Ethnic Variations in Retinal Thickness of Pakistani Population

Sahrish Mukhtar[1], Asma Basharat Ali[2], Mubina Lakhani[3], Urooj Fatima[4], Nadia Younus[5], Nuzhat Hassan[6]

Abstract

Objective: This study was aimed to generate the normative database for RNFL thickness in a multiethnic population of Pakistan so that this data can be used as a baseline for the better diagnosis and evaluation of diseases in the clinical set ups.

Methods: It was a cross sectional study. The study was conducted in an ophthalmology OPD, Karachi, Pakistan for the duration of 9 months. Total 300 healthy eye were included in the study. They were grouped according to their native languages: Urdu, Punjabi, Sindhi, Balochi and Pashto. Data was entered on SPSS version 20. The retinal nerve fiber layer thickness was measured and differences in these multiethnic groups were analyzed by using ANOVA. Subjects with raised intraocular pressure (> 21mmHg), retinopathy, history of intraocular surgery, chronic smoking and high refractive errors were excluded from the study. We took P-value <0.05 as significant.

Results: There was a significant difference noted among different ethnic groups (p<0.001). Total mean retinal nerve fiber layer thickness was found to be 99.02 ± 9.09 ìm in our population. It was measured thickest in the Baloch group (124.00 ± 2.83 ìm) and thinnest in the Urdu-speaking group (98.27 ± 8.79µm). The thickness of each quadrant in all the groups followed the ISNT rule (inferior > superior > nasal > temporal).

Conclusions: Mean RNFL observed in our studies was different in each ethnic group with the thickest being found in the Baloch, followed by Punjabi, Sindhi, Pushto and Urdu speaking group. Future prospect of making this study multi-centric could help the researchers create a robust data pool; the reference values used during OCT in the country can be changed accordingly, aiding early detection of retinal pathologies.

Keywords: Retina, Ethnicity, Optical Coherence Tomography (OCT)

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Introduction

The eyeball contains the optical apparatus of the visual system. There are three layers present in the eyeball. The outer coat is the fibrous layer which consists of posterior 5/6th sclera and anterior 1/6th cornea. The middle coat is the vascular layer also known as uveal tract that comprises the choroid, ciliary body and iris. The inner layer consists of retina which is the sensory neural layer. Histologically, retina comprises of ten layers; retinal nerve fiber layer (RNFL) is one of the ten layers which contains axons of ganglion cells Converging to form optic nerve. Although it can be visualized clearly through the microscope but now it can be visualized in vivo by using Optical Coherence Tomography (OCT) which is a non-invasive imaging technique providing high-resolution measurements of retinal nerve fiber layer thickness, Optic Nerve Head (ONH), macula etc[1]. OCT provides detailed understanding, precise monitoring of disease advancements and its response to various treatment strategies which are used for ophthalmic diseases

[1,2,5] Department of Anatomy Jinnah Medical & Dental College
[3,6]Department of Anatomy, Ziauddin University
[4] Department of Anatomy Sindh Medical College, Jinnah Sindh Medical University

Correspondence: Dr. Sahrish Mukhtar
Jinnah Medical & Dental College
Email: dr.sahrish@gmail.com
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especially those involving the chorioretinal tissue[2]. This advancement in ophthalmology has modernized the ophthalmological practice over the last decade. Further developments in OCT are expected to play a major role in future diagnostics. OCT is not only used in ophthalmology but also widely used in othe field of medicine[3-5].

A number of studies proposed that the retinal nerve fiber layer thickness is affected by multiple factors including age, race, sex, family history of glaucoma, high refractive errors, smoking etc[5-9]. Thus, such factors should be kept in mind while assessing the retinal nerve fiber layer thickness for diagnosis. It should also be considered in assessing the individuals during their follow up.

Ethnicity plays a significant role in understanding the diverse population of Pakistan, influencing many aspects of health, including disease prevalence, genetic makeup, and response to treatment. The Pakistani population is a mosaic of ethnic groups, each with its own distinct cultural, linguistic, and genetic characteristics. This diversity creates a rich tapestry of health profiles, where certain diseases might be more prevalent in one ethnic group than another. It is important to acknowledge these differences, especially in medical and clinical setups, because the same disease might manifest differently across various ethnic backgrounds, and treatments that work for one group may not necessarily be as effective for another.

In clinical diagnostics, taking ethnicity into account helps physicians make more accurate diagnoses. For instance, some ethnic groups may have a higher predisposition to certain genetic disorders, metabolic diseases, or even specific cancers. Without considering ethnicity, healthcare providers might overlook critical risk factors or misdiagnose a condition, leading to ineffective treatment plans. For example, Thalassemia, a blood disorder, is more prevalent among specific ethnic communities in Pakistan, and understanding this can guide better screening and management protocols.

