Original Article

Reliability of OCT Assisted RNFL Thickness In Diagnosing Glaucoma In High Myopia

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Abstract

Aim : *To assess RNFL Thickness in high myopes and evaluating its reliability in diagnosing glaucoma.*

Material And Methods: *This is a cross-sectional study to compare retinal nerve fibre layer thickness (RNFL) in 112 eyes of 56 subjects presenting to our centre from May 2017 to March 2018. They were divided in two groups based on their refractive status (emmetropes and high myopes >-6D). Baseline ocular examination and Fourier domain optical coherence tomography was done and average and quadrant wise RNFL thickness was measured. Both the groups were compared based on their RNFL thickness. Data was analyzed using unpaired t- test, chi-square test/ Fisher exact test wherever applicable. P-value <0.05 was taken as significant.*

Results: *Mean RNFL thickness was 85.40±15.45µ in myopes and99.34±10.26µ in emmetropes. It was significantly less (Mean difference 13.94; 95% CI -18.93 to -8.94) in myopes compared to emmetropes. Quadrant wise analysis showed significant thinning in myopes in comparison to emmetropes except in temporal quadrant.*

Conclusion: *Though OCT is a valuable tool for diagnosing pre-perimetric glaucomatous changes but we have to be very cautious in cases of myopia. There is definite thinning of RNFL in high myopes but we must correlate with the clinical findings. Though the specific pattern of glaucomatous changes can provide clue to differentiate myopic thinning from true glaucomatous thinning which is more generalized butwe should not rely only on OCT with the current normative data.*

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Introduction

Degenerative myopia (>-6D) is accompanied by posterior segment changes like scleral thinning, posterior staphyloma, Fuchs spot, chorioretinal atrophy, large tilted optic discs, lacquer cracks, myopic crescent, and localized retinal nerve fibre layer (RNFL) defects.[1,2] RNFL thinning occurs because of mechanical stretching and retinal degeneration.[3-8] Myopes have 2-3 times higher risk of developing primary open angle glaucoma than emmetropes.[9-10] OCT assisted RNFL thickness is widely used for diagnosing pre-perimetric glaucoma. This study evaluates the effect of high myopia on RNFL thickness and its reliability in diagnosing glaucoma.

Materials and Methods

This is a hospital based comparative cross-sectional study. After obtaining clearance from institutional ethical committee, 112 eyes of 56 subjects were recruited from consenting individuals paying visit to our outpatient department from May 2017 to April 2018. Visual acuity was assessed using Snellen chart. Autorefraction was done after full pupillary dilatation with 0.8% tropicamide and 5% phenylepherine using Accuref-K 9001 (Shinnipon) autorefractometer. Intraocular pressure was measured by averaging three readings taken with the Goldman applanation tonometer. Visual field analysis (30-2) was done by Humphrey's field analyzer (model- 740i). Axial length measured was by amplitude scan (MD – 1000 A, Ultrasonic Biometer Medaco). Dilated fundus examination was performed with +90D lens along with indirect ophthalmoscopy and scleral indentation. RNFL thickness was measured using Optical coherence tomography (Optovue, Inc.; Fremont, California, USA). Three circular scans were obtained at the peripapillary retina at a default radius of 3.45 mm from the centre of the optic disc, and the measurements were averaged to provide average and quadrant wise peripapillary RNFL thickness (superior, inferior, temporal and nasal).

Inclusion Criteria: individuals with age >18 yrs and <76 yrs, emmetropes, Myopes >- 6D and good quality OCT scans. The good quality OCT scans fulfill the following criteria: the fundus image must be clear enough to see the optic disc and scan circle or spokes, signal strength > 6 and color saturation must be even and dense across the entire scan.

Exclusion Criteria: was patients showing any evidence of glaucoma (either on optic disc evaluation or visual field analysis on two separate occasions), lenticular myopia, amblyopia, ocular trauma, previous retinal laser treatment, post refractive surgery, any intraocular surgery, neurological disease and systemic illness like diabetes mellitus, hypertension and thyroid disorders. Based on refractive error subjects were divided into two groups – Group 1 – myopes (> - 6D) and group 2 – emmetropes (< ±0.5 DS).

Statistical analysis: Continuous variables were summarized as mean and standard deviation and were analyzed using unpaired t- test. Normal/categorical variable were expressed as proportions and were analyzed by chi-square test/Fisher exact test, P-value <0.05 was taken as significant.

