Original Research Paper

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

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ABSTRACT

Background: The prevalence of glaucoma and macular disease can rise as a result of myopia. Myopia has significantly grown in recent years due to the growing usage of technological devices. For a better understanding of the possible mechanisms behind myopia and other disorders, it is essential to comprehend the features 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 patients at the Institute who had no ocular conditions influencing ametropia or systemic disorders were evaluated for this investigation. The individuals were split into three groups based on their diopter and AL (axial length): 80 patients were in the high myopia group, 80 subjects were in the low to moderate myopia group, and 64 subjects were in the emmetropia group. A statistical analysis was performed on the collected data.

Results: The superior side had the lowest AST, followed by the nasal side, lower side, and temporal side, with respective values of 550.74 ± 51.32 μm, 671.52 ± 61.74 μm, 692.30 ± 74.74 μm, and 716.43 ± 65.53 μm. The mean AST at four diameter lines and AL showed a link, with the nasal side showing the strongest association ($p<0.001$), followed by the upper, lower, and temporal sides. Age and mean ASE on temporal, nasal, and upper sides showed a strong association ($p<0.001$).

Conclusion: The current study comes to the conclusion that AL and measurement position had an impact on sclera thickness. There is a positive association between age and AST and a negative correlation between AL and AST. Subjects with extreme myopia had narrower anterior scleras than those with low to moderate myopia and emmetropia. AST and posterior sclera thickness are both impacted by myopia.

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

INTRODUCTION

The prevalence of myopia has been rising quickly, making it a major worldwide health issue. By the end of 2050, about 10% of people worldwide are predicted to have high myopia, and almost half of all people will have myopia. There is sufficient evidence from earlier research to suggest that myopia causes axial elongation and an increase in connective tissue remodeling, which puts mechanical tensile tension on the ocular wall. This leads to biomechanical changes in the sclera as well as damage to the retina and choroids. These changes are essential for the growth and advancement of myopia, which encourages the elongation of myopic eyes and leads to posterior scleral staphyloma. 1 The sclera makes up around 85% of the human eyeball's outer layer. Collagen and fibroblasts, which create and preserve the extracellular matrix, make up the majority of it.

The ciliary muscle is supported by the sclera, an extraocular muscular anchor that aids in lens control. Additionally, it offers channels that help the intraocular structure's blood vessels and nerves exchange liquids, including aqueous humor that enters the choroid through the uveoscleral route. Additionally, the sclera keeps the cornea's refractive condition stable, which is essential for vision. From birth to age two, the scleral volume increases, after which it remains constant. However, the sclera thins with axial elongation.2

One of the main determinants of eye size and shape is the sclera. Numerous human and animal research support the idea that different species have a similar mechanism. The axial length (AL) of the eye and the focal length are actively matched using visual cues. We call this active, visual-guided process emmetropization.

Emetropization is based on a feedback mechanism that modifies scleral remodelling and aligns the axial length of the eye with the optical system, according to a number of literature research. Axial elongation and sclera remodeling are regulated by the detection of visual stimuli at the retina, which sends a signal to the sclera. Extensive literature data show alterations in scleral remodeling, biomechanics, structure, and composition as myopia progresses.3

Numerous studies have examined the morphological changes in the posterior sclera of myopic participants and reported changes in the posterior sclera of myopic people. Generally speaking, axially elongated eyes are thought to have substantial sclera thinning and posterior tissue loss.

Few research, nonetheless, have examined alterations in the anterior sclera of myopic eyes, and those that have found conflicting findings. Prior research on histomorphology and optical coherence tomography (OCT) revealed no discernible difference in scleral thickness measured at the limbus between axially and non-axially elongated eyes. Few studies have also documented an increase in AL.4
Macular degeneration and glaucoma can become more common as a result of myopia. The prevalence of glaucoma and macular disease can rise as a result of myopia. Myopia has significantly grown in recent years due to the growing usage of technological devices.

For a better understanding of the possible mechanisms behind myopia and other disorders, it is essential to comprehend the features of the anterior sclera of myopia. 5. The purpose of the current study was to evaluate how axial elongation affected the anterior scleral thickness (AST) of myopic patients.

MATERIALS AND METHODS

The purpose of the current observational study was to evaluate how axial elongation affected the anterior scleral thickness (AST) of myopic participants. The research participants came from the Institute's Department of Ophthalmology. Before participating in the study, all participants and school officials gave their verbal and written informed consent.

244 participants who were treated at the Institute during the research period and did not have any ocular or systemic conditions that affected ametropia were evaluated in this study. participants were split into three groups based on their axial length and diopter: 80 participants were in the high myopia group, 80 subjects were in the low to moderate myopia group, and 64 subjects were in the emmetropia group.
Subjects between the ages of 20 and 35 who had normal binocular vision, intraocular pressure (IOP) $\leq$21 mmHg, astigmatism within $\pm$2 D, and spherical equivalent (SE) refractive error between -12.0 and -0.5 met the study's inclusion criteria.