One of the areas where the race and ethnicity has recently gained attention in medical research is in ophthalmology. Different ethical groups might show variations in the thickness and structure of the retinal layers, which can have implications for diagnosing and managing eye conditions. These variations can be found through researches that compare the retinal anatomy of individuals from different ethnic backgrounds. These differences in retinal layers may affect how certain eye diseases, like glaucoma or macular degeneration, present and progress in people of diverse ethnicities. For example, some groups might have a naturally thicker or thinner retinal nerve fiber layer, which can influence diagnostic measurements.

This understanding highlights the need for personalized medical care, where ethnicity is one of the many factors considered to offer more tailored healthcare. In a city as ethnically diverse as Karachi, integrating ethnic background into medical care can lead to better patient outcomes, improved disease management, and more inclusive healthcare systems.

Keeping such points in mind made us create our research question that when the retinal nerve fiber layer thickness is showing variations among different races then it might get altered among different ethnic groups as well. As Karachi is a multiethnic city, we decided to measure the RNFL thickness in order to see the difference among various ethnic groups.

Hence, the objective of the study was to generate the normative data of retinal nerve fiber layer thickness for our population based on ethnic groups by using Spectralis Heidelberg's Optical Coherence Tomography (OCT). Thus, the ethnic difference should be kept in mind while assessing and diagnosing the patients belonging to different ethnicities. Clinicians must have to keep an account on the likelihood of RNFL thickness variation with different ethnicities to avoid confusion in diagnosing the patients.

Methods

This cross-sectional research included 300 individuals (300 eyes) from an eye clinic located in Karachi, Pakistan. We used convenient method for sampling. For sample size calculation, WHO sample size calculator was used. Ethical approval was taken from Ziauddin University in Karachi, Pakistan. (Ref. # 0271214SMANA) and the samples were taken from the OPD of ophthalmology at Akil bin Abdul Qadir Institute because the facility of Optical Coherence Tomography was not available at Ziauddin Hospital.

Participants of both genders, greater than 40 years of age and possessing apparently normal eyes with controlled intraocular pressure (IOP) and cup-to- disc ratio (CDR) < 0.4 were selected for the study. Those eyes with any retinal pathologies, diabetic retinopathy, hypertensive retinopathy, history of laser therapy or intraocular surgery, diseases such as Parkinsonism or Multiple Sclerosis, chronic smoking, high refractive errors and IOP were not included.

After getting the informed consent, participants were sent for detailed ophthalmic examination which included slit-lamp biomicroscopy, refractive error testing, visual acuity, CDR and IOP measurement followed by OCT. As the internal environment was kept same for both the eyes of an individual, we selected a single eye randomly from each participant.

Optical Coherence Tomography was done by Spectralis Heidelberg's OCT by an expert after using 1% tropicamide eye drops for dilatation to get the cross-sectional images of retina on the computer screen. Retinal nerve fiber layer thickness scans were captured by fixing the participant's eyes at the light which is seen from the lens of OCT apparatus. The eye fixation ensures appropriate placement of an eye globe in line with optic nerve head. The retinal nerve fiber layer thickness measurements were also observed in the all four sectors of optic nerve head to provide a mean thickness of retinal nerve fiber layer globally and for every quadrant (temporal, nasal, inferior and superior).

Statistical analysis was done by SPSS 20. Mean and standard deviation were used for the quantitative variables. For the qualitative variables, percentages and frequencies were used. One-way ANOVA was applied to find differences in between the groups. P= <0.05 was taken as significant.

Results

A total of 300 healthy eyes were involved in this study. The distribution of participants according to ethnic groups is shown in Table 1. Mean age of the participants was 57.67 ± 11.42 years. (Table 1)

Table 2 shows the significant difference in the mean global RNFL thickness. The average mean was found to be 99.02 ± 9.09 μm, in the Urdu speaking group it was found to be 98.27 ± 8.79 μm, in the Pushto group the thickness was 99.58 ± 10.26 μm, in the Balochi group it was calculated to be 124.00 ± 2.83 μm, it was 100.98 ± 9.28 μm in the Punjabi group and 100.44 ± 7.63 μm in the Sindhi group. (Table 2) (Fig.1)

The retinal nerve fiber layer thickness followed the ISNT rule in each ethnic group according to which the retina was thicker in the inferior quadrant getting thinner first in superior quadrant then nasal and temporal quadrants. All the quadrants showed significant difference in each group except superior quadrant (Table 3)

The retinal nerve fiber layer thickness in the Baloch group was found to be greatest whereas it was calculated to be the least in the Urdu Speaking group.

