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RESEARCH ARTICLE

THE CORRELATION OF MACULAR AND PERIPAPILLARY RETINAL NERVE FIBRE LAYER THICKNESS IN DIFFERENT GRADES OF MYOPIA

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ABSTRACT

Background & Introduction; Myopia is a type of refractive error in which parallel rays coming from infinity are focused in front of retina with accommodation being at rest. In myopia there is elongation of eyeball leading to decrease in RNFL thickness. RNFL thinning is observed at high myopic powers. Glaucoma also causes decrease in RNFL thickness. Myopia being a risk factor for glaucoma may give us false positives. Therefore there is a need to evaluate the variation of RNFL thickness both at macula and peripapillary with different grades of myopia and get a baseline value for general population. **Methodology:** The peripapillary and macular retinal nerve fibre thickness was measured by Spectral Domain-OCT in different grades of myopes and compared with that of emmetrope to know the variations. Total no of 40 eyes were studied in each group. There were 04 groups divided on basis of spherical equivalent s follows: **Result:**
1. The peripapillary RNFL thickness in emmetropia, low myopia, moderate and high grade myopic eye were (95.15 + 5.47), (90.38 + 5.06), (82.08+ 13.11), (73.43+14.80) microns respectively.
2. The Central macular thickness in emmetropia, low myopia, moderate and high grade myopic eye were (225.25 +12.73), (226.98 + 21.83), (214.33+ 36.99), (213.08+ 45.48) microns
Conclusion: There is decrease in average (Peripapillary) RNFL and Central Macular thickness with increase in grade of myopia.

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INTRODUCTION

Myopia, a form of refractive error is a leading cause of visual disability throughout the world. The global prevalence of myopia is expected to increase from 27% of the world's population in 2010 to 52% by 2050 (Holden et al., 2000). The prevalence of myopia varies by the country, age and by ethnic group and it is a major cause of visual impairment in both the developed and the developing world.

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In India, uncorrected refractive errors are the most common cause of visual impairment and second major cause of avoidable blindness after cataract. With the increase in prevalence of Myopia, the complications and associated co morbidities are also likely to increase. The histo pathological changes that accompany high myopia are also very well documented (Holden, 2000; Choi, 2006; Hoh, 2006) and may confuse the diagnosis in other ocular conditions. The prevalence of myopia is high in patients with ocular hypertension, primary open-angle glaucoma, and normal-tension glaucoma 5 & the risk of developing glaucoma is two to three times higher in myopic individuals than in normal, independent of other risk factors (Shin Hee Kang, 2010). Myopia & Glaucoma both affect retinal nerve fibre layer thickness (RNFL). The RNFL is a sensitive indicator for predicting early glaucomatous changes and the extent of RNFL damage correlates with the severity of functional deficit in the visual field (VF) (Mwanza, 2011). However, myopic individuals often have enlarged optic discs with a more oval configuration and larger areas of peripapillary atrophy. Thus, RNFL assessment may be more valuable than optic disc assessment in the case of myopic subjects (Myopia, 2009). Also Myopia can act as a confounding factor in RNFL thickness assessment and might lead to over diagnosis of Glaucoma in normal myopic individuals (The relationship between glaucoma and myopia: the Blue Mountains Eye Study, 1999). The quantification of RNFL thickness and macular thickness is necessary in all grades of Myopia as it confounds the evaluation of glaucoma progression because it is difficult to ascertain if the progression in RNFL thinning is due to myopia or glaucoma. Since it is not possible to distinguish glaucomatous from non-glaucomatous changes based on a single examination, it is appropriate to follow up high myopic patients with suspected glaucoma after establishing baseline structural and functional parameters. In most of the previous studies on Myopia, there is no baseline value for RNFL thickness at Macula and peripapillary area in myopic individuals. Also the normal population database for RNFL measurements, which are developed by the manufacturer and packaged within the Stratus OCT software, do not include individuals with moderate or high degrees of myopia (www.octscans.com) leading to a need for a suitable study to establish the baseline parameters.

METHODS

After obtaining clearance from ethical committee of the institute, the study was conducted in a Tertiary Care Centre from Jan 2018 to July 2019. A total of 160 eyes of patients attending OPD were selected and divided into four equal groups. It was Observational (cross sectional), clinical comparative study.

