.288

Mean intraocular pressure was 12.19±1.51 mmHg. The di erence in IOP between three groups is insignificant statistically (p=0.420). SE and axial length were statistically di erent between the three groups (p-value 0.000 for both).

Table 2 shows Mean±SD of the optic disc parameters.

Mean CDR was 0.33±0.14 and mean disc area was 2.24±0.44mm^2 (ranging from 1.29-3.61mm^2) for total population.

The disc area did not show statistically significant di erence with age on an independent sample t-test (p=0.290) and with gender on Chi square test (p= 0.265).

We observed statistically significant di erence among the three groups for disc area (p=0.001) after applying Litmann's formula (table 2). All other optic disc parameters were found to be similar in the three groups.

No correlation between optic disc parameters and axial length was established in our study except for the linear and vertical CDR (table 3). Positive correlation was found for the linear and vertical CDR with axial length. The disc area was positively correlated with the cup area (r=0.467, p=0.000), linear CDR(r=0.296, p=0.006), vertical CDR(r=0.253, p=0.020), cup disc area ratio(r=0.327, p=0.002), cup volume (r=0.459, p=0.000) and horizontal(r=0.371, p=0.001) and vertical diameter of the disc(r=0.517, p=0.000).

Table 3: *Correlations between Optic Disc Parameters and Axial length in Study Subjects after Applying Litmann's Formula*

Optic Disc Parameters	Axial length Correlation coe cient r	p-value
Disc area (mm^2)	-0.114	0.300
Cup area (mm^2)	0.090	0.415
Rim area (mm^2)	0.039	0.722
Cup to disc area ratio(CDR)	0.141	0.200
Linear CDR	0.254	0.020
Vertical CDR	0.302	0.005
Cup volume (mm^3)	0.002	0.988
Rim volume (mm^3)	-0.032	0.772
Horizontal disc diameter (mm)	0.182	0.097
Vertical disc diameter (mm)	0.112	0.309

Discussion

In the present study, we document normal values for optic disc parameters using Topcon SD-OCT in healthy non-glaucomatous Pakistani eyes. We found that the optic disc parameters were normally distributed. Dagdelen K[11] assessed optic disc parameters of patients with primary open angle glaucoma and ocular hypertension and compared them with healthy individual using Cirrus OCT. Their values for healthy eyes (mean age 59.10±10.41 years) were disc area 1.98±0.33 mm^2, rim area 1.40±0.28mm^2 and CDR 0.50 ± 0.15. Another study[12] using Cirrus OCT examined 51 healthy eyes and found mean value of 1.89 ± 0.36 mm^2 for disc area. These values are lower than our values which may be due to di erence in age group studied and OCT used.

According to Kiziloglu OY[13] mean disc area was 2.30 ± 0.42 mm^2 and cup to disc area ratio was 0.20 ± 0.13. These values agree closely with our study although their age group was younger.

In another study by Mansoori T et al.[14], their mean

values were disc area 3.36 ± 0.64 mm^2 (range 2.13–5.08 mm^2), rim area 2.49 ± 0.58 mm^2 (range 1.20–3.62 mm^2), and cup area 1.10 ± 0.75 mm^2 (range, 0–3.07 mm^2). These values are higher than our study and the study by Dacosta S[11] which can be attributed to include a large number of eyes having large disc areas in their study as shown by the range.

In another study[15] optic disc parameters were measured in myopic subject (SE−4.91 ± 2.03DS), mean values were disc area 1.98 ± 0.50 mm^2 and rim area 1.49 ± 0.30 $mm.^2$ These values agree closely with our values for myopic patients with similar SE.

Studies that used Cirrus OCT for measuring optic disc parameters have reported di erent values. Most likely these variations are due to di erent scan patterns, software algorithms and display scans of Topcon OCT as compared to Cirrus OCT.

Knight et al.[8] reported: Mean disc area 1.81 mm^2 and rim area1.32 mm^2, these values are less than our documented values. This may be possible due to di erence in age (18–84 years) and use of di erent OCT (Cirrus OCT). Value for CDR (0.47) was however higher to our study.

