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RESEARCH ARTICLE

Association of macular thickness with Axial length & parapapillary atrophy in myopic eyes - A cross sectional study

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Abstract: ***Background:*** The risks of visual impairment, which include retinal detachment, posterior staphyloma, cataract, choroidal neovascularization, and macular hole, increase dramatically as myopia worsens. With modern imaging technology such as Optical coherence tomography (OCT), which provides high-resolution retinal images, measures retinal thickness with high repeatability.***Aims & Objectives:*** To determine the macular thickness in > -0.5D myopic patients. To correlate macular thickness with axial length.***Methodology:*** An Observational cross sectional study was conducted among 61 patients aged >18 years & <35 attending Out Patient Department of Ophthalmology at R. L. Jalappa Hospital and Research, Kolar. ***Results:*** The mean age of study participants was 27.6 + 3.8 years. The mean axial length was 26.5 + 1.35. The mean power of myopia was -3.97 + 1.56. The mean central macular thickness was 238.6 + 21.3. There was positive correlation found between axial length, and age. Also positive correlation found between power of myopia and central macular thickness. There was negative correlation found between power of myopia and central macular thickness and age. The negative correlation found between power of myopia and axial length as well as central macular thickness. There was no significant correlation between parapapillary atropy & macular thickness in myopic eyes. ***Conclusion:*** The macular thickness in myopic eyes is significantly influenced by axial length. A positive correlation was observed between axial length and age. These findings suggest that progressive axial elongation and increasing myopic power are associated with structural changes in the macula, which may predispose eyes to further complications.

Keywords: Macular thickness, Axial length, Myopia, vision.

INTRODUCTION

Globally, myopia is an extremely common ocular condition. Myopic eyes show a number of pathophysiological alterations, including as sclera, choroid, and retinal thinning, in addition to the elongation of axial length [1-3].

The risks of visual impairment, which include retinal detachment, posterior staphyloma, cataract, choroidal neovascularization, and macular hole, increase dramatically as myopia worsens [4,5]. Myopic eyes may be more prone to glaucoma than normal eyes, according to a number of cross-sectional studies [6,7]. For the purpose of diagnosing myopia-related disorders early, it will be helpful to comprehend the process of myopia and its fundamental impact on the retina. High-resolution pictures and the ability to see specific morphological alterations in each macular intraretinal layer and ONH are made possible by spectral-domain optical coherence tomography (SD-OCT) [8]. The assessment of every intraretinal layer in the macula can provide us with important information for the diagnosis and follow-up of a number of eye conditions, such as macular edema, glaucoma, and optic neuropathy. Additionally, the prediction of its variability is useful for the treatment of retinal disorders [9].

High myopia has been defined differently even in research that define myopia based on axial length. High myopia was described by some research as having an axial length greater than 25.0 mm, while other studies characterized it as having an axial length greater than 26.00 mm or 26.5 mm. With modern imaging technology such as Optical coherence tomography (OCT), which provides high-resolution retinal images, measures retinal thickness with high repeatability, so this study aims to assess the association between Myopia and Axial length.

Parapapillary atrophy (PPA) is common in myopic and glaucomatous eyes, which is classified into the peripheral α-zone and central β-zone on fundus photography. The α-zone is an irregular pigmentation of the retinal pigment epithelium (RPE), while the β-zone is considered atrophy of the choroid and RPE. On the basis of the location of Bruch's membrane (BM) termination, β-zone PPA can be classified into β-parapapillary atrophy with and without BM (PPA+BM and PPA-BM). The region with BM but without the RPE is PPA+BM, and the region with neither the RPE nor BM is PPA-BM (or in other words γ zone PPA)10

Aims & Objectives: To determine the macular thickness in > -0.5D myopic patients. To correlate macular thickness with axial length.

MATERIALS AND METHODS

An observational cross-sectional study was conducted in the Department of Ophthalmology, R. L. Jalappa Hospital and Research Centre, Kolar, to evaluate the association between macular thickness and axial length in myopic eyes.

A total of 61 eyes of 61 myopic patients, aged between 18 and 35 years, were included in the study. The study duration was one year, the sample size was calculated based on a 95% confidence interval, with variance (σ^2) derived from previous studies ($\sigma^2 = 38.81$) and a margin of error of 10, yielding a required sample size of 61 subjects.

Prior to enrolment, written informed consent was obtained from all participants. The study adhered to the tenets of the Declaration of Helsinki, and ethical clearance was obtained from the Institutional Ethics Committee of Sri Devaraj Urs Medical College, Kolar.
All participants underwent a comprehensive ophthalmic examination, which included:
• Distant visual acuity assessment using Snellen's chart.
• Near vision testing using Jaeger's chart.
• Objective refraction using an Autorefractometer (Topcon KR-8900 or equivalent), with spherical equivalent calculated as sphere + ½ cylinder.
• Intraocular pressure (IOP) measurement by Goldmann applanation tonometry.
• Anterior segment evaluation using slit-lamp biomicroscopy.
• Posterior segment evaluation using a +90D lens under slit-lamp to assess optic nerve head and macular contour.
Axial length was measured using A-scan ultrasound biometry (Appasamy Associates or equivalent). Each measurement was performed three times by the same examiner, and the average value was recorded to minimize measurement bias.
Macular thickness was measured using Spectral-Domain Optical Coherence Tomography (SD-OCT). The scans were performed under standardized lighting conditions by a single trained operator.
• The central macular thickness (CMT) was recorded as the mean retinal thickness within the central 1 mm diameter circle of the ETDRS (Early Treatment Diabetic Retinopathy Study) grid centered on the fovea.
• Scans with signal strength <7/10 or segmentation errors were excluded.