Minimum sample size was calculated by formula (Yamane);

n (sample size) = {(Zα)2 p (1-p)}/ e2

Where, n = sample size, Zα= Standard Normal Deviate taken as 1.96, p = proportion, here taken as 34.6% and e = precision, here taken as 10%. Sample size calculated with this formula comes to 87.For convenience purpose we have taken 40 individual eye in each group thereby giving a total sample size of 160. Inclusion criteria were all phakic eyes with patient's age between 20-50 yr old with requisite refractive error. Exclusion criteria were any history of Ocular diseases like glaucoma, posterior uveitis, optic neuritis, macular disorder, optic disc anomaly and any history of cataract surgeries, refractive or retinal / vitreous surgeries or trabeculectomy. Any patient with systemic diseases like diabetes or hypertension affecting macular thickness was also excluded. When both eyes were eligible for study, one randomly selected eye per subject was selected for analysis. All patients attending OPD satisfying the inclusion criteria were taken into study. This includes all patients with Spherical Equivalent (SE) starting from +0.5 DS to negative power of any value. Half of cylindrical power was added to spherical power recorded by manual and auto refraction and thus the spherical equivalent was calculated. The mean value of both manual and auto refraction readings was taken for calculation. Patient was made to sit in a dark room and retinoscopy was done at 1 m distance. The values obtained for each eye was documented and matched with that of an auto refractometer (RM 8800 model, Topcon, Japan). A total no of 3 readings was taken and the average value of 3 readings was taken for mean calculation. Eyes were divided on the basis of Myopic Spherical Equivalent (SE) into following four groups (Kim, 2010).

Group E - Emmetrope [SE= +/- 0.5 Diopter Spherical (DS) of myopic power]
Group L - Low Myope [SE= > 0.5 to 3.00 Diopter Spherical (DS) of myopic power]
Group M - Moderate Myope [SE= > 3.00 to 6.00 Diopter Spherical (DS) of myopic power]
Group H - High Myope [SE= > 6.00 Diopter Spherical (DS) of myopic power]

Each eye was instilled with a drop of 0.8% tropicamide and 5% phenylephrine in each eye 3 times at 15 minute intervals to dilate the pupil in order to do indirect ophthalmoscopy & OCT examination. RNFL thickness and Central macular thickness measurements were done by Spectral Domain OCT (CIRRUS HD OCT Model No- 400, Zeiss, Germany) in the two modes OCT-RNFL and OCT-Macula respectively. Patients were asked to look at the intersection of dotted green color line on the OCT and asked not to move their eyes. A macular cube of 200x200 was chosen for analysis of thickness at macula. RNFL thickness was measured by taking scan for OCT RNFL mode. The values obtained after scan were assessed. All scans with a signal strength of <6/10 were discarded. OCT for high myopia patients were obtained after adjusting for their spherical equivalent values in the scan. Axial length was calculated with the help of optical biometry using IOL master. The average of 3 readings was taken as final value for the selected eye. The eyes satisfying all criteria were included in the study. Variables of interest were axial length in mm, Macular thickness in microns and RNFL thickness in microns in the various subgroups. Continuous variables were expressed as Mean, Median and Standard Deviation and compared across the groups using Kruskal Wallis Test. Associations between continuous variables were captured by Spearman's Rank Correlation Coefficient. The statistical software SPSS version 20 was used for the analysis. An alpha level of 5% was considered as significant.

RESULTS

Total 160 eyes were evaluated and distributed in groups depending upon SE value of individual. Group E had 24 males and 16 females. Group L had 23 males and 17 females. Group M had 13 males and 27 females. Group H had 18 males and 22 females. All groups were matched for gender and were statistically comparable. Fig 01 shows the bar chart representation of the data mentioned in Table 01. Group E represents the mean and standard deviation of Spherical Equivalent, Peripapillary RNFL, among the 40 person in the Emmetropic group. (SE +0.50DS to -0.50DS). The minimum Macular RNFL thickness was 179 micron and maximum was 241 micron and the mean was 225.25+12.73micron. The mean SE was – 0.17+0.34 DS. The Peripapillary RNFL thickness observed was from 85 microns (minimum) to 114 microns (maximum) and the mean was 95.15+5.47 micron. The mean value of axial length was 23.19+ 0.37 mm.

