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Original Research Article

"STUDY OF ASSOCIATION BETWEEN AXIAL LENGTH AND MACULAR THICKNESS IN MYOPIC EYE IN ADULT POPULATION"

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ABSTRACT:

Background: Myopia is one of the most common explanation for visual disability. The global prevalence of myopia threatens to increase to twice the present by the year 2050 from the present 22.9 percentage. [1] Near-sightedness is considered a scourge within the Asian continent attributable to the considerably high prevalence.

Objective:

1. To identify myopic patients in the age group 20-40 years attending the ophthalmology department of National Institute of Medical Sciences (NIMS) hospital, Jaipur.
2. To determine axial length (AL) in myopic eyes of patients using A scan ultra-sonography.
3. To calculate central macular thickness (CMT) using spectral domain optical coherence tomography (SD-OCT) in myopic patients.
4. To analyze and correlate these values in various grades of myopia in adults.
5. To compare AL and CMT in age and gender matched control group.

Material & Methods:

Study Design: Prospective hospital based observational study. Study area: department of Ophthalmology, NIMS hospital, Jaipur, India. Study Period: July 2021 - June 2022. Study population: all myopic patients within the age group 20-40 years attending the Ophthalmology OPD, NIMS hospital, Jaipur were included in the study. Sample size: study was done on 150 patients of myopia in the age group 20-40 years. A control group of 100 patients was taken. Sampling method: simple random sampling method. Study tools and Data collection procedure: those patients with complaints of diminution of vision underwent detailed history and examination. Detailed history including basic demographic data, presenting complaints, duration of myopia, past history and family history was noted for all

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patients. Detailed examination including best corrected visual acuity (BCVA) using Snellen's chart, refraction, slit lamp bio microscopy, indirect ophthalmoscopy, and intraocular (IOP) measurement by Schiotz tonometer was performed.

Results: The means (+-SD) of SE, AL and CMT of the study population were -9.38(±3.82D), 25.69(±1.83) mm ad 285.13(±60.46) micro metres respectively. There was a strong positive association between values of SE and AL as well as values of SE and CMT (p-values for both <0.00001) indicating that with increasing degrees of myopia, AL and CMT both show and increasing trend.

Conclusion: In our study we found statistically significant increase in the average AL and CMT with increasing degrees of myopia.

Keywords: Myopia, axial length, macular thickness

INTRODUCTION:

Myopia is one of the most common explanation for visual disability. The global prevalence of myopia threatens to increase to twice the present by the year 2050 from the present 22.9 percentage. [1] Near-sightedness is considered a scourge within the Asian continent attributable to the considerably high prevalence. [2]

Multiple causative factors are implied in the occurrence of myopia. An association study based on genetics proves interrelation between thirty nine genetic loci for myopia.[3] Those children who have a strong family history or are predisposed to myopic genes witness early onset of a myopic refractive error and it might worsen faster.[4] Various aspects linked to myopia include rays from LED screens, reading for longer hours and sitting close while watching television in the environmental sector.[5] Myopia is also known to be linked with vitamin D in the nutritional sector.[6] Different classifications have been used to describe myopia on the basis of different criterias.[7]

High myopia is associated with an elongated eye and there are no prefixed definitions available for it. Some define high myopia as axial length (AL) more than 26.5 mm or as the spherical equivalent (SE) greater than 8D. Although, the joint report of the WHO on "the impact of myopia and high myopia" determines high myopia as spherical equivalent more than 5D, degenerative changes which are frequently coupled with such high degrees of myopia are a significant reason provider for low vision in individuals.[8,9]

Thus, establishing correlation between high myopia and AL is significant. Research data from a past few decades, on adult myopic individuals, indicates that trends in AL distribution are bimodal.[10] When these myopic cases are grouped into two samples, two peak points are noted: 24 mm being the 1st peak point for low myopia and 30 mm being the 2nd peak point for high myopia.[11]

The normal global AL determination could be by various techniques. These techniques include the indirect method (1909), radiographic method (1942), ultrasonic method (1961), angiographic method (1962) and Photographic method (1976). The average axial length of the human eye as determined by the above methods ranges between 22 – 27 mm.

This study has been planned to investigate SE, AL and CMT; and simultaneously to investigate the effect of SE or degree of myopia on changes in AL and macular thickness (which are measured by Nidek echo scan 800 A-scan ultrasonography and Nidek RS 3000 Advance respectively). The purpose of this study was to evaluate axial expansion of the

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eyeball and posterior segment anatomical changes in high myopia using spectral domain optical coherence tomography (SD- OCT).

