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Original Article

Co-relationship between the thickness of the retinal nerve fiber layer and the axial length of the eyeball

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Purpose: To investigate the correlation between the average thickness of the retinal nerve fiber layer (aRNFL) and the axial length (AL) of the eyeball in normal individuals with optical coherence tomography (OCT) Optovue.

Method: In the current study, 124 eyes (with or without refractive error) of 62 normal individuals (10 years or more) were recruited. The thickness of the RNFL was measured using the three-dimensional OCT Fourier domain, Optovue. The axial length was measured by A-scan (Quantel Medical).

Result: Bivariate correlation between aRNFL and AL was -0.64 with $p < 0.001$. So aRNFL has significant negative correlation with AL. aRNFL can be predicted with the linear formula aRNFL = 1.62E2 - 2.34 * AL (r2 Linear = 0.404). For every 1 mm increase in axial length the aRNFL decreases by 2.34 µm.

Conclusion: The thickness of the RNFL shows a negative correlation with the axial length of the eyeball. Physicians need to consider anatomical variations in the RNFL for better patient management.

Introduction

Diagnosis of glaucoma is based on direct objective observation of optic nerve fibers within the optic disc. Many normal eyes have a disc appearance that is indistinguishable from that of eyes with early glaucoma, therefore, sometimes the sensitivity of this clinical observation is far from perfect. The appearance of the optic disc is often unusual and tilted and makes the glaucoma diagnosis challengeable. Currently, optical coherence tomography (OCT) is considered useful in the diagnosis and monitoring of glaucoma and other optic neuropathies due to its excellent ability to quantitatively evaluate the thickness of the RNFL.

The evaluation of the thickness of the mean peripapillary retinal nerve fiber layer (mRNFL) has been an important tool to evaluate and diagnose glaucoma and its progression. The literature suggests that myopic eyes have a higher risk of developing glaucoma. This study provides an idea of the relationship of the thickness of the RNFL with the axial length in the normal population.[1]

The analysis of the thickness of the retinal nerve fiber layer (RNFL) is an invaluable tool in the early diagnosis and periodic evaluation of glaucoma and other optical neuropathies. As has been widely recognized, short-sighted people (myopes) have an increased risk of developing glaucoma and the clinical diagnosis can be a challenge due to anatomical variations and, sometimes, to an unusual appearance of the optic disc.

Optical coherence tomography (OCT) has become a new imaging device for the quantitative and objective evaluation of the thickness of the RNFL. It has been reported that the evaluation of the thickness of the RNFL is not reliable in myopic eyes with OCT. In previous studies due to the variable topographic profiles observed in myopic eyes and has been classified as outside the normal limits for the nasal sector. The thickness of the RNFL is also subject to variability with age, sex, race and ethnicity.[2] The Fourier domain OCT can eliminate this error as it takes into account the sector by sector analysis of the RNFL thickness profile in each scan of the optical disk.

There are only a few clinical studies that have studied and analyzed the thickness of the RNFL (average that varies from 101.07 ± 10.13 to 111.75 ± 4.83 μm). The normal database available for the Indian population and its variation according to axial length was studied by Ramakrishnan et al.[3]

Recognizing the various studies carried out in the past and each one with variable results, the present study aimed to study the correlation between the thickness of the RNFL and the axial length of the eye by the Fourier domain OCT (RTVue-100, Optovue) in normal healthy people in individuals visiting Mayo Hospital, Lahore.

The normal population database for RNFL measurements, which was developed by the manufacturer and packaged within the Stratus OCT software, did not include individuals with moderate or high degrees of myopia.

Myopia has been reported as a risk factor for glaucoma, and myopic fundus changes may complicate glaucoma diagnosis and management. Conflicting data exist regarding the influence of myopia on peri-papillary retinal nerve fiber layer (RNFL) thickness. Some show no association whereas Budenz et al[4] and Leung et al[5] found significant correlations. The purpose of this study is to assess whether longer axial lengths are correlated with aRNFL thickness.

Despite the fact, the retinal nerve fiber layer thinning/decreasing is symbolic of glaucomatous changes, it remains unclear that whether the retinal nerve fiber layer thickness varies with the refractive status of eye or not. It is hence necessary to analyze any correlation between retinal nerve fiber layer thickness and the axial length of the eyeball.

In glaucoma the aRNFL is markedly decreased as compared to that in normal eyes. If in longer eyes aRNFL is decreased, it is necessary to conclude this change in aRNFL is due to axial length and is not related to glaucoma change. The reason for doing this study is very necessary as it measures retinal nerve fiber layer thickness changes with increase in axial length.

