ORIGINAL RESEARCH PAPER

Ophthalmology

"CORRELATION OF MACULAR PARAMETERS WITH SEVERITY OF AXIAL MYOPIA USING SPECTRAL DOMAIN OCT (SD-OCT)"

KEY WORDS: Myopia, retinal thickness (MT), macular volume (MV), central foveal thickness (CFT), Axial myopia

Dr. Prabha Chouriya MS Ophthalmology, Shyam Shah Medical College Rewa.

Dr Eva Rani Tirkey* MS Ophthalmology (Associate professor), Shyam Shah Medical College Rewa.*Corresponding author

ABSTRACT

This study gives correlation between average macular retinal thickness (MT), macular volume (MV), central foveal thickness (CFT) with severity of axial myopia using SD-OCT. In this study, a total of 142 axial myopic eyes of 74 consecutive patients were divided into 3 groups on the basis of spherical equivalent -52 eyes in low (≥-1 to -3 D), 49 in moderate (≥-3 to -6D), 41 in high (> -6D). From the study we obtained average MT thickness was 262.5 ± 20.2 μm, 237.3 ± 27.1μm, 198.8 ± 28.3μm, and MV was 9.4 ± 0.8 mm3, 8.3 ± 1mm3, 7.3 ± 1.1 mm in 3 groups, respectively. The study revealed that MT and MV was significantly thinner with increase in severity ($p<0.0001$). Further, study on CFT was observed 246.9 ± 21.1μm, 246 ± 20μm, 236.4 ± 31.7 μm in 3 groups, respectively and was not significantly differed ($p=0.2$). Overall from this study we concluded that average MT and MV significantly vary with severity of axial myopia. As axial myopia increase, average macular thickness was thinner, macular volume decreased and foveal thickness remain unchanged. Therefore, this is very important to consider myopic changes while interpreting OCT results.

INTRODUCTION

Myopia, is the most common refractive eye disorder worldwide, referred to as short sightedness is a form of refractive error (AttaAllah, Omar, & Abdelhalim, 2017). Joint report of World Health Organization and Brien Holden vision institute global scientific meeting on myopia estimated that it will affect 34.0% world population by 2020 (Holden et al., 2016). Generally, in axial myopia condition increase in antero-posterior length of the eyeball commonly observed among the patient. Increased axial elongation of globe leads to fundus changes. It is assumed that fundus changes are the consequence of mechanical tissue strain and vascular changes that occur secondary to a process of stretching (Curtin & Karlin, 1970). The anatomical changes that occur in longer axial length eyes such as globe elongation, sclera widening and enlargement of lamina cribrosa result into larger disc area and macular changes (Flores-Moreno, Lugo, Duker, & Ruiz-Moreno, 2013). Histopathological findings associated with increased axial length include partial expansion of the posterior pole, thinning of sclera and sensory retina with choroidal degeneration and atrophy (Choi & Lee, 2006). It is known that posterior segment OCT is used for the evaluation of macular changes in various retinal diseases which can be confounded by the retinal changes induced by moderate to high axial myopia (Lim et al., 2005).

Spectral- Domain Optical Coherence Tomography (SDOCT) is non- invasive, accurate scanning technique with much higher repeatability of results and production of cross sectional images with quantitative analysis of retinal features. It makes the detection of the subtle changes in the retina and choroid earlier, therefore, it can be used to diagnose and monitor various types of retinal diseases (Wakitani et al., 2003). Previous studies imply that there occur significant thinner average macular thickness, lower macular volume and thicker foveal thickness were associated with longer axial length (Hwang & Kim, 2012; Luo et al., 2006; Wu et al., 2008). Whereas, some studies found no significant average macular thickness variation with degree of myopia (Choi & Lee, 2006; Seo et al., 2017). Since, conflicting data exist among previous studies on individual parameters, thus this study is very helpful and undertaken to give the correlation of average MT, MV and CFT with severity of myopia using SD-OCT.

