· Clinical Research ·

Tomographic and biomechanical corneal characteristics of patients with angioid streaks

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Abstract

● **AIM:** To evaluate the corneal biomechanical properties in patients with angioid streaks (AS), and to compare these parameters with those of healthy subjects.

● **METHODS:** A retrospective study was conducted, enrolling AS patients and healthy participants as controls. The collected corneal tomographic parameters included flat keratometry, steep keratometry, mean keratometry, maximum keratometry, topographic cylinder value, central corneal thickness, and the total deviation value of the Belin-Ambrósio enhanced ectasia display measured with Pentacam tomography. Corvis ST was used to measure corneal biomechanical parameters, non-contact tonometry intraocular pressure (IOPnct), and biomechanically corrected intraocular pressure (bIOP).

● **RESULTS:** The study comprised 18 eyes from 10 male and 8 female AS patients with a mean age of 48.83±10.66y, and the controls included 31 eyes from 12 male and 19 female healthy participants with a mean age of 47.87±10.69y. All corneal tomographic parameters were comparable between the two groups (all P>0.05), and no corneal ectasia was observed in any AS patient. Compared with the controls, AS patients exhibited statistically significant increases in applanation 1 (A1) time and stiffness parameter A1 (SP-A1), along with significant decreases in applanation 2 (A2) velocity, deformation amplitude (DA), DA ratio (2 mm), and Corvis biomechanical index (CBI; all P<0.05), which indicated higher corneal stiffness in AS. The IOPnct value in AS was significantly elevated, while no significant difference was found in the bIOP value compared to controls (P=0.031 and P=0.095, respectively).

● **CONCLUSION:** Eyes with AS exhibit normal corneal tomographic characteristics and increased corneal stiffness.

● **KEYWORDS:** angioid streaks; corneal biomechanics; corneal tomography; intraocular pressure
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INTRODUCTION

Angioid streaks are irregular linear breaks in the Bruch's membrane that typically occur around the optic disc and extend to the retinal periphery[1]. Angioid streaks are a rare (annual incidence of 0.52/1 000 000) retinal disorder, and most patients with angioid streaks are asymptomatic; however, when lesions progress to the foveola or cause complications such as macular choroidal neovascularization (CNV) or the Bruch's membrane rupture, the patients become symptomatic with impaired vision[1-2]. Angioid streaks are accepted as a connective tissue disorder, and the primary pathology is observed in the Bruch's membrane, which is rich in collagen and elastin fibers[1].

Several studies have shown that several connective tissue disorders affect the corneal tomographic and biomechanical characteristics[3-5]. These possible changes have become important in the diagnosis of ocular pathologies (such as keratoconus), planning of corneal refractive surgery, and accurate intraocular pressure (IOP) measurement[3-5]. Refractive surgery is no longer considered an absolute contraindication in individuals with connective tissue disorders, as screening for refractive surgery eligibility has become better owing to the advances in corneal tomography and biomechanics evaluation[6]. Moreover, corneal curvature, thickness, and rigidity changes influence the IOP and may result in IOP values misinterpretations in these patients[7-9]. Therefore, considering the corneal tomographic and biomechanical features using various tonometers may give more reliable IOP results.

Currently, it is possible to evaluate *in vivo* corneal biomechanical characteristics and accurate IOP *via* non-contact rapid air pulse with the corneal visualization Scheimpflug technology (Corvis ST; Oculus, Germany) and ocular response analyzer (ORA; Reichert Ophthalmic Instruments, USA). To date, only two clinical studies have investigated the biomechanical features of the cornea in individuals with angioid streaks; however, they reported controversial results[10-11]. Furthermore, there is no data in the literature about the tomographic characteristics of the cornea in those with angioid streaks.

The primary aim of this study was to evaluate the corneal biomechanics and tomographic characteristics in individuals with angioid streaks and compare them with those of healthy individuals. Additionally, this study aimed to investigate whether anti-vascular endothelial growth factor (VEGF) injections had an effect on corneal tomographic and biomechanical parameters in patients with angioid streaks.