Group L represents the mean and standard deviation of Spherical Equivalent, Peripapillary RNFL, among the 40 person in the Low myopia group. Minus (-) sign in Table 03 and rest of tables are indicative of myopic power. (SE >-0.50DS to -3.00DS). The mean SE was – 1.97 + 0.67 DS. The Macular RNFL thickness was from 123 micron (minimum) to 255 micron (maximum) and the mean was 226.98 + 21.83 micron. The Peripapillary RNFL thickness was from 74 microns (minimum) to 98 microns (maximum) and the mean was 90.38 + 5.06 micron. The mean value of axial length was 23.34 + 0.28 mm. Group M represents the mean and standard deviation of Spherical Equivalent, Peripapillary RNFL, among the 40 person in the Moderate myopia group. (SE > -3.00DS to -6.00DS). The mean SE was – 1.97 + 0.67 DS. The Macular RNFL thickness was from 68 microns (minimum) to 273 microns (maximum) and the mean was 226.98+ 21.83 microns. The Peripapillary RNFL thickness was from 49 microns (minimum) to 103 microns (maximum) and the mean was 90.38+ 5.06 micron. The mean value of axial length was 23.34 + 0.28 mm.

Group H represents the mean and standard deviation of Spherical Equivalent, Peripapillary RNFL,among the 40 person in the High myopia group. (SE > -6.00DS). The mean SE was -9.87+/-5.65 DS. The Macular RNFL thicknesswas 23 microns (minimum) and 284 microns (maximum) and the mean was213.08+ 45.48 microns. The peripapillary RNFL thickness was from 38 microns (minimum) to 126 microns(maximum) and the mean was 73.43+ 14.80 micron. The mean value of axial length was 25.03+ 2.23 mm. The observation between increase in myopia and decrease in RNFL thickness was statistically significant. This is graphically depicted in Fig 02.

DISCUSSION

Myopia as described earlier is a type of refractive error affecting a majority of population. The scope of myopia was limited to glasses till Donders examined 1500 myopic eyes and describe fundus findings of myopes with help of ophthalmoscope. There was evidence of changes in myopic fundus like presence of crescent around disc area, known as myopic crescent, Lacuqer cracks which are ruptures in the RPE – Bruch membrane- choriocapillaris complex, tigroid appearance due to atrophy of retinal pigment epithelium & focal chorioretinal atrophy characterized by patchy visibility of choroidal vessels, and often sclera. These changes are consistent with high degrees of myopia. It was also speculated that there is thinning of nerve fibre layer in myopic people which might be significant when compared with that of a normal population. The use of OCT helps us to quantify the nerve layer thickness and asses the layers of retina. It also helps in quantifying RNFL thickness and their progressive loss in cases of glaucoma. The OCT uses a normative data for analysis of RNFL thickness both in macula and peripapillary area of patients and any value beyond two standard deviation from mean is coded in red color. This normative data is available for people with emmetropia or mild refractive error. The normal data in cases of moderate to high myopia is not available in the OCT software. Also there is no previous study documenting baseline values of RNFL in myopic eyes. Hence this study was designed to quantify the RNFL thickness at macula and peripapillary region and to try and find out if any statistically significant variation was present with change in refractive error of eye.

Frederick M. Rauscher[6] studied 27 subjects and found mean age was 34 ± 8 years (range 23–54) with average axial length of25.65 mm (range 22.63 to 27.92). 70% subjects had an axial length of >25 mm. Mean spherical equivalent was −5.40D (range −1.25 to −11.25). Mean cup-to-disk ratio by fundus biomicroscopy was 0.38 and by the Fast Optic Disk algorithm on the OCT-3 it was 0.56 horizontally & 0.57 vertically. The ratio was slightly higher by OCT. Temporal peripapillary atrophy was seen in eight subjects (30%) and temporal disk tilt was seen in six (22%) . Seventeen (63%) had neither atrophy nor tilt. When RNFL thickness was compared with age (p=0.20), gender, cup-to-disk ratio, tilt or peripapillary atrophy, there was no significant association present . For every 1 mm increase of axial length, the overall RNFL decreased by 7 microns. Nasal and temporal RNFL thickness showed no significant associations with myopia. It was concluded that there is a strong association between Axial length and peripapillary RNFL thickness but no association with SE. In comparison, our study shows a significant association of SE with Macular and peripapillary RNFL thickness . Also in our study there was a negative correlation between SE and RNFL thickness at both macula and peripapillary region, i.e higher the myopia more was the decrease in RNFL thickness.

In the study by Malakar et al. (2015) the mean RNFL thickness in low and high myopia group was found to be 87.89 μm and 111.64 μm, respectively. The results are similar to our study, only difference being that the study did not sub classify low and moderate myopia and there was no sub group comparison with axial length as was done in our study. Mansoori et al. (2011) analysed the mean RNFL thickness in healthy subjects and patients with early glaucoma and found it to be 105.7 ± 5.1 μm and 90.7 ± 7.5 μm respectively, the difference being statistically significant. This shows thinning in peripapillary RNFL thickness in glaucomatous persons compared with that of normal individuals, however they didn't categorize the patients as per their refractive errors. As per our study, moderate myopia and high myopia had peripapillary RNFL value of 82.08+13.11 micron and 73.43+14.80 microns respectively, the difference being statistically significant. Hence ignoring refractive error can give false positive results in glaucoma screening if the status of myopia is not taken into consideration.

