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ARTICLE

CORRELATION OF MEAN RETINAL NERVE FIBRE LAYER (RNFL) THICKNESS WITH TYPE OF REFRACTIVE ERROR

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ABSTRACT

OBJECTIVE: *To evaluate the mean retinal nerve fiber layer (RNFL) thickness in individuals with myopia, hyperopia, and astigmatism and correlate it with specific refractive error.*

METHOD: *This comparative cross-sectional study was performed on type of refractive error, included Myopia, Hyperopia, and Astigmatism. Sixty six eyes of thirty three subjects comprising twenty four eyes with myopia, twenty eyes with hyperopia and twenty two eyes with astigmatism were examined. Optical Coherent Tomogram (OCT) was used to measure RNFL thickness. Data were analyzed with SPSS-25.*

RESULTS: *Mean RNFL thickness in myopic eye was (92.62 ±8.43) with (SE: -1.00to -7.50), Mean RNFL thickness in Hyperopic eye was (101.25 ±8.82) with (SE: +0.75 to +3.75). Mean RNFL thickness in Astigmatic eye was (96.95 ±8.23) with (Cyl:-1.00 to -4.00 at 180). The difference between mean RNFL thickness for myopia, hyperopia and astigmatism was statistically significant (One way-ANOVA, f=8.2689, p= 0.0019). There was positive moderate correlation between average RNFL thickness and refractive error (r=0.451). There was very weak positive correlation of average RNFL thickness between myopia (r=0.283), and hyperopia (r=0.118) respectively and positive moderate correlation with astigmatism (r=0.564).*

CONCLUSION: *RNFL is significantly associated with type of refractive error being thickest for hyperopia and thinnest for myopia. Careful clinical interpretation is a must especially in myopia to avoid misdiagnosis with glaucoma.*

KEYWORDS: *RNFL, Myopia, Hyperopia, Astigmatism*

INTRODUCTION

The retina is the photosensitive component of the central nervous system (CNS), that forms the inner most layer of the eye ball.[1] The retinal cells are organized into three distinct layers which are separated by two plexiform layers.[2] Adjacent to the photoreceptor layer is the retinal pigment epithelium (RPE). In the first synaptic layer, the nuclei of rods and cones, establish synapses with the horizontal cells and bipolar cells comprise the outer plexiform layer (OPL). In the second synaptic layer, the inner plexiform layer, bipolar and amacrine cells make synaptic contacts with ganglion cells i.e. (GCL). The Müller cells are glial cells that stretch across the retina and provide support, extending radially across the full thickness of the retina.[2] The projection neurons of the retina i.e. ganglion cell, transmit information via axons through the optic nerve to visual center of the brain.[1]

The studies on RNFL showed that high myopia and high astigmatism have significant thinning in Retinal Nerve Fiber layer than in Hyperopic eyes. It is very important to measure because imaging of Retinal Nerve Fiber has potential clinical values and It could be a major cause of visual impairment with massive social and economic burden.[3] The evaluation of the retinal nerve fiber layer (RNFL) is very important for the diagnosis and follow-up of any optic nerve abnormality. The peri-papillary RNFL thickness measurements have been used for the detection and monitoring of glaucoma and other optic neuropathies.4 Optical coherence tomography (OCT), is a noninvasive technique that permits cross-sectional Tomographic imaging of the retina and optic nerve.[5]

Refractive error is listed as one of the leading causes of vision impairment worldwide by the World Health Organization (WHO). Uncorrected refractive errors affect approximately 123 million individuals across the globe, out of which, 4 million are blind.[6] Almost everyone has some degree of refractive error, including myopia and hyperopia known as spherical errors.[7] As a global public health concern with the highest prevalence in Asia-Pacific, rich countries and the least in African and Oceania population. Myopia recently affects more than 1.4 billion people all over the world especially young adults. New studies have suggested that almost half of the global population will be Myopic by 2050. The prevalence of hyperopic with respective to myopia, increases with age and reaches by 10 percent at the age of 60.[8] Both genetic and environmental factors influence the axial length of eye or its power are instrumental for developing refractive errors.[9] Disregulations in Emmetropization lead to the occurrence of myopia and hyperopia in addition to the cause of adult onset of refractive error such as changes in eye shape, diabetes and cataract. Elongation in axial length and reduction in thickness of sclera, choroid and retina are considered to be the main cause of myopia.[10] Although several studies on myopia and hyperopia suggest that changes in choroid thickness paved the scleral reshaping and alteration in AL, other studies imply that the progressive increase in axial length lead to sclera surface expansion and chorioretinal thinning and stretching.[11] Unanimously these defects in ocular structure induce many pathophysiological consequences.[12]