Source of Data
The study population consisted of patients attending the Outpatient Department of Ophthalmology at R. L. Jalappa Hospital and Research Centre, Kolar, who were diagnosed with myopia and met the inclusion criteria during the study period. All data were collected prospectively using a structured proforma designed for the study.

Inclusion Criteria
• Age between 18 and 35 years.
• Refractive error of myopia greater than –0.5 diopters (spherical equivalent).
• Intraocular pressure ≤ 21 mmHg.
• Normal optic nerve head on stereoscopic fundus examination.
• Clear ocular media allowing good OCT image quality.

Exclusion Criteria
• Presence of systemic diseases affecting the retina (e.g., diabetes mellitus, hypertension).
• Retinal diseases such as macular edema, retinopathy, or dystrophies.
• History of ocular trauma, intraocular or refractive surgery.
• Glaucoma, uveitis, or any optic nerve pathology.
• Poor-quality OCT images due to media opacities (corneal scar, cataract, or vitreous haze).

Statistical Analysis
All collected data were entered in Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) software version 22.0.
• Descriptive statistics were used to summarize demographic and clinical data. Continuous variables were presented as mean ± standard deviation (SD), and categorical variables as frequency and percentage.
• The Pearson correlation coefficient (r) was employed to assess the relationship between central macular thickness (CMT) and axial length, refractive error, and age.
• Scatter plots were generated to visualize the correlation between CMT and the independent variables.
• A p-value < 0.05 was considered statistically significant.

RESULTS AND OBSERVATIONS:

Total 61 study participants were included in the study.

Table 1. Age wise distribution of study participants (n=61)

Age group (in years)	Frequency	Percentage
21-25	21	34.4

26-30	24	39.3
31-35	16	26.2
Mean age	27.6 ± 3.8 years	

The mean age of study participants was 27.6 ± 3.8 years. Out of total, 21(34.4%) study participants belonged to 21-25 years of age group, 24(39.3%) cases belonged to 26-30 years and 16 (26.2%) cases belonged to 31-35 years of age group. [Table 1]

Table 2. Eye examination variables wise distribution of study participants (n=61)

Variables	Mean ± SD
Axial length	26.5 ± 1.35
Power of Myopia	-3.97 ± 1.56
Central macular thickness	238.6 ± 21.3

The mean axial length was 26.5 ± 1.35. The mean power of myopia was -3.97 ± 1.56. The mean Central macular thickness was 238.6 ± 21.3. [Table 2]

Table 3. Correlation between various variables and macular thickness (n=61)

Variables		Age	Axial length	Power of Myopia	Central macular thickness (CMT)
Age	Pearson's r	—			
	df	—			
	p-value	—			
Axial length	Pearson's r	0.692	—		
	df	59	—		
	p-value	< .001	—		
Power of Myopia	Pearson's r	-0.571	-0.889	—	
	df	59	59	—	
	p-value	< .001	< .001	—	
Central macular thickness (CMT)	Pearson's r	-0.760	-0.619	0.337	—
	df	59	59	59	—
	p-value	< .001	< .001	0.008	—

On applying Pearson's correlation test, there was positive correlation found between axial length , and age. Also positive correlation found between power of myopia and central macular thickness. There was negative correlation found

between power of myopia and Central macular thickness and age. The negative correlation found between power of myopia and axial length as well as central macular thickness. [Table 3]

There was no significant correlation between parapapillary atropy & macular thickness in myopic eyes.

DISCUSSION

In the present study, the mean central macular thickness (CMT) among myopic participants was 238.6 ± 21.3 µm, with significant correlations observed between axial length, degree of myopia, and macular thickness. A negative correlation was found between axial length and CMT, which is consistent with the general understanding that progressive axial elongation leads to retinal thinning in myopic eyes. Similar findings were reported by Gupta et al. (2018) in a North Indian population, where increasing axial length was associated with significant reduction in central and parafoveal macular thickness, suggesting a direct structural impact of axial elongation on retinal architecture. [11]

In contrast, Rani et al. (2019) observed that while axial length showed an inverse relationship with macular thickness in high myopia, the correlation was less pronounced in low to moderate myopes. This difference highlights the potential role of pathological changes occurring predominantly in higher degrees of myopia, which may not be as evident in moderate cases. Our study included patients with mean myopia of -3.97 D, thus representing the moderate range, which may explain why some correlations were weaker compared to high myopia cohorts. [12]

Furthermore, Shukla et al. (2021) conducted a study in a South Indian population and demonstrated significant association between parapapillary atrophy (PPA) and reduced macular thickness, particularly in the β-zone. Their results align with the present study, where PPA was also considered as a factor influencing macular thinning. The observed relationship between power of myopia, axial length, and CMT in our data supports their conclusion that both mechanical stretching of the globe and parapapillary changes contribute to central retinal thinning in myopia. [13]

According to Lee et al. [14], when compared to the inner retinal structures in the developing eye, the development of PPA-BM reflected scleral overgrowth. The high correlation between PPA-BM and axial length may therefore explain the link between PPA-BM and myopia. In summary, we propose that PPA-BM mostly represents the broad posterior pole shift brought on by optic nerve traction from axial elongation, while PPA+BM primarily contributes to localized disruption of parapapillary choriocapillaris circulation.

CONCLUSION

The macular thickness in myopic eyes is significantly influenced by axial length. A positive correlation was observed between axial length and age. These findings suggest that progressive axial elongation and increasing myopic power are associated with structural changes in the macula, which may predispose eyes to further complications. Early identification of such alterations using spectral-domain OCT can aid in monitoring disease progression and timely management of myopia-related retinal disorders. Larger studies with longitudinal follow-up are recommended to validate these associations and to better understand the long-term implications of myopia on macular health.

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