AttaAllah[16] analysed optic discs of 86 myopic and 92 healthy eyes using Cirrus OCT. They reported lesser values for disc and rim areas (1.83±0.35 mm^2 and 1.27 mm^2 respectively) and greater values for CDR (0.51±0.16) as compared to our study.

In the present study positive correlation was observed between disc area and other disc parameters. This is in accordance with Knight et al.[8] where rim area (r = 0.15), average CDR (r=0.33), vertical CDR (r=0.33), and cup volume (r=0.37) were moderately associated with disc area.

Mansoori T[14] found that the disc area was positively correlated with other parameters like the rim and cup area, cup disc area ratio, both vertical and horizontal, mean and maximum cup depth (P < 0.001).

We did not observe any correlation between optic disc parameters and axial length (after correction for magnification e ect). This is in agreement with other studies like Savini G[17] who measured disc and rim area in 45 eyes with Cirrus OCT and documented that disc (r=−0.74, r2=0.54, p<0.0001) and rim area (r=−0.41, r2=0.17, p=0.0051) decreased with increased axial lengths. But this relationship disappeared after applying Littman formula. Studies discussed below did not correct the parameters for e ect of ocular magnification and found a negative correlation of optic disc parameters with axial length. Knight et al.[8] found weak but statistically significant correlations of axial length with disc parameters. Disc area (r=−0.29; P<.001) and rim area (r=−0.24; P<.001). Nagaoka N[18] reported that disc and rim area increased significantly with axial length (correlation coe cient: 0.45).

In the present study we did not find significant e ect of gender or age on disc area and this is in accordance with Knight et al.[8] Zeried FM noticed similar results for age of normal patients.[19] However Mansoori[14] and Poon et al reported that optic disc parameters varied with age.

The strengths of our study include the use of a spectral domain OCT, standardized examination protocols, a relatively uniform sample and use of Littman's formula. Possible limitations include relatively small sample size and limited range of spherical equivalent considered. However, the study provides baseline data on optic disc measurements in Pakistani eyes. Therefore, it is recommended that studies with larger sample size and with a wider range of spherical equivalent be conducted in future.

Conclusion

We have reported normal values for optic disc parameters in healthy Pakistani eyes as measured by Topcon SD-OCT. We further document that optic disc parameters are significantly associated with axial length, refractive error and disc area. The latest available OCT devices have built-in software to correct the e ect of refractive error and axial length which should be taken into account to enhance the diagnostic accuracy of these devices.

Ethical Approval: Given
Conflict of Interest: None
Funding Source: None

References

1. Vonor K, Ayéna KD, Maneh N, Nononsaa KB, Amédomé KM, Dzidzinyo K, et al. Optic disc features on OCT in glaucomatous and normal black