OBJECTIVE:

1. To identify myopic patients in the age group 20-40 years attending the ophthalmology OPD of NIMS hospital, Jaipur, India.
2. To determine axial length in myopic eyes of patients using A scan ultra-sonography.
3. To calculate macular thickness using SD-OCT in myopic patients.
4. To analyze and correlate these values in various grades of myopia in adults.
5. To compare axial length and macular thickness in age and gender matched control group.

Material & Methods:

Study Design: Prospective hospital based observational study.

Study area: Department of Ophthalmology, National Institute of Medical Sciences (NIMS) hospital, Jaipur.

Study Period: July 2021 - June 2022.

Study population: All myopic patients within the age group 20-40 years attending the Ophthalmology OPD, NIMS hospital, Jaipur were included in the study.

Sample size: Study was done on 150 patients of myopia in the age group 20-40 years. A control group of 100 patients was taken.

Sampling method: Simple Random sampling method.

Inclusion criteria:

1. Patients of age group 20-40 years, of either gender, coming to Ophthalmology OPD in NIMS hospital diagnosed with myopia.
2. Patients who are willing to give written informed consent for the study.

Exclusion criteria:

1. Any other ocular disease or ocular trauma.
2. Patients with history of intraocular surgery or refractive surgery.
3. Patients with macular pathologies.
4. Patients with history of systemic diseases like diabetes mellitus, hypertension.
5. Patients with any structural deformity who couldn't participate for OCT evaluation.
6. Un-cooperative patients.

Ethical consideration: Institutional Ethical committee permission was taken prior to the commencement of the study.

Study tools and Data collection procedure:

All patients presenting to eye OPD of NIMS hospital with complaints of diminution of vision underwent detailed history and examination. Detailed history including basic demographic data, presenting complaints, duration of myopia, past history and family history was noted for all patients. Detailed examination including BCVA using Snellen's chart, refraction, slit lamp bio microscopy, indirect ophthalmoscopy, and IOP measurement by Schiotz tonometer was performed. Those patients diagnosed as myopia after complete history and examination were selected. Inclusion and exclusion criteria were applied on the selected patients. Those patients fulfilling the Inclusion and Exclusion criteria were enrolled in the study and written informed consent was taken from each patient. Axial length of all patients was measured by A-scan ultrasonography [NIDEK ECHO SCAN 800]. Macular thickness of each patient was measured by OCT [NIDEK RS-3000 ADVANCE]. Horizontal scans (9mm* 9mm) in the

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MACULA MAP X- Y mode were taken for each patient. All the scans were taken by the same examiner under the same conditions. A group of 100 patients- age matched and non-myopic, were included as controls. Detailed history was taken and examinations were performed on controls.

Statistical Analysis:

The statistical analysis was carried out using IBM SPSS (Statistical Package for Social Sciences) statistical version 21. The analysis included frequency table, bar, pie chart, association of variables based on Chi-square. All quantitative variables were estimated using measures of central location "mean" and measures of dispersion (standard deviation). For normally distributed data, Means were compared using independent t-test (for two groups). For not normality distributed data, Medians were compared using Mann Whitney U test (for two groups). For relationships, Pearson Correlation method was used using chi square test.

OBSERVATIONS & RESULTS:

Table 1: Mean Age-Wise Distribution of Cases and Controls

Groups	Mean Age (Years)	Standard Deviation
Cases	30.04	5.91
Controls	30.15	5.86

This study included 300 eyes of 150 subjects with high myopia with spherical equivalent being -6.00D or above and 200 eyes of 100 emmetropes (0.00 D). All subjects belonged to the age group of 20-40 years with the mean age of 30.04±5.91 years in cases and 30.15 ±5.86 years in controls (table 1).

Table 2: Frequency and Gender-Wise Distribution of Cases and Controls

Groups	Frequency (N))		Percentage (%)	
	Males	Females	Males	Females
Cases	87	63	58	42
Controls	51	49	51	49

The study group had 87 males (58%) and 63 females (42%). More cases of high myopia were observed in males as compared to females as per the study. As controls, 51 males and 49 females were recruited out of total of 100 subjects (table 2).

Table 3: Observations with Degree of Myopia

Groups	Mean spherical equivalent (SE) (D)	Standard deviation (D)	Range of values (D)
Cases	-9.48	+-3.82	-6.00 to -18.00
Controls	0.00	0.00	0.00

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The mean (±SD) SE of the study population was - 9.38(±3.82D) with a range of -6.00D to -18.00D and controls being emmetropes (0.00D) (table 3).