Participants who had not worn orthokeratology lenses in the previous week, had been diagnosed with diabetes or hypertension, had elevated intraocular pressure, had retinopathy, or had a history of glaucoma, intraocular or refractive surgery, or pathological myopia in first-degree relatives were excluded from the study.

Following final inclusion, all participants had a primary and thorough evaluation of their eyes, which included taking wide field fundus photos, calculating the central diopter, measuring the AL and mean meridian corneal curvature, assessing scleral thickness, measuring intraocular pressure, evaluating BCVA (best corrected visual acuity), evaluating ametropia, examining the fundus of mydriasis, and using slit-lamp biomicroscopy.

On average, central refraction was measured three times and AL was constantly measured five times. 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 SE minor, which was computed as SE= spherical mirror degree + 1/2 × cylindrical mirror degree. Laser scanning ophthalmoscopy was utilized to further rule out fundus illnesses other than myopia.

AST was measured using an OCT scanner with a 9mm single line scan and the addition of the anterior portion of the eye. For about five seconds, participants were instructed to look at four fixation points: upward, downward, right, and left.

The initial B-scan OCT images were obtained at four diameters from the nasal, temporal, upper, and lower sides. Caliper was used to conduct manual measurements after the OCT picture was acquired. The sclera's length was measured at 6-mm intervals, beginning at the scleral spur (SP) and ending at 1-mm intervals. The vertical distance between the top and lower scleral margins represented the sclera's thickness. Grouping was done as follows: emmetropia group $-0.5D < SE < +0.5D$ ($22 < AL < 24.5$ mm), low to moderate myopia group: -6.00 D < -0.5 D ($24.5 < AL < 26.5$ mm), and severe myopia group: SE < -6.00 D (AL > 26.5 mm).

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

RESULTS

The purpose of the current observational study was to evaluate how axial elongation affected the anterior scleral thickness (AST) of myopic participants. During the designated study period, 244 participants at the Institute who had neither systemic nor ocular disorders influencing ametropia were evaluated for this investigation.

The individuals were split into three groups based on their diopter and AL (axial length): 80 patients were in the high myopia group, 80 subjects were in the low to moderate myopia group, and 64 subjects were in the emmetropia group.

Comparing the demographic features of the research participants, it was found that 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, with no statistically significant difference (p0.164). In the emmetropia group, there were 28 males and 36 females with a statistically non-significant difference (p=0.625), 42 males and 38 females with extreme myopia, and 34 males and 46 females with low to moderate myopia.

BMI showed a similar non-significant difference (p=0.141). On the other hand, SE showed a statistically significant difference (p<0.001). With p<0.001, AL was substantially greater in the group with high myopia, followed by those with medium to moderate myopia, and lowest in the group with emmetropia (Table 1).

According to the study's findings, there was a significant correlation (p<0.001) between the mean AST, gender, axial length, and age of the study participants for age, while there was no significant correlation (p<0.116) between gender and lower side AST. With a p-value of less than 0.001, axial length was significantly correlated with mean nasal AST, mean temporal AST, mean lower side AST, and mean upper side AST (Table 2).

Additionally, it was observed that the mean AST for both males and females was 551.37±41.47 and 560.87±52.47, respectively, with a statistically insignificant difference (p=0.383). The 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

During the designated study period, 244 participants at the Institute who had neither systemic nor ocular disorders influencing ametropia were evaluated for this investigation. The individuals were split into three groups based on their diopter and AL (axial length): 80 patients were in the high myopia group, 80 subjects were in the low to moderate myopia group, and 64 subjects were in the emmetropia group.

The study design was consistent with earlier research by Han LF et al. in 2023 and Panda Jonas et al. in 2022, where the authors also used a study design akin to this one in their respective investigations. According to the study results, there was no statistically significant difference (p0.164) in the mean age of the high, low to moderate, and emmetropia groups, which were 31.33±0.47, 31.47±7.54, and 30.45±6.46 years, respectively, when comparing the demographic data of the study subjects. In the emmetropia group, there were 28 males and 36 females with a statistically non-significant difference (p=0.625), 42 males and 38 females with extreme myopia, and 34 males and 46 females with low to moderate myopia. BMI showed a similar non-significant difference (p=0.141).

On the other hand, SE showed a statistically significant difference (p<0.001). With p<0.001, AL was considerably greater in the group with high myopia, followed by those with medium to moderate myopia, and lowest in the group with emmetropia. These findings were in line with those of Sung MS et al. (2021) and Fernández Vigo JI et al. (2022), whose findings for comparing demographic characteristics in study participants with myopia were similar to those of the current investigation.

