

Research Article



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EVALUATING HOW AXIAL ELONGATION AFFECTS AST ANTERIOR SCLERAL THICKNESS IN MYOPIC PATIENTS

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ABSTRACT

Background: Macular degeneration and glaucoma can become more common as a result of myopia. Myopia has significantly increased due to the recent rise in the usage of technological devices. Therefore, in order to better grasp potential myopia mechanisms and other diseases, it is essential to comprehend the characteristics of the anterior sclera of myopia.

Aim: The purpose of this study was to evaluate how axial elongation affected the anterior scleral thickness (AST) of myopic patients.

Methods: During the specified study period, 244 participants without any systemic illnesses or ocular conditions affecting ametropia were evaluated at the Institute. The subjects were split into three groups based on the diopter and AL (axial length): 80 people in the high myopia group, 80 people in the low to moderate myopia group, and 64 people in the emmetropia group. The collected data was statistically examined.

Results: The superior side had the lowest AST, followed by the nasal side, lower side, and temporal side, with respective values of $550.74 \pm 51.32 \mu\text{m}$, $671.52 \pm 61.74 \mu\text{m}$, $692.30 \pm 74.74 \mu\text{m}$, and $716.43 \pm 65.53 \mu\text{m}$. The mean AST at four diameter lines and AL showed a link, with the nasal side showing the strongest correlation ($p < 0.001$), followed by the upper, lower, and temporal sides. Age and mean ASE on the temporal, nasal, and upper sides were significantly correlated ($p < 0.001$). AST and age showed a positive association, while AST and AL showed a negative correlation with $p < 0.05$.

Conclusion: The current study concludes that AL and measurement position affected the sclera thickness. Age and AST are positively correlated, but AL and AST are negatively correlated. Individuals with extreme myopia have a thinner anterior sclera than those with low to moderate myopia and emmetropia. AST is impacted by both myopia and posterior sclera thickness.

Keywords: Anterior sclera thickness, AST, axial length, myopia, optical coherence tomography

INTRODUCTION

The prevalence of myopia has been rising quickly, making it a global health concern. By the end of 2050, about half of the world's population is predicted to have myopia, with about 10% exhibiting extreme myopia. There is sufficient prior research to show that axial elongation in myopia causes an increase in connective tissue remodeling, which puts mechanical tensile tension on the eyeball wall. This leads to biomechanical changes in the sclera as well as damage to the

choroid and retina. These changes are essential for the development and advancement of myopia, which encourages the elongation of myopic eyes and causes posterior scleral staphyloma. 1 The sclera makes up around 85% of the human eyeball's outer layer. It is mostly composed of collagen with fibroblasts scattered throughout to produce and preserve the extracellular matrix.

The sclera supports the ciliary muscle, which aids in lens control, by acting as an extraocular muscular anchor. Additionally, it offers a conduit that makes it easier for blood vessels and neurons in the intraocular structure to interchange liquids, including aqueous humor entering the choroid through the uveoscleral pathway. Additionally, the sclera preserves the cornea's refractive condition, which is essential for vision. From birth to two years of age, scleral volume increases before remaining constant. However, the sclera thins with axial elongation.²

The sclera has a major role in determining the size and shape of the eye. Numerous human and animal studies support the idea that different species share a common mechanism. The AL (axial length) of the eye is actively matched with the focal length via visual cues. Emmetropization is the term for this active, visually directed process.

The foundation of emmetropization is a feedback mechanism that modifies scleral remodeling and aligns the axial length of the eye with the optical system. This mechanism involves the detection of visual stimuli at the retina, which sends a signal to the sclera and controls axial elongation and sclera remodeling. Numerous studies in the literature show how scleral remodeling, biomechanics, structure, and composition change as myopia advances.³

Numerous studies have examined morphological changes in the posterior sclera of myopic people and reported changes in the posterior sclera in these subjects. Axially elongated eyes are typically thought to have substantial sclera thinning and posterior tissue loss. Nevertheless, only a small number of studies have evaluated alterations in the anterior sclera of myopic eyes, and those that have done so have produced conflicting findings.

According to earlier research, there was no discernible difference in the scleral thickness measured at the limbus between axially and non-axially elongated eyes using OCT (optical coherence tomography) and histomorphology. Few studies have also documented an increase in AL.⁴

Macular degeneration and glaucoma may become more common as a result of myopia. Macular degeneration and glaucoma can become more common as a result of myopia. Myopia has significantly increased due to the recent rise in the usage of technological devices. Therefore, in order to better grasp potential myopia mechanisms and other diseases, it is essential to comprehend the characteristics of the anterior sclera of myopia. 5 The purpose of the current study was to evaluate how axial elongation affected myopic patients' anterior scleral thickness, or AST.