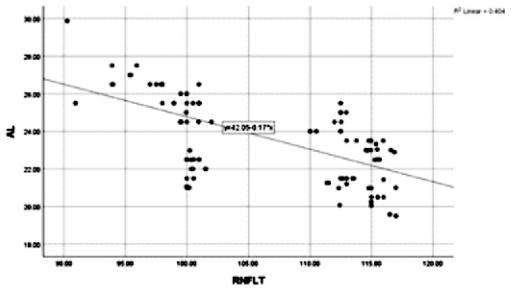
Methodology

Ethical authorization to conduct the study was obtained from the Ethics Review Board of the College of Ophthalmology and Allied Vision Sciences, King Edward Medical University, Lahore. A transversal comparative analytical study was used. In the current study, 124 eyes of 62 normal individuals (10 years or more) were recruited with or without refractive error. Individuals of both genders were included. The thickness of the RNFL was measured using three-dimensional Fourier domain OCT (Optovue). The axial length was measured by A-scan (Quantel Medical). The data was collected by a self-designed Performa. The statistical package for social sciences (SPSS version 20.0) was used for data entry of all types and its analysis.

Results

The minimum, maximum, mean, standard deviation value for AL and aRNFL was 19.50, 29.87, 23.66, 21.48 and 90.27, 116.99, 106.40 and 7.90 microns respectively.

Figure 1: Scatter plot between axial length and aRNFL



aRNFL can be predicted with the formula aRNFL = 1.62E2 - 2.34*AL (r^2 Linear = 0.404). For every 1 mm increase in axial length the aRNFL decreases by 2.34 µm.

Discussion

In this study, the maximum thickness of the RNFL was observed in the lower quadrant and the lowest in the nasal and lateral quadrants, both in the males and in the females. The females had a considerably thicker RNFL in the superotemporal and inferotemporal quadrants (value p = 0.04 and 0.01) in relation to the males.

In this study it was observed that for each 1 mm increase in axial length of the aRNFL decreases by 2.34 µm. This is similar to findings of Akram et al, who mentioned in his study that for every 1.0 mm of increase in axial length, the average thickness of the retinal nerve fiber layer decreases by approximately 2.1 µm.[6]

Many researches have investigated that the RNFL thickness measurements, utilizing OCT, is highly reproducible as well as highly dependable. By means of the modernized OCT instruments and modernized software OCT has already become a necessary observation in the investigation, diagnosis and management of glaucoma.

Many investigators have investigated that the measurements of thickness of the RNFL, using OCT, are highly reproducible and highly reliable. Through modernized OCT instruments and modernized software, OCT has already become a necessary tool in the diagnosis and treatment of glaucoma and is also a reliable tool in research based on this disease.

In this research, a remarkable alteration in the thickness of the RNFL was observed (p <0.001) with different refractive errors. In myopia there was a continuous decrease in the cRNFL as the degree of the myopia increased. On the other hand there was an increase in the thickness of the RNFL in the hyperopic patients. In both myopic and hyperopic patients, considerable fluctuations are observed when the error exceeds more than 3 diopters.[6]

Our research observations were similar with Sung-Won Choi et al., who said that the thickness of peripapillary RNFL in 3 different groups of myopic individuals (less than -2, -2 to -4 and more than -4D) using Stratus OCT. They stated that the thickness of the peripapillary RNFL decreased with the increase in the rate of myopia.[7] Leung et al[5], estimated RNFL thickness in the myopic eyes (-0.5 to -6.0D). They observed that the thickness of the RNFL fluctuates with the axial length and the refractive defects of the eye.[1] This study shows a constant decrease in an RNFL with axial length. The research by Budenz et al, analyzed that the thickness of the RNFL was related both to the axial length and to the refractive defects.[8] The larger eyes and the more myopic eyes had a smaller thickness of retinal nerve fibers. However, our research is incompatible with that presented by Mrugacz et al, who narrated that when myopia increases, the peripapillary RNFL remains unchanged.[9]

Our investigation showed that during the time when the rate of hyperopia increases, the mRNFL also increases, compared with myopia, hyperopia showed considerable fluctuations in the nasal and temporal quadrants of the eye.

OCT has turned out to be a widely used instrument in clinical and diagnostic ophthalmology. The standardization of information inevitably occurs through the OCT, but backend databases only include subjects 18 years of age or older, which restricts their use in young subjects. It is highly advisable to analyze our results with discoveries of past research.

During the current research and investigation, it was estimated that there were no considerable deteriorations of the RNFL thickness along with age. Somewhat similar outcomes were presented by Vernon et al[10], and also Pakravan et al[11]. It has been provided in literature, that a huge difference (7×10^5 to 1.4×10^6 strands) presents for the retinal ganglion cell complex with in the standard inhabitants, which additionally intricates the investigation.[9] Clashing outcomes were seen by Kusuhura et al[2], and Mansoori et al[12], and it was accredited that decrease in RNFL thickness along with increasing age was because of possible decrease in great amount of axons along with increasing age.[10] In the research performed by Mansoori et al[2], and many others till now, no correlation of the RNFL thickness with gender has been investigated.

Contemporary research focuses on the point that the RNFL and GCC are influenced by the increasing axial length and recommends that fluctuations occur both in the RNFL layer and in the innermost retinal in the eye. It also investigates that age does not influence the thickness of the RNFL in our area. A larger study with a large sample size is required for further evaluation of this.

Conclusion

This study concludes that there is an inverse relation between aRNFL thickness and axial length of an eyeball.

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