When examining the relationship between the research subjects' mean AST, gender, axial length, and age, it was found that, for age, there was a significant connection (p<0.001) between mean nasal, mean temporal, and mean upper side AST, but there was no significant correlation (p<0.116) between gender and lower side AST. The mean nasal AST, mean temporal AST, mean lower side AST, and mean upper side AST all showed a significant connection with axial length (p<0.001).

These results were consistent with those of Shen L et al. (2015) and Ebneter A et al. (2015), who also observed a link between mean AST, gender, axial length, and age in myopia participants that was comparable to the current study.

According to the study's findings, the mean AST for males and females was 551.37±41.47 and 560.87±52.47, respectively, with a statistically insignificant difference (p=0.383). The 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.

These findings were consistent with those of Coudrillier B et al. (2012) and Dogan M et al. (2013), who found that the mean AST in the two genders compared by the authors in their investigations was similar to the current study's findings.

CONCLUSION

The present study, within its limitations, concludes that the sclera thickness changed with measurement position and AL. A negative correlation is seen between AL and AST and positive relation in age and AST. Anterior sclera is thinner in subjects with high myopia compared to low-to-moderate myopia and emmetropia. Myopia affects AST along with the thickness of the posterior sclera.

REFERENCES

1. Piao H, Guo Y, Zhang H, Sung MS, Park SW. Acircularity and circularity indexes of the foveal avascular zone in high myopia. Sci Rep 2021;11:16808.
2. Boote C, Sigal IA, Grytz R, Hua Y, Nguyen TD, Girard MJA. Scleral structure and biomechanics. Prog Retin Eye Res 2020;74:100773.
3. Watson PG, Young RD. Scleral structure, organisation and disease. A review. Exp Eye Res 2004;78:609-23.
4. Watson PG, Young RD. Scleral structure, organisation and disease. A review. Exp Eye Res 2004;78:609-23.
5. Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, Sankaridurg P,et al. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. Ophthalmology 2016;123:1036-42.
6. Han LF. New progress in application of optical tomography angiography (OCTA) in retinal diseases. Ophthalmology 2023;12:77-84
7. Panda-Jonas S, Jonas JB, Jonas RA. Photoreceptor density in relation to axial length and retinal location in human eyes. Sci Rep 2022;12:21371.
8. Sung MS, Ji YS, Moon HS, Heo H, Park SW. Anterior scleral thickness in myopic eyes and its association with ocular parameters. Ophthalmic Res 2021;64:567-76.
9. Fernández-Vigo JI, Shi H, Burgos-Blasco B, Fernández-Aragón S, De-Pablo-Gómez-de-Liaño L, Kudsieh B, et al. Anterior scleral thickness dimensions by swept-source optical coherence tomography. Clin Exp Optom 2022;105:13-9.
10. Shen L, You QS, Xu X, Gao F, Zhang Z, Li B, et al. Scleral thickness in Chinese eyes. Invest Ophthalmol Vis Sci 2015;56:2720-7.
11. Ebneter A, Häner NU, Zinkernagel MS. Metrics of the normal anterior sclera: Imaging with optical coherence tomography. Graefes Arch Clin Exp Ophthalmol 2015;253:1575-80.
12. Coudrillier B, Pijanka JK, Jefferys JL, Goel A, Quigley HA, Boote C, et al. Glaucoma-related changes in the mechanical properties and collagen micro-architecture of the human sclera. PLoS One 2015;10:e0131396.
13. Dogan M, Elgin U, Sen E, Tekin K, Yilmazbas P. Comparison of anterior segment parameters and axial lengths of myopic, emmetropic, and hyperopic children. Int Ophthalmol 2019;39:335-40.

Characteristics	**High myopia group (n=80)**	**Low to moderate myopia group (n=80)**	**Emmetropia group (n=64)**	**p-value**
Mean age (years)	31.33±0.47	31.47±7.54	30.45±6.46	0.164
Gender				
Males	42	34	28	0.625
Females	38	46	36	
BMI (kg/m2)	23.44±3.44	22.47±4.52	23.39±3.44	0.141
SE (D)	-14.45±5.42	-5.11±2.11	-0.14±0.21	**<0.001**
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

parameter	**Mean nasal AST**		**Mean temporal AST**		**Mean lower side AST**		**Mean upper side AST**	
	r	**p**	**r**	**P**	**r**	**p**	**r**	**p**
Age	0.409	**<0.001**	0.424	**<0.001**	0.134	0.116	0.543	**<0.001**
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

Diameter	**Females (n=100)**	**Males (n=104)**	**p-value**
All mean AST (µm)	551.37±41.47	560.87±52.47	0.383
Nasal average AST (µm)	561.47±5.47	573.64±65.82	0.212
Mean temporal AST (µm)	591.46±45.46	605.71±44.17	0.134
Mean lower AST (µm)	591.47±31.42	587.55±37.76	0.413
Mean upper AST (µm)	489.45±32.38	475.44±29.47	0.222

Table 3: Comparison of mean AST in the two genders