Besides the difficulties refractive error creates for daily life activities, many studies indicate that higher degrees of refractive error are prompted with severe and sight alarming ocular changes.[13] Myopia with an axial length higher than 26 mm or spherical equivalent equal to or greater than 6 diopter is considered as high myopia or pathological myopia.[14] High myopia is corresponded with choroidal neovascularization, patchy or diffused chorio-retinal atrophy, retinal detachment, macular retinoschisis, retinal vessel morphologic changes, cataract and glaucoma.[15] Hyperopia is also connected to some specific pathologies like macular atrophy, angle closer glaucoma and cataract.[16] Hence a complete analysis of morphological alterations in different retinal regions, layers and especially its thickness may disclose the underling process of complications and co morbidities associated with refractive error and there is dire need of sophisticated approach for its prevention, diagnosis and treatment.[17]

ISNT rule (Inferior >Superior> Nasal>Temporal) can be used to measure peri papillary retinal nerve fiber layer thickness with decreasing values from the thickest quadrant inferiorly to the thinnest quadrant temporally, inferior quadrant (126 ± 15.8), superior quadrant (117.2±16.13), nasal quadrant (75 ± 13.9), and temporal quadrant (70.6 ± 10.8 pm).[18] OCT measurements is believed to have potential clinical values, for example assessing RNFL thickness could be used for diagnosing and evaluating glaucoma in myopic patients instead of evaluating the optic disc appearance as visual field defects in myopias are very close to those assessed in glaucoma. Therefore, in this study we have done a systematic review of literature with an aim to gather findings of the relationship between retinal thickness and spherical refractive error. This study was conducted to assess the change in retinal OCT measurement in myopic and hyperopic patients as compared to controls.

Other studies performed in China noted that the high corneal astigmatism group had significantly thinner RNFLs in the temporal, 2 o'clock, 9 o'clock and 10 o'clock sectors than the normal astigmatism group.[19]

We went through various studies that were being conducted by OCT measurements on different retinal layers and regions such as retinal nerve fiber layer (RNFL), macular, foveal, parafoveal, perifoveal, foveola, ganglion cell complex (GCC), peripapillary retinal nerve fiber layer and ganglion cell and inner plexiform layer (GC-IPL) thickness and optic disc in myopias, hyperopic and astigmatism.

A study was done recently in eye department Mayo Hospital Lahore. It was concluded that myopia had an adverse effect on retinal nerve fiber layer thickness as the mean RNFL thickness was decreased in myopic eyes as compared to normal individuals. RNFL thickness clearly manifest with glaucoma diagnosis.[20]

It was reported in a Chinese study that no noticeable difference in cup to disc ratio and cup volume was found but significant thinner retinal nerve fiber layer thickness was observed in suprotemporal and inferotemporal quadrants. Apart from temporal quadrants there was no visible difference in retinal nerve fiber layer thickness in other quadrants.[21]

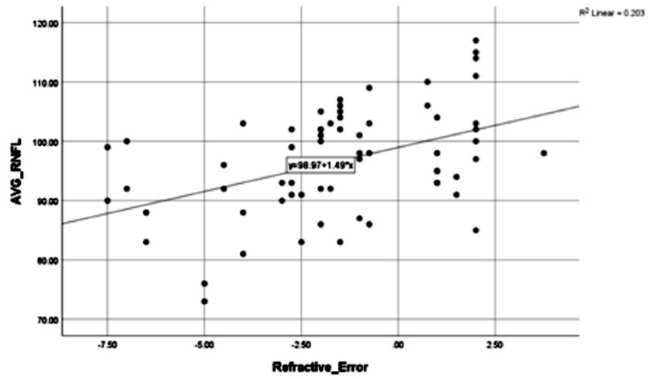
With my research refractive error individual will get awareness and become more conscious regarding their visual status. Retinal thinning occurring in refractive patients is mostly associated with open angle glaucoma, a disease also prevalent in high myopias.