MATERIALS AND METHODS

The goal of the current observational study was to evaluate how axial elongation affected the anterior scleral thickness (AST) of myopic participants. The Institute's Department of Ophthalmology provided the study participants. Before participating in the study, all subjects and school administrators gave their verbal and written informed consent. The current study evaluated 244 patients treated at the Institute over the specified study period who did not have any systemic or ocular conditions affecting ametropia.

The subjects were split into three groups based on the axial length and diopter: 80 individuals in the high myopia group, 80 in the low to moderate myopia group, and 64 in the emmetropia group. Ages 20 to 35, normal binocular vision, intraocular pressure (IOP) ≤ 21 mmHg, astigmatism within ± 2 D, and spherical equivalent (SE) refractive error between -12.0 and -0.5 were the study's inclusion criteria. Participants who had not worn orthokeratology lenses during the previous week, had been diagnosed with diabetes or hypertension, had raised intraocular pressure (IOP), had a history of glaucoma, had undergone intraocular or refractive surgery, or had pathological myopia in first-degree relatives were excluded from the study.

Following final inclusion, each subject underwent a primary and thorough evaluation of the eye, which included taking wide field fundus pictures, calculating central diopter, measuring AL and mean meridian corneal curvature, assessing scleral thickness, measuring IOP, measuring BCVA (best corrected visual acuity), measuring ametropia, examining mydriasis fundus, and using slit-lamp biomicroscopy.

Central refraction was measured three times and AL was measured five times on average. The same examiner performed all measures, and a qualified and experienced optometrist performed subjective optometry on each participant. Comprehensive optometry was used to measure the diopter, and the result was expressed as SE minor, which was computed as $SE = \text{spherical mirror degree} + 1/2 \times \text{cylindrical mirror degree}$. Laser scanning ophthalmoscopy was utilized to further rule out fundus conditions other than myopia.

AST was measured using an OCT scanner with a 9mm single line scan and the addition of the anterior segment of the eye. For about five seconds, participants were required to look at four fixation points: right, left, downward, and upward. The original B-scan OCT pictures were obtained at four diameters from the nasal, temporal, upper, and lower sides. Caliper was used to conduct manual measurements following the acquisition of the OCT image.

Starting from the scleral spur (SP), the length of the sclera was measured at 6 mm intervals, with 1 mm separating each measurement point. The vertical distance between the upper and lower scleral margins indicated the thickness of the sclera. High myopia group: $SE < -6.00\text{ D}$ ($AL > 26.5\text{ mm}$); mild myopia group: $-6.00\text{ D} < -0.5\text{ D}$ ($24.5 < AL < 26.5\text{ mm}$); and emmetropia group: $-0.5\text{ D} < SE < +0.5\text{ D}$ ($22 < AL < 24.5\text{ mm}$).

Gender, age, SE, BMI (body mass index), AL (axial length), and AST thickness on the temporal, nasal, lower, and upper sides were all collected for research participants. The chi-square test, Fisher's exact test, Mann Whitney U test, and ANOVA, chi-square test, and student's t-test were used in the statistical analysis of the collected data using SPSS (Statistical Package for the Social Sciences) software version 24.0 (IBM Corp., Armonk, NY, USA). A p-value of less than 0.05 was used as the significance criterion.

RESULTS

The goal of the current observational study was to evaluate how axial elongation affected the anterior scleral thickness (AST) of myopic participants. During the specified study period, the current study evaluated 244 participants who did not have any systemic illnesses or ocular conditions that could cause ametropia at the Institute.

The subjects were split into three groups based on the diopter and AL (axial length): 80 individuals in the high myopia group, 80 in the low to moderate myopia group, and 64 in the emmetropia group. When the study subjects' demographic data were compared, the mean age of the high, low to moderate, and emmetropia groups was 31.33 ± 0.47 , 31.47 ± 7.54 , and 30.45 ± 6.46 years, respectively, indicating no statistical difference with $p=0.164$. In the groups with high myopia (42 men and 38 females), low to moderate myopia (34 males and 46 females), and emmetropia (28 males and 36 females), there was a statistically non-significant difference ($p=0.625$). BMI showed a similar non-significant difference ($p=0.141$). Nevertheless, SE showed a statistically significant difference ($p<0.001$). With $p<0.001$, AL was lowest in the emmetropia group and considerably greater in the high myopia group, followed by low to moderate myopia (Table 1).

According to the study's findings, there was a non-significant correlation between gender and lower side AST ($p=0.116$) and a significant correlation between age and mean nasal, mean temporal, and mean upper side AST ($p<0.001$). Axial length was shown to be significantly correlated with mean nasal AST, mean temporal AST, mean lower side AST, and mean upper side AST ($p<0.001$) (Table 2). Additionally, it was observed that while comparing the two genders' mean AST,

The average AST for males and females was 551.37 ± 41.47 and 560.87 ± 52.47 , respectively, with a statistically insignificant difference ($p=0.383$). Nasal average AST, mean temporal AST, mean lower AST, and mean upper AST all showed similar non-significant differences, with p-values of 0.212, 0.134, 0.413, and 0.222, respectively (Table 3).