Material and Methods

Study subjects

department who met the inclusion criteria were recruited. This cross sectional study was carried out in the Department of Ophthalmology, Shyam Shah Medical College & associated Gandhi Memorial Hospital, Rewa (M.P.) during the period from January 2018 to September 2019.

Axial myopic subjects of ≥ 18 year of age with axial length ≥ 23.60 mm, Spherical equivalent (SE) ≥ -1.0 Diopter were included in study. Subjects with Glaucoma, Astigmatism > -2.5 D, any fundus abnormality other than myopic changes, optic neuropathy, media opacities, history of any ocular surgery and subjects unable to fixate/cooperate in SDOCT were excluded.

Informed consent was obtained from all subjects. The tenets of declaration of Helsinki were followed. All subjects were subjected to detailed history taking regarding history of present illness, duration of myopia and history of spectacle usage. History of any ocular surgery, trauma.

All patient underwent a detailed clinical evaluation including Visual acuity was recorded for each eye separately at 6-meter distance using a standard Snellen's chart followed by visual acuity with pin hole and with spectacles. Objective refraction was performed using retinoscopy under cycloplegia. Postcycloplegic test done after 3 days of retinoscopy. Refraction and best corrected visual acuity (BCVA) were assessed. Refraction data were converted to spherical equivalents (SE), Which were calculated using the spherical diopter plus one half the cylindrical dioptre power.

Axial length measurements were obtained with the contact technique of A scan biometry (OPHTHALMIC ULTRASOUND SCANNER MODEL: APPASCAN MAX). IOP was recorded using Goldman applanation tonometry. The normal range was taken between 10-21 mm of Hg. A thorough anterior segment examination was conducted using slit lamp biomicroscopy. All the subjects underwent fundus examination under full mydriasis using indirect ophthalmoscopy and slit lamp biomicroscopy with 90D lens.

Study subjects and classification

The selected study subjects were divided into three groups according to their SE, using classification system of American Optometric Association.

Group A- Low myopia group (-1 D to -3.00 D)
Group B- Moderate myopia group (> -3.00D to -6.00 D)
Group C- High myopia group (> -6.00 D)

SDOCT measurement

Subjects were scanned with SDOCT, CIRRUS HD OCT MODEL 500.

Macular scan

Macular cube scanning using the macular cube 512x128 was used for the measurement of macula through 6mm square grid by acquiring a series of 128 horizontal scan lines each compose of 512 A scan and a central horizontal B scan. Macular Thickness Analysis (MTA) and Ganglion Cell OU Analysis performed by accessing CIRRUS HD-OCT analyses which provides interactive scan images as well as the fundus image with a scan cube overlay. Macular parameters recorded were MT, CFT and MV. A single operator collected all measurements. One with best quality scan with signal strength of 6 or above chosen for study.

Statistical analysis

The results of this study was reported in the form of means ± standard deviation (SD) of all data values tested using one-way ANOVA at ($p<0.05$) using GraphPad InStat version 3.06 software and Tukey Krammer Comparisons test was used to evaluate the differences.