MATERIAL AND METHOD

A comparative cross-sectional study was performed. Twenty four eyes with myopia, twenty eyes with hyperopia and twenty two astigmatic eyes were included. The individuals were enrolled from Ophthalmology outpatients department of Mayo hospital. For the purpose of analysis, the patients were divided into three groups as myopic patients having dioptric value -1.00 to -7.50 D), hyperopic have dioptric value (+0.75 t0 +3.75 D) and astigmatic having cylinder (-1.00 to -4.00 at 180). The mean RNFL thickness was defined according to the ISNT rule as, thickest quadrant inferiorly (126±15.8µm), Superior quadrant values (117.2±16.13 µm), and Nasal quadrant values (75±13.9 µm) to the thinnest quadrant and temporally (70.6±10.8µm) the thinnest quadrant. Patients included in this study were those between 18 to 35 years of age, who had previous history of being treated/ untreated refractive error and of any gender. And excluded from the current study were those who had the history of any systemic diseases, any organic ocular pathology, uncooperative individuals, and glaucomatous eyes. Ethics committee clearance was obtained from the institution and informed consent were obtained through proper channel. A detailed history was taken along with a complete ophthalmological examination. Auto refraction and retinoscopy was performed to check the amount of refractive error. Retinal nerve fiber layer thickness measurement was performed by using OCT (NIDEK RS-33.0, software-ex 1.5.2). Data was entered in SPSS-26.

RESULTS

Figure -1: Scatter graph.



The above scatter plot shows the relationship between average RNFL and refractive error. Myopia values falls between -1 to -7.5, hyperopia +0.75 to 3.75, and astigmatism -1 to -4.

The r^2 value is 0.203. This represents the percentage of variation in the response variable that can be explained by the predictor variable. In this case it means 20.3% of variation in Average RNFL thickness can be explained by the number of refractive error.

Table-1: Correlation of mean RNFL thickness with type of refractive error.

	N	r
Refractive Error	66	0.451
Avg RNFL	66	
Myopia	24	0.283
Avg RNFL	24	
Hyperopia	22	0.118
Avg RNFL	22	

There is positive moderate correlation between Avg RNFL thickness and refractive error where r = 0.451.

Correlation between myopia and Avg RNFL is weak positve where r=0.283.

Correlation between hyperopia and Avg RNFL weak positive where r=0.118.

Positive moderate correlation with astigmatism where r=0.564.

Mean RNFL thickness in myopic eye was (92.62 ±8.43) with (SE: -1.00to -7.50), Mean RNFL thickness in Hyperopic eye was (101.25 ±8.82) with (SE: +0.75 to +3.75). Mean RNFL thickness in Astigmatic eye was (96.95 ±8.23) with (Cyl: -1.00 to -4.00 at 180).

Using one-way ANOVA (with df1=2, df2=41, f =8.2698), p= 0.00192 which is statistically highly significant, meaning that RNFL thickness is significantly associated with type of refractive error being thickest for hyperopia and thinnest for myopia.

DISCUSSION

Many studies have been performed in different populations by using OCT, reported changes in retinal layer thickness due to different type of refractive error. The result produced was not correlated and inconsistent. Therefore, we plan to analyze the mean retinal nerve fiber layer measurements in myopic, hyperopic and astigmatic patients comparing their relative effect on RNFL thickness. The evaluations of this retinal layer are very important for diagnosing, treating and developing novel approaches toward prevention and its complications especially glaucoma.

Our result showed that There is positive moderate correlation between average RNFL thickness and refractive error (r=0.451). There is very weak positive correlation of average RNFL thickness between myopia (r=0.283), and hyperopia (r=0.118) respectively and positive moderate correlation with astigmatism where (r=0.564). Mean RNFL thickness in myopic eye was (92.62 ±8.43) with (SE: -1.00to -7.50), Mean RNFL thickness in Hyperopic eye was (101.25 ±8.82) with (SE: +0.75 to +3.75). Mean RNFL thickness in Astigmatic eye was (96.95 ±8.23) with (Cyl: -1.00 to -4.00 at 180).

