

Correlation Between Axial Length and Retinal Nerve Fiber Layer Thickness in Myopia

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ABSTRACT

BACKGROUND

The study was designed to evaluate the anatomical changes in the eyeball that may directly affect the retinal nerve fiber layer thickness. The role of the axial length of the eyeball in the progression of myopia with stretching of the posterior segment of the eyeball has been the subject of the study. This study aimed to correlate the axial length of the eyeball with the retinal nerve fiber layer thickness in myopia.

METHODS

In this prospective observational study, a total of 80 myopic eyes of 40 subjects with mean age of 25.72 ± 3.01 years (range 21 to 30 years) consisting of 23 males and 17 females were recruited for the study. Careful history was taken in all the subjects. The patients were examined and refraction for the power, A scan biometry for axial length of the eyeball and Optical Coherence tomography for the measurement of circum-papillary retinal nerve fiber layer thickness were performed.

RESULTS

Myopia ranged from -1D to -12D (mean -3.75 ± 2.62 D). The axial length varied from 21.98 mm to 28.68 mm (mean 24.8 ± 3.18 mm). Average 360-degree mean RNFL thickness in cases having axial length <24 mm was 101.26 ± 5.85 μ m, in cases with axial length between 24-26 mm was 88.72 ± 5.13 μ m and in cases having axial length >26 mm was 76.18 ± 6.06 μ m.

CONCLUSIONS

There was a significant inverse correlation associated between the anatomical anterior posterior (axial) length of the eye ball and average 360 degree circum-papillary RNFL thickness in myopic eyes.

KEYWORDS

Axial Length of The Eyeball, Myopia, Retinal Nerve Fiber Layer

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BACKGROUND

The Axial Length (AL) of the eyeball is the distance between the anterior and posterior poles of the eye and this is expressed in millimeters.¹ The elongation of the AL usually takes place in the first 3 to 6 months of life and a gradual reducing rate of growth over the next two years. By the age of 3 to 6 years the adult eye size is attained.¹ The antero-posterior length of the eyeball reaches up to 24 mm in a normal healthy individual. The light converging power of the cornea depends upon its curvature. Both the axial length and the corneal curvature have been shown to give a better correlation with myopia than is obtained with axial length alone. It has been demonstrated that an increase in the length was the largest determinant factor for the stretching of the posterior segment of the eyeball. Also, the increase in length in high myopia usually associated with the stretching of the posterior segment of the eyeball.^{1,2} AL is measured by A scan Ultrasonography (USG) machine.

The Retinal nerve fiber layer (RNFL) consists of axons of the ganglion cell layer. It is situated in between the internal limiting membrane (inner side) and the ganglion cell layer (outer side) of the retina. RNFL courses parallel to the retinal surface and converges at the optic nerve head (Optic Disc) in the following manner:³

1. Fibers from the macular region pass directly in the temporal aspect of the disc as papillo-macular bundle.
2. Fibers from the temporal retina arch above and below the macula and papillo-macular bundle as superior and inferior arcuate fibers.
3. Fibers from the nasal retina course directly to the optic disc as superior and inferior radiating fibers.

Optical Coherence Tomography (OCT) is a non-invasive procedure for the acquisition in vivo cross-sectional images of the retina from which RNFL thickness measurement can be made. The mean circum-papillary RNFL thickness on average is $105 \pm 38.79 \mu\text{m}$, with 95% confidence interval ranging 97.8 to $111.8 \mu\text{m}$ in normal Indian population.⁴

The RNFL thinning occurs due to some ocular diseases such as glaucoma, multiple sclerosis and optic neuropathies,⁵ it is still uncertain whether it has any relation with the anatomical elongation of the axial length of the eye ball? Our study was to evaluate whether lengthening of the axial length of the eye ball in myopia has any effect on the RNFL thickness?

METHODS

After obtaining the institutional ethical committee permission, the subjects aged 21 to 30 years with simple myopia, range from -1.00 to -12.00 Diopter spherical were selected from the outpatient department. Patients with a history of any systemic diseases, family history of glaucoma, ocular trauma, intraocular surgery, laser therapy, high astigmatism >1 Diopter were excluded from the study. During ocular examination if any anterior or posterior

segment pathology was detected, they were also excluded. After making above exclusion 40 (80 eyes) myopic patients (21 – 30 years of age group) consisting of 23 males and 17 females were selected for the study. Higher age group was not included as because RNFL thickness decreases with the advancement of age. Informed consent was obtained from all the recruited subjects after explaining the purpose of the study.

The refractive status was recorded objectively (using Streak retinoscope, Welch Allyn) and subjectively (using trial lens set- American Optical). Spherical Equivalent Refractive (SER) status values in Dioptre Spherical were evaluated for each eye of the individual subject. In case of associated astigmatism <-1 Diopter, SER was calculated by adding half of the cylindrical power to the spherical component. Axial Length (anatomically anterior to posterior) of each eyeball in mm was measured by the standard A scan biometry machine (Appasamy). The average of eight readings was calculated as the measured axial length.

The candidates underwent Spectral Domain OCT (Topcon) measurement of each eye following papillary dilatation with mydriatics. Individual myopic power of the eye (SER) was recorded in the OCT machine. The scanning records 3 circular scan of 3.4 mm diameter around the centre of the optic disc. Average 360-degree mean RNFL thickness in μm was obtained.

All data were in the form of mean \pm SD. ANOVA test was done to calculate p value and <0.05 was considered significant. Pearson correlation coefficient was done to evaluate the effect of axial length over RNFL thickness.