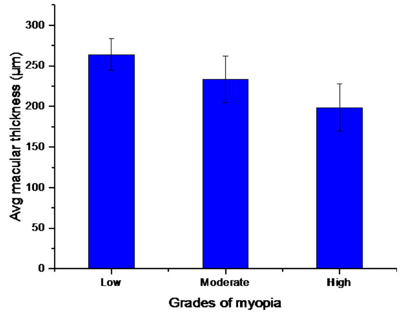
Result and observation

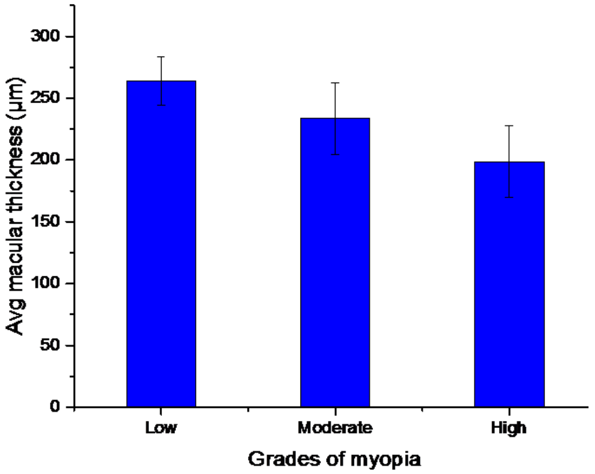
Study subjects between 18 to 40 years of age were included and no significant age difference found between the groups. In present study, 142 eyes among 74 subjects (36 Females, 38 Males) -7.78 ± 2.55 D and 26.37 ± 0.96 mm was observed, respectively. Further, three groups of study subject their SE_{mean} and AL_{mean} were found to be in; group A-(-1.76 ±1.08 D, 24.04 ± 0.33 mm), group B-(-4.11 ± 0.79 D, 25.01 ± 0.39 mm), and group C-(-7.87±1.50 D, 26.37 ± 0.44 mm).

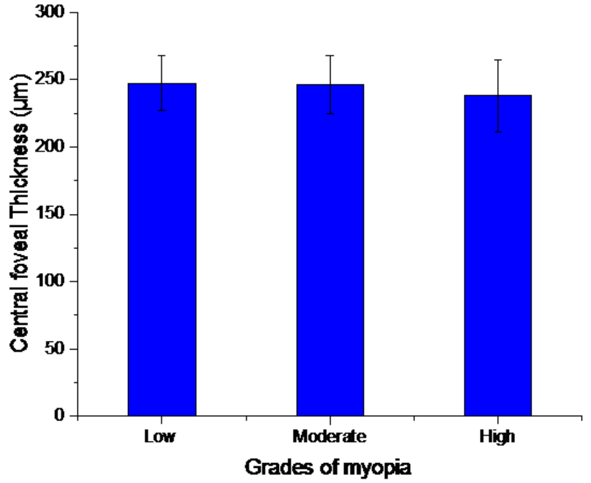
Table 1: Comparison of macular parameters among different grades of axial myopia (spherical equivalent)

MACULAR PARAMETERS MEAN±SD	LOW MYOPIA (-1D TO -3 D) n = 52 GROUP-A	MODERATE MYOPIA (>-3D TO -6 D n = 49 GROUP-B	HIGH MYOPIA(>-6 D) n = 41 GROUP-C	p VALUE (ANOVA)	p VALUE (Tukey-Kramer Multiple Comparison test)
AVERAGE THICKNESS(µm)	262.5±20.2	237.3±27.1	198.8±28.3	<0.0001	A vs B <0.01 A vs C <0.01 B vs C <0.01
CENTRAL FOVEAL THICKNESS(µm)	246.9±21.1	246±20.1	236.4±26.91	0.2	Post test were not calculated as p value>0.05
VOLUME(mm^3)	9.4±0.8	8.3±1.06	7.3±1.1	<0.0001	A vs B <0.01 A vs C <0.01 B vs C <0.01

From the Table 1 it is clear evident that the average MTmean was found to be significantly thinner in high myopia when compared with low and moderate myopia groups ($p<0.01$). Similarly, low myopia and moderate myopia were also significantly different from each other ($p< 0.01$). Whereas, the mean MV was among 3 groups and was significantly less in high myopia when compared with low myopia and moderate myopia groups ($p<0.01$). Similarly, low myopia and moderate myopia groups also differed significantly from each other ($p<0.01$). The mean CFT was in 3 groups, respectively, and was not differed significantly ($p=0.2$).







DISCUSSION

In present study in different age group under evaluation in our study included individuals from 18- 40 years of age, amongst which the 95% of study subjects were found to be below the age of 30 years (21-25 years, 39.39%). We observed that 74 subjects have the females with M/ F ratio of 1:0.98 (effect of age and gender was not studied). In previous study, Lim *et al.* (2005), Choi *et al.* (2006), and Wu *et al.* (2008) recruited study subjects among young adult aged 19-24, 23-26, and 18-40 years, respectively. Luo *et al.* (2006) and Wu *et al.* (2008) reported the similar to M/F (~1/1).