Table 4: Correlation between spherical equivalent (SE) and axial length AL)

Groups	Mean (mm)	Standard deviation (mm)	Range (mm)	p- value	t- value
Cases	25.69	+-1.83	22 to 30.15	0.00001	35.006051
Controls	21.99	+-0.84	21 to 23		

The mean (±SD) AL of the study population was 25.69(±1.83) mm with a range of 22 to 30.15mm in cases and 21.99(±0.84) mm with the range being 21 to 23 mm in controls as shown in table 4. There was a strong positive association between SE and AL (p- value 0.00001, t- value 35.006051) signifying that in higher degrees of myopia, the AL elongation was more.

Table 5: Correlation between spherical equivalent (SE) and central macular thickness (CMT)

Groups	Mean (micrometres)	Standard deviation (micrometres)	Range (micrometres)	p- value	t- value
Cases	285.13	+-60.46	48 to 400	0.00001	22.853918
Controls	205.00	+-24.07	172 to 242		

The mean (+-SD) central macular thickness of the study population was 285.13(±60.46) micro metres in cases with the range being 40 to 400 micrometres and 205.00 micrometres in controls with the range being 172 to 242 micrometres as shown in table 5. The association value between SE and CMT was quite strong (p-value 0.00001, t-value 22.853918) denoting that with increasing order of degree of myopia, thickness of central macula increases.

There is a strong positive association between values of SE and AL as well as values of SE and CMT (p-values for both <0.00001) indicating that with increasing degrees of myopia, AL and CMT both show and increasing trend. Also, there was a positive correlation between values of AL ad CMT in myopic patients. An observation also states that trend in the values of CMT is flat until 24.5 mm AL after which only it begins to steepen indicating that increase in CMT begins only after elongation of AL is 24.5mm or more irrespective of the SE (p-value < 0.00001, t- value 5.524218).

DISCUSSION:

Previously, the major cause of degenerative changes in high Myopia was believed to be atrophy of the pigment epithelium. With the advent of OCT, we have been able to analyze the macular anatomy and changes in high myopes much better than earlier times. Thus, we studied values of AL and CMT in high myopic subjects to evaluate changes leading to stretching of the posterior pole and eventually increase in the thickness of central macula/fovea. This study is based on the hypothesis that high myopes may have a significant increase in AL and CMT that could place them outside the normal range, as compared with the values of controls.

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In our study, we included age matched cases and controls where the age ranged from 20 to 40 years as age could be a confounding factor for determination of AL and CMT. The mean age of cases was 30.04 +- 5.91 years and controls was 30.15 +- 5.86 years. The study included males (58%) more than females (42%). Wu, P-C et al conducted a similar comparative study in a prospective fashion which was nonrandomized with two groups: high myopic and non-myopic population. The mean age of the high myopic group and non-myopia group was 29.6 and 27.5 years respectively.[12]

In the present observational study, the major goal was to observe high myopic eyes using A-scan ultrasonography and OCT machines. So, the predetermined inclusion criteria were -6.00D or more and subjects with no refractive error (0.00D) were taken as controls to abolish instrument error in values of observed variables. The mean SE observed was -9.48D (±3.82D) in cases and controls were emmetropes (0.00D).

Wu, P-C et al took into recruitment similar groups of subjects: 80 high myopic subjects, defined as SE < -6.00D or AXL>or=26.5 mm and 40 healthy subjects, defined as an error with SE between 1.5D and -1.5 D. They included one more criterion of BCVA better than 20/25 in cases as well as controls. The mean error of refraction was -9.27D in the highly myopic group and -0.22D in healthy subjects identical to that observed in our study.[12]

Similar mean of SE was found in a study by Nishida, Yasunori et al with the value being -10.9 D (±3.6 D) in the New York cohort and -9.2 D (±3.1 D) in the Japanese cohort.[13] Flores-Moreno, Ignacio et al also performed an analysis of relationship between thickness of retina and choroid and tried to correlate them with visual acuity (VA) in 60 eyes of 46 highly myopic patients where an identical population to our study that is those with spherical equivalent ≥-6 D or AL ≥26 mm was studied in a clinical setting.[14] The mean value of SE was -12.05±5.02 D (range -6 to -26). Whereas Chen, Si et al evaluated the macular thickness or volume in 194 Chinese myopic children where they divided them into subgroups as emmetropia (- 0.5 diopters [D] < SER ≤ 0.5 D), low myopia (-3.0 D < SER ≤ -0.5 D), and moderate to high myopia [(spherical equivalent refraction (SER ≤ -3.0 D)]; and assessed correlation of macular thickness or volume with SER along with other values like AL and factors like sex and age. Each child underwent ophthalmic examinations including VA, cycloplegic refraction, and AL measurement.[15]

In the current study, we have excluded eyes with any ocular disease including macular pathology or any systemic disease like diabetes mellitus and hypertension which may or may not have an influence on the values of CMT of cases. Then the values observed solely may be influenced by the SE or the AL of the subjects.