RESULTS

In this prospective observational study, 80 eyes of 40 patients with simple myopia were selected. Age of the patients ranged from 21 to 30 years (mean 25.72 years and SD was 3.01 years). There were 23 males and 17 females. Myopia ranged from -1D to -12D spherical equivalent (mean -3.75 ± 2.62 D). The axial length varied from 21.98 mm to 28.68 mm (mean 24.8 ± 3.18 mm). Average 360-degree circum-papillary mean RNFL thickness in subjects having axial length lesser than 24 mm was $101.26 \pm 5.85 \mu\text{m}$, in cases with axial length between 24-26 mm was $88.72 \pm 5.13 \mu\text{m}$ and in those cases having axial length greater than 26 mm was $76.18 \pm 6.06 \mu\text{m}$ (table). 'p' value was <.0001. That was significant. The significant negative correlation was found between the axial length and the average 360-degree circum-papillary RNFL thickness ($r = -0.874$)

Axial Length of Eye Ball	No. of Myopic Eyes	RNFL Thickness (Mean \pm SD)
Lesser than 24 mm	32	$101.26 \pm 5.85 \mu\text{m}$
24mm to 26 mm	29	$88.72 \pm 5.13 \mu\text{m}$
Greater than 26 mm	19	$76.18 \pm 6.06 \mu\text{m}$

Table 1. Average 360 Degree RNFL Thickness according to the Axial Length of Eye Ball

DISCUSSION

80 eyes of 40 patients of 21 to 30 years age group were studied to find out any correlation exist between the increment of axial length of the eye ball with Retinal nerve fiber layer thickness in axial myopia. The interaction between AL and corneal radius of curvature has played a major role in the compensatory adjustments of the optical components of the eyeball towards attaining normal refractive state. The increment of myopic power is not solely dependent upon AL. That means greater the axial length will not produce the proportionate increase in myopic power which can be compensated by the corneal curvature. It has been demonstrated that an increase in the AL is the largest determinant factor for the stretching of the posterior segment of the eyeball. Therefore, the study has been designed to evaluate the correlation of AL only with the RNFL thickness. As the elongation of AL is usually associated with myopia, myopic subject has been chosen.

The study established that there was a significant inverse correlation existed between antero posterior length of eye ball and all quadrant 360 degree circum-papillary RNFL thickness. So, inference is that, RNFL thickness decreases with increase in the axial length. Hoh et al⁶ (2006) found that average peripapillary RNFL thickness did not correlate with the axial length of the eyeball with varying OCT scan diameters. But Leung et al⁷ (2006) observed the average RNFL thickness in high power myopic eye was $100.69 \pm 10.36 \mu\text{m}$ which was significantly thinner than that was found in low to moderate myopic eyes ($107.49 \pm 12.74 \mu\text{m}$).

Kim et al⁸ (2010) noticed that the average global RNFL was significantly thinner in the high myopia group than in the lower variety ($107.4 \pm 7.6 \mu\text{m}$ vs $115.8 \pm 8.5 \mu\text{m}$). Savini et al (2012)⁹ evaluated the increase of AL on RNFL in normal subjects. They found negative correlation. Oner et al (2013)¹⁰ also found a negative and significant association between the two. Kamath et al¹¹ (2014) found that average 360° mean RNFL thickness in low myopia was $94.9 \pm 7.8 \mu\text{m}$, in moderate myopic group was $87.1 \pm 10.8 \mu\text{m}$ and high myopia group was $80.4 \pm 10.1 \mu\text{m}$. So, they concluded that the thinning of average 360° RNFL was associated with the increase in power of the myopia. Dennis L. Del Rosario et al¹² (2014) published average RNFL thickness in low myopic eyes (-0.75 to -3.00 D) was $102.44 \mu\text{m}$ and myopic eyes greater than -3.00 D was $97.91 \mu\text{m}$. Chowdhary et al¹³ (2015) studied RNFL thickness in myopic eyes in Rajasthani population in India. They also found a negative correlation.

Dhami et al (2016)¹⁴ studied RNFL thicknesses in three different subgroups according to the axial length. The average RNFL thickness was $110.14 \pm 9.32 \mu\text{m}$ in < 22.5 mm AL group, $106.70 \pm 8.93 \mu\text{m}$ in 22.51-25.5 mm AL group and $102 \pm 12.78 \mu\text{m}$ in >25.5 mm AL group. In our study the mean RNFL thickness in subjects having axial length lesser than 24 mm was $101.32 \pm 4.01 \mu\text{m}$, in cases with axial length between 24-26 mm was $91.31 \pm 3.13 \mu\text{m}$ and in those cases having axial length greater than 26 mm was $77.32 \pm 5.81 \mu\text{m}$. All those observations tally with the result of our study.

The decrease of RNFL thickness with increment of the AL could be explained by the fact that there is thinning of the sclera and retina is associated with the elongation of the AL of the eye ball. In myopia the lengthening of the eye ball may lead to mechanical stretching and thinning of the sclera as well as the retina. Therefore, it can be conferred that the extent of elongation would be correlated with the amount of retinal thinning. Thinning of RNFL is a pre-perimetric indicator for glaucoma. But it can also be seen in elongated myopic eye. So assessment of RNFL thickness without measuring the axial length can lead to misdiagnosis for ocular pathology.

CONCLUSIONS

There was a significant inverse correlation between the anatomical anterior posterior length of the eye ball and all 360 degree circum-papillary RNFL thickness. So Axial Length of the eyeball should be considered while measuring thickness of peri-papillary RNFL thickness.

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