In the present study we observed that -7.78 ± 2.55 D mean spherical equivalent was and 26.37 ±0.96 mm mean axial length. Study subjects of three groups and their SE_{mean} and AL_{mean} were found to be as mentioned below; group A-(-1.76 ± 1.08 D, 24.04 ± 0.33 mm), group B-(-4.11 ± 0.79 D, 25.01 ± 0.39 mm) and, group C- (-7.87 ± 1.50 D, 26.37 ± 0.44 mm). Our study is well correlated with study by Wakitani *et al.* (2003) showed same type of results as emmetropic and low myopic (-2.20 ± 2.40 D, 24.11 ± 0.56 mm), mildly myopic (-5.75 ± 2.24 D, 25.96 ± 0.56 mm), and highly myopic (- 9.13 ± 3.05 D, 27.94 ± 0.78 mm). Whereas, AttaAllah *el al.*(2017) included two groups one control group (SE -0.65 ± 0.41 D) and high myopic group (SE –12.70 ± 3.87 D), their result might be differs from our study due to lesser selection of subjects group (2) gives less accurate result compared to this study (AttaAllah et al., 2017). In the present study we found that the mean average MT and mean MV differed significantly ($p =0.0001$) among the three groups. Thinner mean average MT and lower MV was found in high myopia when compared with the low and moderate myopia groups ($p<0.01$). Similarly, low myopia and moderate myopia were also statistically significantly differed. These findings are consistent with the results from earlier studies. Hwang & Kim (2012)., Luo *et al.* (2006), and Wu *et al.* (2008) reported thinner macular retinal thickness ($p<0.05$), lower macular volume ($p<0.05$) as the degree of myopia and axial length increases. These result and our results were consistent with other studies using SDOCT (Ooto et al., 2010; Song, Lee, Lee, Kim, & Kim, 2010). The reason behind phenomenon may be due to the increased axial length observed due to enlarge eyeball, thus it resulted in mechanical stretching of the sclera. In this condition, retinal stretching causes pan retinal thinning.

In present study no significant ($p = 0.0802$) variation was found in mean CFT amongst various grades of axial myopia. This study is well correlated with the Wakitani *et al*. (2007) found no significant variation in all the parameters of in the central fovea ($P = 0.35$). However, in previous studies done by Hwang & Kim (2012)*,* Luo *et al.* (2006), *and* Wu *et al.* (2008) they found greater foveal thickness ($p<0.05$) as the degree of myopia and axial length increased They explained by flattening and stretching tendency of the internal limiting membrane and the centripetal force of the porterior vitreous which leads elevation of the foveola and fovea. There were high incidence of macular hole due to elevated foveola and fovea area in healthy, highly myopic eyes which might be associated with retinal detachment, myopia traction maculopathy, and foveoshisis. In this study among 142 eyes only 41 eyes were high myopic eye with -7.87 ± 1.50 D SE. Whereas, Wu *et al.* (2008) studied highly myopic eyes ($SE_{mean} = -9.27 \pm 3.30, n = 80$) in comparison to nonmyopic eye ($SE_{mean} = -0.22 \pm 0.50, n = 40$). Therefore, discrepancy in CFT variation might be attributed to remarkable difference which was found in number and SE_{mean} of high myopia groups (Wu et al., 2008). This study confirmed that mean average MT and MV differed significantly ($p=0.0001$) among different grades of axial myopia but no significant ($p = 0.0802$) variation to be found in mean CFT between various grades of axial myopia.

CONCLUSION

From the all above observations we concluded that as severity of axial myopia and axial length increases, average MT was thinner, MV decreased, and CFT remain unchanged. Therefore, consideration of myopic changes is must while interpreting OCT results in macular disorders diagnosis and prognosis.