Nishida, Yasunori et al conducted an identical study measured choroidal thickness as a predictor of visual acuity in high myopes (≥6 diopters [D]) in 2 retina centers, one in the United States and the other in Japan. As a similarity, no other pathology such as choroidal neovascularization (CNV) , foveal lacquer cracks or myopic macular schisis was included.[13]

Also, Flores-Moreno, Ignacio et al excluded those highly myopic eyes with any clinically available evidence of macular disease or amblyopia analogous to our study.[14] Whereas, in a study by El Matri, L et al, they analyzed 64 highly myopic eyes with CNV and 64 highly myopic eyes without CNV to establish association between choroidal thinning and choroidal pathologies that might be due to hypoxic changes.[16]

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When with proper consent of the subjects, the AL was measured with a-scan ultrasonography, the mean AL observed in cases was 25.69+-1.83 mm and in controls was 21.99+- 0.84 mm. This study, on the basis of the observed values in high myopic eyes (-6.00D or more), concludes that elongation in AL is seen with progressive values of SE (p-value <0.00001, t- value 22.853918).

Lam, Dennis Shun Chiu et al concluded results coinciding with our study as in there was a positive correlation between the AL and the average foveal thickness (r = 0.374, P < 0.001) when they tried to establish regional variations between foveal thickness in myopic population.[17] Harb, Elise et al in an ethnically diverse 'Correction of Myopia Evaluation Trial (COMET)' cohort found that AL was significantly associated with mild thickening of central fovea (p = 0.001) which is in correlation to the results observed in our study.[18]

In our study, the mean values of CMT in cases were 285.13 +- 60.46 micrometres and in controls was 205.00 +- 24.07 micrometres. The study analysis showed that CMT was significantly positively associated with increase in the refractive error in high myopic subjects (p- value <0.00001, t- value 22.853918). Also, increase in CMT was seen only after increase in AL values beyond 24.5mm (p- value 0.00001, t- value 5.524218).

Similar results were found in a study conducted by Yeon Woong chung et al with the trend of central foveal thickness being relatively flat at value of AL below 25.5mm and beyond which a positive association is seen with increasing values of AL.[19]

Lam, Dennis Shun Chiu et al in their study concluded similar results that there was a positive correlation between the AL and the average foveal thickness (r = 0.374, P < 0.001). They concluded that retinal thickness is related to refractive error/AL in normal subjects with regional variations in correlation within the 6-mm macular region.[17]

Similarly**,** Wu, P-C et al concluded that high myopia group had significantly higher values of mean retinal thickness in the foveola and fovea 1 mm area than the emmetropic group (166 vs149 micron, P<0.0001, 199 vs 188 micron, P=0.0063, respectively).[12]

Even**,** Harb, Elise et al proved in their study that increased AL was significantly associated with slightly thicker central foveal (p = 0.001) and thinner parafoveal (p = 0.02) and perifoveal (p < 0.0001) regions.[18]

In an identical scenario, Hwang et al found mean value of foveal thickness and macular volume as 277.3 ± 12.3 µm and 10.1 ± 0.4 mm respectively which is quite similar to our study. They also showed that average foveal thickness increased as the degree of myopia/AL increased (p< 0.01).[20]

As contrasting conclusions, in each group, New York and Japan in the study by Nishida Yasunori et al subfoveal choroidal thickness showed a strong negative correlation when analyzed by increasing myopic refractive SE. The subfoveal choroidal thickness was inversely correlated with logMAR VA (P = 0.041, New York group; P = 0.001, Japan group).[13]

CONCLUSION: In our study we found statistically significant increase in the average axial length and central macular thickness with increasing degrees of myopia. It is important because, these observations suggest that there might be presence of early anatomical changes in the retinas of population with axial myopia which can be detected with the help of advanced OCT systems. In the evaluation of macular pathologies and diseases like glaucoma,

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values of macular thickness should be interpreted only in the context of refractive errors and measurement location.

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