DISCUSSION

The current study evaluated 244 participants at the Institute over the specified study period who did not have any systemic illnesses or ocular conditions that could cause ametropia. The subjects were split into three groups based on the diopter and AL (axial length): 80 people in the high myopia group, 80 people in the low to moderate myopia group, and 64 people in the emmetropia group. The study design was in line with earlier research by Han LF et al. (2023) and Panda Jonas et al. (2022), whose authors also used a study design akin to this one.

According to the study's findings, there was no statistically significant difference between the high, low to moderate, and emmetropia groups' mean ages of 31.33 ± 0.47 , 31.47 ± 7.54 , and 30.45 ± 6.46 years, respectively. In the groups with high myopia (42 men and 38 females), low to moderate myopia (34 males and 46 females), and emmetropia (28 males and 36 females), there was a statistically non-significant difference ($p=0.625$). BMI showed a similar non-significant difference ($p=0.141$).

On the other hand, SE showed a statistically significant difference with $p<0.001$. AL was lowest in the emmetropia group ($p<0.001$) and significantly greater in the extreme myopia group, followed by low to moderate myopia. These findings were in line with those of Sung MS et al. (8) and Fernández Vigo JI et al. (9), whose findings for comparing the demographic characteristics of study participants with myopia were similar to the current study's findings.

The link between the research individuals' mean AST, gender, axial length, and age was shown to be significant for mean nasal, mean temporal, and mean upper side AST ($p<0.001$) and non-significant for gender and lower side AST ($p=0.116$).

Axial length showed a significant connection ($p<0.001$) with mean nasal AST, mean temporal AST, mean lower side AST, and mean upper side AST. These results were consistent with those of Shen L et al. (2015) and Ebnetter A et al. (2015), who also observed correlations between mean AST, gender, axial length, and age in myopia participants similar to the current study.

The study's findings also revealed that the mean AST for men and women was 551.37 ± 41.47 and 560.87 ± 52.47 , respectively, with a statistically insignificant difference of $p=0.383$. The mean temporal AST, mean lower AST, and nasal average AST all showed similar non-significant differences, and mean upper AST with p-value of 0.212, 0.134, 0.413, and 0.222 respectively. These findings were consistent with those of Coudrillier B. et al. (2015) and Dogan M. et al. (2019), whose comparisons of the mean AST in the two genders were similar to those of the current study.

CONCLUSION

Within its constraints, the current study concludes that the sclera thickness varied with AL and measurement position. Age and AST are positively correlated, but AL and AST are negatively correlated. Individuals with extreme myopia have a thinner anterior sclera than those with low to moderate myopia and emmetropia. AST is impacted by both myopia and posterior sclera thickness.

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S. No	Characteristics	High myopia group (n=80)	Low to moderate myopia group (n=80)	Emmetropia group (n=64)	p-value
1.	Mean age (years)	31.33±0.47	31.47±7.54	30.45±6.46	0.164
2.	Gender				
a)	Males	42	34	28	0.625
b)	Females	38	46	36	
3.	BMI (kg/m ²)	23.44±3.44	22.47±4.52	23.39±3.44	0.141
4.	SE (D)	-14.45±5.42	-5.11±2.11	-0.14±0.21	<0.001
5.	AL (mm)	30.42±1.31	25.46±0.89	23.69±0.87	<0.001

Table 1: Comparison of demographic characteristics in study subjects

S. No	parameter	Mean nasal AST		Mean temporal AST		Mean lower side AST		Mean upper side AST	
		r	p	r	p	r	p	r	p
1.	Age	0.409	<0.001	0.424	<0.001	0.134	0.116	0.543	<0.001
2.	Axial length	-0.453	<0.001	-0.361	<0.001	-0.404	<0.001	-0.429	<0.001

Table 2: Correlation between mean AST, gender, axial length, and age of study subjects

S. No	Diameter	Females (n=100)	Males (n=104)	p-value
1.	All mean AST (μm)	551.37 $\pm$ 41.47	560.87 $\pm$ 52.47	0.383
2.	Nasal average AST (μm)	561.47 $\pm$ 5.47	573.64 $\pm$ 65.82	0.212
3.	Mean temporal AST (μm)	591.46 $\pm$ 45.46	605.71 $\pm$ 44.17	0.134
4.	Mean lower AST (μm)	591.47 $\pm$ 31.42	587.55 $\pm$ 37.76	0.413
5.	Mean upper AST (μm)	489.45 $\pm$ 32.38	475.44 $\pm$ 29.47	0.222

Table 3: Comparison of mean AST in the two genders