Africans. J Fr Ophtalmol. 2018;41(9):847-51.
2. Mwanza JC, Budenz DL. Optical coherence tomography platforms and parameters for glaucoma diagnosis and progression. Curr Opin Ophthalmol. 2016;27(2):102-10.
3. Pawar N, Maheshwari D, Ravindran M, Ramakrishnan R. Interocular symmetry of retinal nerve fiber layer and optic nerve head parameters measured by Cirrus high-definition optical coherence tomography in a normal pediatric population. Indian J Ophthalmol. 2017; 65(10): 955-62.
4. Suh MH, Yoo BW, Park KH, Kim H, Kim HC. Reproducibility of spectral-domain optical coherence tomography RNFL map for glaucomatous and fellow normal eyes in unilateral glaucoma. J Glaucoma. 2015;24(3):238-44.
5. Shin HY, Park HY, Park CK. The e ect of myopic optic disc tilt on measurement of spectral-domain optical coherence tomography parameters. Br J Ophthalmol. 2015;99(1):69–74.
6. Yapp M, Rennie G, Hennessy MP, Kalloniatis M, Zangerl B. The impact of optic nerve and related characteristics on disc area measurements derived from di erent imaging techniques. PLoS One. 2018; 13(1):e0190273.
7. Chansangpetch S, Huang G, Coh P, Oldenburg C, Amoozgar B, He M, et al. Di erences in Optic Nerve Head, Retinal Nerve Fiber Layer, and Ganglion Cell Complex Parameters Between Caucasian and Chinese Subjects. J Glaucoma. 2018;27(4):350-56.
8. Knight OJ, Girkin CA, Budenz DL, Durbin MK, Feuer WJ; Cirrus OCT Normative Database Study Group. E ect of race, age, and axial length on optic nerve head parameters and retinal nerve fiber layer thickness measured by Cirrus HD-OCT. Arch Ophthalmol. 2012;130(3):312-18.
9. Kazunori Hirasawa, Nobuyuki Shoji, Yukako Yoshii, Shota Haraguchi; Comparison of Kang's and Littmann's Methods of Correction for Ocular Magnification in Circumpapillary Retinal Nerve Fiber Layer Measurement. Invest Ophthalmol Vis Sci. 2014; 55(12): 8353-58.
10. Parthasarathy MK, Bhende M. E ect of ocular magnification on macular measurements made using spectral domain optical coherence tomography. Indian J Ophthalmol. 2015; 63(5): 427-31.
11. Dagdelen K, Dirican E.The assessment of structural changes on optic nerve head and macula in primary open angle glaucoma and ocular hypertension. Int J Ophthalmol. 2018; 11(10): 1631-37.
12. Sato S, Ukegawa K, Nitta E, Hirooka K. Influence of Disc Size on the Diagnostic Accuracy of Cirrus Spectral-Domain Optical Coherence Tomography in Glaucoma. J Ophthalmol. 2018; 11:5692404.
13. Kiziloglu OY, Toygar O, Toygar B, Hacimustafaoglu AM. Optic Nerve Head Parameters Measured with Spectral-Domain Optical Coherence Tomography in Healthy Turkish Children: Normal Values, Repeatability, and Interocular Symmetry. Neuroophthalmology. 2018;42(2): 83-89.
14. Mansoori T, Viswanath K, Balakrishna N. Optic disc topography in normal Indian eyes using spectral domain optical coherence tomography. Indian J Ophthalmol. 2011; 59(1): 23-27.
15. Qiu K, Lu X, Zhang R, Wang G, Zhang M. Relationship of corneal hysteresis and optic nerve parameters in healthy myopic subjects. Sci Rep. 2017;7(1):17538.
16. AttaAllah HR, Omar IAN, Abdelhalim AS. Evaluation of Optic Nerve Head Parameters and Retinal Nerve Fiber Layer Thickness in Axial Myopia Using SD OCT. Ophthalmol Ther. 2017;6(2):335-41.
17. Savini G, Barboni P, Parisi V, Carbonelli M. The influence of axial length on retinal nerve fiber layer thickness and optic-disc size measurements by spectral-domain OCT. Br J Ophthalmol 2012; 96(1): 57–61.
18. Nagaoka N, Jonas JB, Morohoshi K, Moriyama M, Shimada N, Yoshida T, et al. Glaucomatous -Type optic discs in high myopia. 2015. PLoSONE10 (10). Available from: https://doi.org/10.1371/journal.pone. 0138825. [cited on 15 Jan 2018]
19. Zeried FM, Osuagwu UL. Changes in retinal nerve fiber layer and optic disc algorithms by optical coherence tomography in glaucomatous Arab subjects. Clin Ophthalmol. 2013;7:1941-9.
20. Poon LY, Antar H, Tsikata E, Guo R, Papadogeorgou G, Freeman M, et al. E ects of Age, Race, and Ethnicity on the Optic Nerve and Peripapillary Region Using Spectral-Domain OCT 3D Volume Scans. Trans. Vis. Sci. Tech. 2018;7(6):12.