The findings of the current studies confirm major differences in OCT measurements comparing with myopic, hyperopic and astigmatic eyes as a potential biomarker of severe refractive error complications. It becomes easy for researchers to more detailed study with advance application of OCT, the possible correlation between refractive error and retinal thickness in its various regions. An in-depth analysis of OCT values in this study confirms the evidence of correlation of spherical refractive error and alterations in mean retinal nerve fiber layer thickness (RNFL). The conclusion of analysis of our study by using OCT values measured at retinal nerve fiber layer showed that myopia had sufficiently lower mean value. On the hand, hyperopia had greatly thicker meanvalues.

The retina consists of RNFL, GCL, IPL, and inner nuclear layer (INL). GCC comprises of three innermost retinal layers i.e. RNFL GCL AND IPL. GCL and IPL have homogeneous reflection and can only be recognizable near fovealarea. The thickness of these two layers is measured as GC-IPL. A number of studies have reported the considerable decrease in breadth of RNFL in myopic eyes which is sufficiently compatible with our results.

This thinning which is perceived to be functionally correlated because of weak spatial resolution might be elongation of eye ball and following traction in eyeball layers. In addition to elongation, pathological myopia is assumed to have close relation with reduced micro vascular density and peripapillary perfusion. The thinning of parapapillary RNFL is imagined to cause a reduction in retinas metabolic demand subsequently less need of retinal blood supply that reduced parapapillary micro vascular density. It is articulated that axial length is a large risk factor for myopic eyes with glaucoma have thinning RNFL and thickness of this layer is vulnerable and prone for detecting glaucomatous damage. A significantly thicker RNFL is observed in hyperopic eyes after adjustment of age. All the study that analyzes hyperopic refractive patients was of the age between 18 and 35.

Recently, the interest in studying different retinal regions as well as layers of various ocular and non-ocular complications has grown surprisingly. Optical Coherence Tomography (OCT) is a noninvasive technique that permits cross sectional tomography imaging of retina and optic nerve as well as its thickness.[22] Additionally, development in this imaging technology, advancing from time-domain(TD) to spectral-domain(SD) and swept-source(SS) OCT has helped researchers to measure the relationship between refractive status and retinal thickness more accurately.[23] In this regard multiple studies have assessed alteration in retinal thickness in its different regions i.e. macula, fovea, parafovea, perifovea, foveola and optic nerve head (ONH) disc area. Apart from different cellular layers specifically ganglion cell complex (GCC) that consist of Retinal Nerve Fiber layer (RNFL) ganglion cell layer (GCL) inner plexiform layer(IPL) in different patients with varying degrees of myopia and hyperopia.[24] These assessments are often observed in high myopia because of the predictable effect of increase in axial length on the thickness of the choroid and retina.[25] These studies have been done in various populations with varying degrees of refractive error, thus prompted to different and even in some cases, opposite results about retinal thickness changes. For example Gupta and coworkers have argued that high myopic patient have lesser thickness than controls, whereas Hsu and coworkers had totally contrary results.[26]

To the best of our knowledge this is first analysis in Pakistan that has studied the thickness of RNFL among eyes with type of refractive error. We categorized groups according to the type refractive error for analysis using OCT measurements. The study intends to correlate the possible effect of mean RNFL thickness from each type of refractive error and explore its relation with glaucomatous changes. This study has several limitations. We used SD OCT for analysis so that we could be able to gather valuable data more accurately and analyze the thickness of retinal layer in all type of refractive error. Our analysis is performed on the cases that described myopia, hyperopia and astigmatism with their specification as a whole. The case that labeled as moderate to high myopia were included as sub group and generalize its data as myopic case and similarly hyperopic and astigmatic patients have specified respective group. Role of aging in changing retinal thickness specifically in adults and non-adults is excluded from our criteria because of limited capacity of studies for each OCT measurements. Our study is all inclusive of treated and untreated refractive errors having clear ocular media and participants were aged between 18 and 35.

CONCLUSION

There is association between RNFL thickness and type of refractive error. Clinically Careful interpretation is needed in myopia specially to avoid misdiagnosis with glaucoma.

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