Table 1. Basic distribution of data on the basis of ethnic groups

Ethnic groups	Gender Distribution of eyes (n	Total Number of eyes (n)	Mean Age ± SD (yrs)
Urdu (n)	M=110 F=114	224	58.42 ± 11.29
Pushto (n)	M=10 F=02	12	58.67 ± 11.66
Sindhi (n)	M=12 F=06	18	55.89 ± 11.40
Punjabi (n)	M=18 F=26	44	55.14 ± 11.56
Balochi (n)	M=00 F=02	02	40.00 ± 00
Total	M=150 F=150	300	57.67 ± 11.42

n= no. of eyes SD= standard deviation

Table 2: Mean Global Retinal Nerve Fiber Layer Thickness (RNFLT) in different ethnic groups

Global Retinal Nerve Fiber Layer Thickness in Ethnic groupsMean ± S.D (μm)						*P*-value
Average Mean	Urdu (n)	Pushto (n)	Sindhi (n)	Punjabi (n)	Balochi (n)	
99.02 ±9.09	98.27 ±8.79	99.58 ±10.26	100.44 ±7.63	100.98 ±9.28	124.00 ±2.83	0.001*

*very highly significant n= no. of eyes

Table 3. Retinal Nerve Fiber Layer Thickness in each quadrant of Optic Nerve Head (ONH) in different ethnic groups

Ethnic Groups	Optic Nerve Head QuadrantsMean ± S.D.(μm) Inferior	Superior	Nasal	Temporal
Urdu	125.11 ± 16.02	121.38 ± 15.27	77.96 ± 13.87	68.28 ± 12.32
Pushto	124.67 ± 16.67	121.25 ± 10.98	76.42 ± 10.28	76.33 ± 22.6
Sindhi	129.11 ± 16.81	120.00 ± 12.29	80.78 ± 10.21	72.17 ± 13.72
Punjabi	131.27 ± 15.31	122.18 ± 16.09	82.84 ± 15.07	67.52 ± 12.25
Balochi	157.00 ± 12.73	135.50 ± 9.19	110.00 ± 5.66	93.50 ± 4.95
P value	0.010*	0.734	0.004*	0.011*

*very highly significant

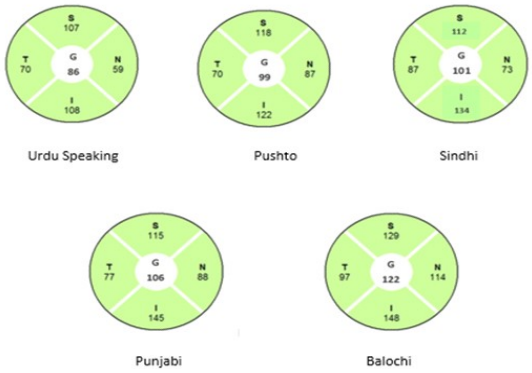

Fig.1. Multiethnic Retinal Nerve Fiber Layer Thickness variations in each quadrant of Optic Nerve Head (μm)

Discussion

Normal values for retinal nerve fiber layer thickness (RNFLT) has shown to vary significantly with race, age and sex[8,11]. The selection of ethnic groups in our study for the evaluation of retinal thickness is crucial for ensuring accurate, generalizable findings. Ethnic diversity plays a significant role in retinal anatomy, with studies showing that the thickness of retinal layers varies across different races. By including multiple ethnic groups, we can better understand these anatomical variations and how they influence the diagnosis and management of retinal diseases. Without considering ethnicity, findings might lead to skewed results that are only applicable to certain groups, limiting the broader application of the study's outcomes. In ophthalmology, retinal thickness is often used as a biomarker for diseases like glaucoma, diabetic retinopathy, and macular degeneration. However, the reference ranges for retinal thickness can differ between ethnicities, which could lead to misdiagnosis or inappropriate treatment if these variations are not considered. For instance, individuals from some ethnic groups may naturally have thicker or thinner retinal layers, and failing to account for this could either overestimate or underestimate disease severity. Including a broad range of ethnic groups allows us to establish more accurate, ethnicity-specific reference standards that can be used in clinical practice to improve diagnostic precision.

The present population-based study was aimed at establishing normative values for the multiethnic

population of Pakistan. With the continuous influx of migrants from different parts of the country into the city, Karachi has emerged as the hub of multiethnic and multilingual diverse representation of the Pakistani population[10]. Therefore, a total of 300 eyes were selected from a private ophthalmic out-patient center in Karachi and were divided according to their ethnicity/mother-language, i.e. Urdu, Pushto, Sindhi, Punjabi and Balochi groups.