Table 1: Age distribution in the two groups

Age Group (years)	Group 1 (N=30)	Group 2 (N=26)	Total (N=56)
	No. (%)	No. (%)	No. (%)
<35	23 (76.66)	18 (69.23)	41 (73.2)
>35	7 (23.33)	8 (30.76)	15 (26.8)
Total	30 (100.0)	26 (100.0)	56 (100.0)
Min. Age – Max. Age	18-67	19-60	
Mean Age	26.86	32.53	

Table 2: Sex distribution in both the groups

Sex	Group 1 (N=30)	Group 2(N=26)		
	No.	%	No.	%
Male	19	63.33	9	34.61
Female	11	36.66	17	65.38
Total	30	100.0	26	100.0

Table 3: Quadrant wise and average RNFL thickness

	Group 1 (N=60)	Group 2 (N = 52)	Mean change in RNFL 95% CI	P value
	Mean (SD)	Mean (SD)		
Superior	101.75 (21.99)	120.29 (13.85)	-18.54 (-25.55 to -11.53)	0.0001
Nasal	70.70 (23.69)	80.08 (13.57)	-9.38 (-16.76 to 1.99)	0.013
Inferior	98.05 (19.37)	119.77 (15.08)	-21.72 (-28.3 to -15.14)	0.0001
Temporal	71.10 (18.77)	77.21 (12.94)	-6.11 (-12.24 to 0.019)	0.051
Average	85.40 (15.45)	99.34 (10.26)	-13.94 (-18.93 to -8.94)	0.0001

Results

A total number of 112 eyes of 56 patients were included in this study. Age and sex distribution of these subjects is shown in table 1and 2. There was no statistical difference between these groups in terms of age. (Chi-square =0.105 with 1 degree of freedom; p = 0.746) and sex distribution. (Chi-square =3.518 with 1 degree of freedom; P = 0.061)
(Table 3)and figure 1shows the mean RNFL thickness in all the quadrants as well as the average value in both the groups. There was a significant difference in mean RNFL thickness between both the groups in average as well as quadrant wise except for temporal quadrant.

Discussion

Primary open angle glaucoma is 2-3 times more common in high myopes, so if we are able to diagnose it in pre-perimetric stage it will be very helpful to decrease the burden

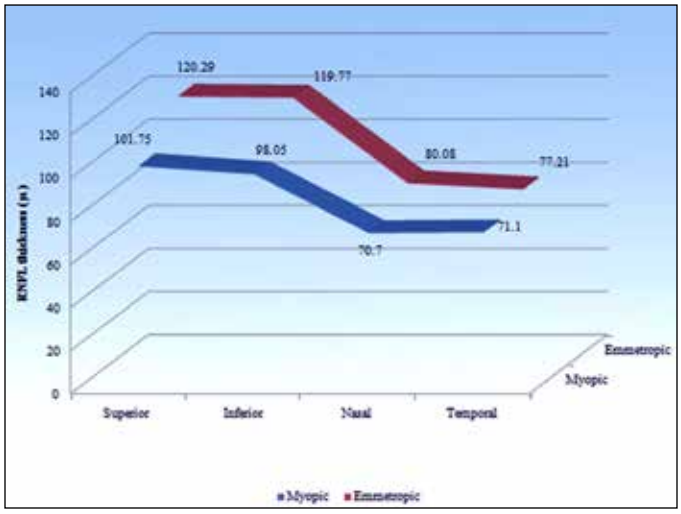

Figure 1: *Mean retinal nerve fibre thickness in the two groups in different quadrants.*

of disease. For diagnosing pre-perimetric glaucoma, out of a variety of techniques such as scanning laser polarimetry and confocal scanning laser ophthalmoscopy, optical coherence tomography (OCT) has emerged to the forefront of ocular imaging because of the wide variety of information it can provide like high resolution and the complex 3-dimensional (3D) data.[11-13] But it has been reported that high myopia is also associated with significant RNFL loss in some cases.[14-16] Therefore it is important to collect RNFL thickness data of emmetropes and high myopes to distinguish glaucomatous changes found on OCT.

Our study compares the RNFL thickness on OCT in healthy emmetropes and otherwise healthy high myopes (normal, non-glaucomatous). The mean RNFL thickness overall was 99.34 ± 10.26µ in emmetropes, 85.40 ±15.45µ in myopes. High myopes have stastically significant thinner RNFL as compared to emmetropes.

Yi Zha et al[17] compared RNFL thickness in emmetropes, low myopia (<-3D), median myopia (-3D to -6D) and high myopia (>-6D) and found that it was significantly thin in high myopes. They concluded that, as the negative spherical error increases, decrease in RNFL thickness occurs.Our study is comparable to their study in terms of mean RNFL thickness values and comparison results between these groups.

Also in a study by Kelley D schmeitzer et al[18] the average RNFL thickness in emmetropes and high myopes were observed to be 108.8µ and 80.0µ respectively (p= 0.001). Their results were almost the same as ours. There was a negative correlation of -0.712 with p<0.001 between axial length and RNFL thickness. They proposed that increased axial length is the reason behind RNFL thinning in high myopes. We also found a negative correlation of -0.140 between axial length and RNFL thickness, so it can be proposed that increase in axial length may be the reason behind RNFL thinning.
Similar study was done in Indian population by Kamath et al[19] and D Singh et al.[20] They also found significant RNFL thinning in high myopia group.