Singh D et al. (2017) analyzed 100 eyes of healthy individuals comprising of 50 eyes with emmetropia , 25 eyes with moderate myopia (SE between -4 D and -8 D), and 25 eyes with high myopia (SE between -8 D and -12 D). Average and mean clock hour RNFL thicknesses measured by cirrus HD-OCT showed average RNFL measurements were significantly lower in high myopia (78.68 + 5.67) and moderate myopia (83.76 + 3.44) group compared with emmetropia group (91.26 + 2.99). These results were comparable with our study. But even in this study, there was no baseline values for low myopia group which was adequately analysed in our study. Also the decrease in macular RNFL thickness was observed in our study separately for each group of myopia. This also adds to the point that macular RNFL thickness is also affected if the SE varies significantly. Hence a detailed and cautious analysis is required while evaluating the macular RNFL thickness in moderate to high myopes with diseases involving macula. This study examined the baseline values of peripapillary and macular RNFL thickness in individuals with different grades of myopia and also studied the variation between them.

Table 1. Gender distribution within individual groups

Gender	GROUP E	GROUP L	GROUP M	GROUP H
MALE (Percentage)	60% (n=24)	57.5% (n=23)	32.5% (n=13)	45% (n=18)
FEMALE (Percentage)	40% (n= 16)	42.5% (n=17)	67.5%(n=27)	55% (n=22)
Total	100% (n=40)	100% (n=40)	100% (n=40)	100% (n=40)

Table 02. Statistical comparison of parameters measured in the study between different groups

GROUP		Spherical Equivalent	Peripapillary rnfl	Macular Rnfl
GROUP E	Mean (+/- SD)	-0.17 ± 0.34	95.15 ± 5.47	225.25 ±12.73
	Median	-0.25	94.00	227.00
GROUP L	Mean +/- SD	-1.97 ± 0.67	90.38 ± 5.06	226.98 ± 21.83
	Median	-2.13	91.00	230.00
GROUP M	Mean (+/- SD)	-4.48 ± 0.78	82.08± 13.11	214.33± 36.99
	Median	-4.63	83.00	217.00
GROUP H	Mean (+/- SD)	-9.87± 5.65	73.43±14.80	213.08± 45.48
	Median	-9.00	74.00	211.00
Total	Mean	-4.12	85.26	219.91
	p Value	<0.001	<0.001	0.006
	Significance	Significant	Significant	Significant