RNFLT was acquired by Spectralis Heidelberg's OCT for each group. The mean age of participants was calculated to be 57.67 ± 11.42 years. Significant difference in RNFLT was observed among each group. Many other studies also contributed to the same ethical difference of retinal nerve fiber layer thickness in their researches[11]. Henrietta et al. found significant racial variation in RNFLT amongst individuals of Ethnic Chinese, Malay, and Indian descent in Singapore[12]. The RNFLT was found to be greatest in the Chinese while the lowest in Indian individuals. In a study conducted in America, Nousome et al. found significant difference between RNFLT of Blacks, Chinese and Latinos, with the thickest RNFL measurements in the Latinos and thinnest in the Black Americans. They accounted optic disc size and axial lengths for such difference[13]. However, Davey et al. found contrasting results in their research of 336 eyes where they did not find any significant difference between the RNFLT of Caucasians, Hispanics, African-Americans and South-Asian Indians[14].

The ISNT rule was introduced by Jonas et al. in Germany in 1999[15]. It demonstrates the normal thickness of nerve fiber layer in the different quadrants of the retina. The maximum retinal nerve fiber layer thickness is in the inferior quadrant. This thickness decreases sequentially with superior, nasal and superior quadrants[16]. In a study by Sarhan et al., it was stated that peripheral retina is thinner as compared to the central retina[17]. This is because the optic nerve head is not perfectly round, leading to variations in retinal thickness in different quadrants[18]. Ocansy et al. stated that these findings prove to be valuable clinically while looking for the factors influencing retinal parameters[19]. Any deviation from the ISNT rule will aid the ophthalmologists to discover optic nerve pathologies at an early stage. Our study complied with the ISNT rule in each ethnic group. This is in agreement with a study done by Rafati et al. on a large Iranian geriatric population while a study by Lingham et al. on young Australians showed greater variation from this ISNT rule[20,21]. Al-Sa'ad et al stated that the proportion of population following normal ISNT rule was greater than 42% and 23% respectively[22]. It is suggested in a Nigerian study, that about half of normal eye may show deviations in the morphology of the retinal nerve fiber layer not obeying the ISNT rule[23]. Qiu et al. also did not find the retinal thickness following the ISNT rule in their study and commented that the ISNT rule has limited possible convenience while diagnosing any retinal diseases[24].

The collection of normative values for any ethnic population is essential in the diagnosis of various ophthalmic conditions especially glaucoma. and suggested that ethnic-specific normative database helps in disease detection[25]. Therefore, the baseline data attained through our study will help the ophthalmologists in their set ups to screen the high-risk people prior to the commencement of diseases that involve eye especially retina. It can also prove to be helpful during the follow up of individuals. This approach strengthens the validity of our study by ensuring that the results are not biased toward a single population group. It also contributes to a more inclusive understanding of retinal health, promoting better individualized care across diverse populations. In a country like Pakistan, where ethnic diversity is vast, this inclusion becomes even more essential for providing equitable healthcare outcomes.

Optical Coherence Tomography (OCT) offers significant advantages for retinal measurements due to its non-invasive, high-resolution imaging capabilities. It allows for detailed cross-sectional visualization of retinal layers, making it ideal for diagnosing and monitoring diseases such as glaucoma, diabetic retinopathy, and macular degeneration. OCT

provides precise measurements of retinal thickness, enabling early detection of abnormalities, even before clinical symptoms arise. Additionally, its quick and painless procedure enhances patient comfort while providing real-time data that helps clinicians make more informed decisions, track disease progression, and evaluate treatment efficacy with high accuracy.

Therefore, the use of a high frequency spectral domain OCT and standardized examination techniques by the single trained technician becomes the strength of our study. Smaller sample size and varied difference in number of eyes between each group can be taken as the limitations of this study because larger sample size would have given more validation to our data and results.

However, our study generated the baseline data on retinal nerve fiber layer thickness measurements among different ethnic groups residing in Karachi, Pakistan. Advanced researches can be planned by using our results as baseline which can provide more detailed aspects of retinal nerve fiber layer thickness in each quadrant of optic nerve with respect to ethnic groups. Longitudinal studies should be planned to further validate our findings and assess the influence of ethnicity and race on retinal thickness in the clinical application. Moreover, future studies can be conducted to identify the molecular involvement that causes the difference in retinal nerve fiber layer thickness among different ethnic groups.

Conclusion

This study concludes that retinal nerve fiber layer thickness exhibits significant variation among different ethnic groups. These variations are critical in assessing retinal thickness and must be carefully considered when evaluating and diagnosing retinal diseases. Ethnic differences in retinal anatomy can influence the presentation and progression of diseases such as glaucoma and diabetic retinopathy, making it essential for clinicians to account for these factors. Incorporating ethnicity into retinal evaluations ensures more accurate diagnoses and improved personalized treatment approaches for diverse populations.

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