Mrugacz et al also divided myopes into 3 groups low myopia (<-3D), median myopia (-3D to -6D) and high myopia (>-6D). Significant difference was seen between RNFL thicknesses of high myopia and control group. They found that average RNFL thickness in high myopes was 140μ while we found that its 85.50μ. This difference with our study can be attributed to lower mean age patients in Mrugazs's study (15.05years) compared to our study (26.86 years).

Melo GB et al,[5] Garcia-Valenzuela E et al,[23] Hoh et al[6] did not find a significant association between myopia and RNFL thickness but these studies may have been limited by the poorer resolution of earlier generation OCT and confocal laser devices, and thus lower sensitivity. Furthermore, the ethnicity in each of these studies was different from our sample.

Though we have found that there is significant average RNFL thinning, we thought that measurement and comparison of each quadrant of high myopes with emmetropes is important to find any specific thinning, like in cases of glaucoma which shows typical quadrantic pattern. As per our study there was significant thinning present in all quadrants except temporal. (Table 3)

In Kamath et al[19] study of myopia, RNFL thickness in superior, inferior, nasal and temporal quadrant was 98.8μ, 100.5μ, 58.8μ and 64.8μ respectively. They found significant thinning in superior, inferior and nasal quadrants. They also reported thinning in temporal quadrant but it was not statistically significant.

Similar quadrantic difference was also found in studies conducted by Yi Zha et al[17] D singh et al[20] and Savini et al.[24]

Kang et al and Wang et al[25] also found that there was thinning in superior, inferior and nasal quadrants (significant only in superior and inferior quadrants) whereas in temporal quadrant there was significant thickening.

The above mentioned studies have found that temporal quadrant is least affected in myopia, it is even thicker in some of the above mentioned studies. We observed insignificant temporal thinning. The increased thickness in temporal quadrant might be due to redistribution of retinal nerve fibre. As the axial length increases there is dragging of retina towards the temporal quadrant and compression of RNFL against the bundles originating from the opposite hemisphere at the horizontal raphe which can cause temporal RNFL thickening. Kim et al[26] and Hoh et al also supported this theory of 'temporal dragging of retina.

Study by Moriyama et al[27] imaged the shape of the globe in 44 highly myopic eyes using high-resolution magnetic resonance images and demonstrated that myopic eyes had symmetrical or asymmetrical anteroposterior elongation and posterior protrusions, which could draw the superior and inferior RNFL bundles closer to the macula. This results in thinning at superior and inferior quadrants while dragging of temporal fibres leads to thickening temporally. Though the techniques of RNFL measurement are different in Moriyama's study but results are similar to ours.

However, Leung et al [28] considered the temporal convergence of the RNFL bundles as an image artifact consequential to an increase in the vertical curvature of the retina.

Our study also supported that there's no typical pattern of RNFL thinning in high myopes (Table 3) and this can be a clue to differentiate it from glaucomatous RNFL thinning. As we know glaucomatous optic nerve neuroretinal rim thinning has a characteristic pattern, inferior RNFL quadrant area is the most affected area. RNFL thickness generally follows ISNT rule (inferior > superior > nasal > temporal), and any violation from this rule is indicative of glaucoma.[30,32] Sihota et al[29] also found that in early glaucomatous eyes the most commonly affected area was inferior retinal nerve fibre layer. Average RNFL thickness is also significantly less.

Other clue to differentiate myopia from glaucomatous changes is presence of normal optic disc and visual fields in presence of moderate to severe thinning on OCT.[33]

To conclude, we can say that though OCT is a valuable tool for diagnosing pre-perimetric glaucomatous changes but we have to be very cautious in cases of myopia. There is definite thinning of RNFL in high myopes but we should correlate with clinical findings. Though the specific pattern of glaucomatous changes can provide clue to differentiate myopic thinning from true glaucomatous thinning, as in myopia retinal nerve fibre layer thinning is more generalized while early glaucomatous RNFL thinning is mostly limited to superior and inferior quadrants. We should never rely solely on OCT; visual field analysis and disc evaluation is indispensable in differentiating the two.

But as we know that Primary Open angle glaucoma is more common in high myopes (2-3 times more risk), we should collect more normative data for myopic patients and incorporate it into OCT software, to differentiate glaucomatous and normal thinning in myopia.

Conclusion

This study concludes that average RNFL thickness in high myopes is significantly low as compared to healthy individuals. But quadrant wise analysis showed that in high myopes RNFL thinning was present in all the quadrants except temporal, which is different from the pattern usually found in glaucoma patients.

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