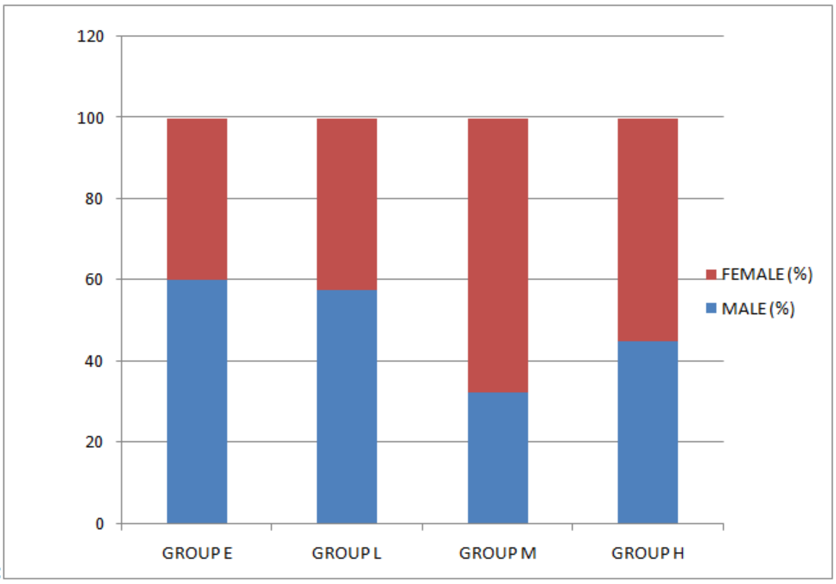

Fig 01. Gender percentage distribution in each group

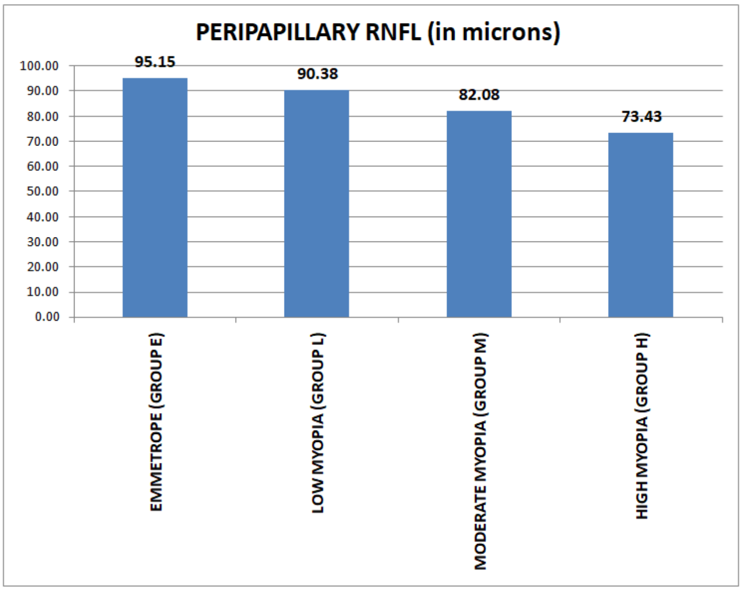

Fig 02. Mean Peripapillary Rnfl Thickness in Different Groups

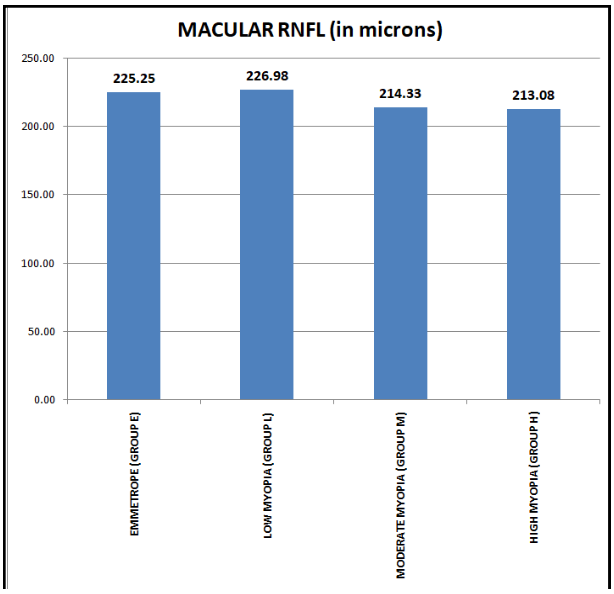

Fig 03. Mean Macular Rnfl Thickness In Different Groups

Previous studies have documented the decrease in peripapillary RNFL thickness in high myopia person. In our study there was an effort to quantify and statistically analyze the normative value of peripapillary RNFL thickness and macular RNFL thickness in emmetropic individuals also. As there was no earlier normative data of these values in low and moderate myopia individuals, this study helps in determining the baseline values.

This study also determines that as the degree of myopia increases from low to high, there is significant thinning in peripapillary and macular RNFL thickness. There was also a negative correlation between axial length and peripapillary & macular RNFL thickness. The above inferences will help in accurately screening glaucoma patients in which OCT based RNFL thickness is an important parameter taking refractive errors into consideration. Myopes need to be followed up at a regular basis for glaucoma as well as macular disorders as what may seem abnormal in OCT can be a normal value for a myopic eyes both for peripapillary and macular RNFL area.

Funding

This study being an observational cross section study did not had any funding source. The instruments used were available at the OPD of the tertiary care centre.

Conflict Of Interest: None Declared

Key points

- The study helps to quantify RNFL thickness in emmetrope and myopic eyes.
- It showed thinning in both Macular and Peripapillary RNFL thickness as the grade of myopia increased.
- While considering evaluation of glaucoma in myopic patients OCT RNFL cannot be totally reliable criteria as myopia itself is a confounder when RNFL thickness is considered.
- Even if OCT scan is showing a myope in outliers, the person can be totally normal for his spherical equivalent power

Abbreviations and Keyword

CMT - Central Macular Thickness
DS - Diopter Spherical
IOL - Interaocular Lens
OCT - Ocular Coherence Tomography
OPD - Out-patient Department
RNFL - Retinal Nerve Fibre Layer
SE - Spherical Equivalent
SPSS - Statistical Product and Service Solution
VF - Visual Field

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