REFERENCES

1. AttaAllah, H. R., Omar, I. A. N., & Abdelhalim, A. S. (2017). Evaluation of Optic Nerve Head Parameters and Retinal Nerve Fiber Layer Thickness in Axial Myopia Using SD OCT. Ophthalmol Ther, 6(2), 335-341. doi:10.1007/s40123-017-0095-5
2. Choi, S.-W., & Lee, S.-J. (2006). Thickness changes in the fovea and peripapillary retinal nerve fiber layer depend on the degree of myopia. Korean journal of ophthalmology : KJO, 20(4), 215-219. doi:10.3341/ kjo. 2006. 20.4.215
3. Curtin, B. J., & Karlin, D. B. (1970). Axial length measurements and fundus changes of the myopic eye. I. The posterior fundus. Transactions of the American Ophthalmological Society, 68, 312-334.
4. Flores-Moreno, I., Lugo, F., Duker, J. S., & Ruiz-Moreno, J. M. (2013). The relationship between axial length and choroidal thickness in eyes with high myopia. Am J Ophthalmol, 155(2), 314-319.e311. doi:10.1016/ j.ajo. 2012. 07. 015
5. Holden, B. A., Fricke, T. R., Wilson, D. A., Jong, M., Naidoo, K. S., Sankaridurg, P., . Resnikoff, S. (2016). Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050. Ophthalmology, 123(5), 1036-1042. doi:10.1016/j.ophtha.2016.01.006
6. Hwang, Y. H., & Kim, Y. Y. (2012). Macular thickness and volume of myopic eyes measured using spectral-domain optical coherence tomography. Clinical and Experimental Optometry, 95(5), 492-498. doi:10.1111/j.1444-0938.2012.00749.x
7. Lim, M. C., Hoh, S. T., Foster, P. J., Lim, T. H., Chew, S. J., Seah, S. K., & Aung, T. (2005). Use of optical coherence tomography to assess variations in macular retinal thickness in myopia. Invest Ophthalmol Vis Sci, 46(3), 974-978. doi:10.1167/iovs.04-0828
8. Luo, H.-D., Gazzard, G., Fong, A., Aung, T., Hoh, S. T., Loon, S.-C., . . . Saw, S.-M. (2006). Myopia, Axial Length, and OCT Characteristics of the Macula in Singaporean Children. Invest Ophthalmol Vis Sci, 47(7), 2773-2781. doi:10.1167/iovs.05-1380
9. Ooto, S., Hangai, M., Sakamoto, A., Tomidokoro, A., Araie, M., Otani, T., . . . Yoshimura, N. (2010). Three-Dimensional Profile of Macular Retinal Thickness in Normal Japanese Eyes. Invest Ophthalmol Vis Sci, 51(1), 465-473. doi:10.1167/iovs.09-4047
10. Seo, S., Lee, C. E., Jeong, J. H., Park, K. H., Kim, D. M., & Jeoung, J. W. (2017). Ganglion cell-inner plexiform layer and retinal nerve fiber layer thickness according to myopia and optic disc area: a quantitative and three-dimensional analysis. BMC Ophthalmol, 17(1), 22. doi:10.1186/s12886-017-0419-1
11. Song, W. K., Lee, S. C., Lee, E. S., Kim, C. Y., & Kim, S. S. (2010). Macular Thickness Variations with Sex, Age, and Axial Length in Healthy Subjects: A Spectral Domain–Optical Coherence Tomography Study. Invest Ophthalmol Vis Sci, 51(8), 3913-3918. doi:10.1167/iovs.09-4189
12. Wakitani, Y., Sasoh, M., Sugimoto, M., Ito, Y., Ido, M., & Uji, Y. (2003). Macular thickness measurements in healthy subjects with different axial lengths using optical coherence tomography. Retina, 23(2), 177-182. doi:10.1097/00006982-200304000-00007
13. Wu, P. C., Chen, Y. J., Chen, C. H., Chen, Y. H., Shin, S. J., Yang, H. J., & Kuo, H. K. (2008). Assessment of macular retinal thickness and volume in normal eyes and highly myopic eyes with third-generation optical coherence tomography. Eye (Lond), 22(4), 551-555. doi:10.1038/sj.eye.6702789