PARTICIPANTS AND METHODS

Ethical Approval Patient data were obtained from the electronic medical archives after receiving approval from the Institutional Ethics Committee of Gazi University School of Medicine (approval number: E.380707 date: 07.06.2022). All participants provided written informed consent after the study procedure was explained to them. Informed consent was obtained in written form, and participants did not receive any stipend for their participation.

Study Design and Patient Selection This retrospective comparative study included patients with angioid streaks who were followed between March 2001 and April 2022. Eighteen eyes of 18 patients with angioid streaks (study group) and 31 eyes of 31 healthy subjects (control group) were enrolled. The control group was randomly selected from a population of 56 healthy individuals (without any ophthalmological abnormalities in anterior segment and fundoscopic examinations) according to sex, age, central corneal thickness (CCT), and IOP to ensure comparability of corneal biomechanical measurements between the study and control groups.

Fundoscopic evaluation was performed for each patient to determine the diagnosis of angioid streaks, which was also confirmed by fundus autofluorescence. Fundus autofluorescence demonstrated hypoautofluorescent fissures due to the atrophy of the retinal pigment epithelium. Twelve eyes in the study group that developed secondary CNV had received intravitreal anti-VEGF (bevacizumab or ranibizumab) injections with a 30-gauge needle. Fundoscopic exams, fluorescein angiography, and optical coherence tomography scans were used to diagnose secondary CNV. In addition, all patients were consulted by the internal medicine and dermatology departments to exclude possible concomitant systemic disorders.

The exclusion criteria in both groups were the presence of diabetes mellitus, corneal diseases potentially affecting corneal biomechanical properties, chronic use of topical ocular medications, contact lens use, history of ocular surgery and ocular trauma, glaucoma, and manifest spherical equivalent (MSE) of more than 4 diopters.

Examination Protocol and Measurements Each subject underwent a comprehensive ophthalmic exam, including visual acuity, anterior segment examination with slit lamp biomicroscopy, IOP measurement with the Goldmann applanation tonometer (IOP-GAT), fundoscopy, and optical coherence tomography assessment. The axial length (AL) was measured with optical biometry (Lenstar LS 900; Haag-Streit AG, Switzerland). The corneal tomography and biomechanical measurements in 12 patients who received anti-VEGF injections were performed after the injections.

Corneal tomography with the rotating Scheimpflug camera system (Pentacam; Oculus, Germany) was performed, and the parameters obtained were as follows: flat keratometry and steep keratometry for the 3-mm central zone, mean keratometry, maximum keratometry, topographic cylinder value, CCT, and total deviation value of the Belin-Ambrósio enhanced ectasia display (BAD-D).

The biomechanical parameters, IOP with non-contact tonometer (IOPnct), and biomechanical corrected IOP (bIOP) were measured with the Corvis ST tonometer. Measurements with the Corvis ST were only performed once in each eye according to a standardized protocol by an experienced technician, as previous studies have revealed that accurate and high-quality results can be achieved even after a single proper measurement[12-13].

The working principle of the Corvis ST is based on non-contact tonometry. A high-speed (4330 frames per second) dynamic Scheimpflug imaging analysis system detects the corneal deformation caused by a standardized fast air puff (Figure 1)[14-16]. The cornea moves inward after the air puff until it encounters its highest deformation (concave phase) and then returns to its initial form. The first applanation phase (A1) and then the highest concavity (HC) stage are obtained during the cornea deformation. Finally, the second applanation phase (A2) is obtained when the cornea gradually returns to its initial curvature. The duration, length, and velocity of both corneal applanations are assessed throughout the deformation process and the Corvis ST software provides 35 device-specific parameters[15-16].

The primary outcome measures obtained from the Corvis ST were A1 length, A1 time, A1 velocity, A2 length, A2 time, A2 velocity, highest concavity peak distance (HC-PD; the distance between the highest points of the non-deformed regions of the cornea during the concave phase), deformation amplitude (DA; the maximum amplitude of the highest concavity), DA ratio (2 mm; the relation between the DA at the apex and the DA at 2 mm), integrated radius (IR; the radius of curvature during the concave phase), Ambrósio's relational thickness horizontal

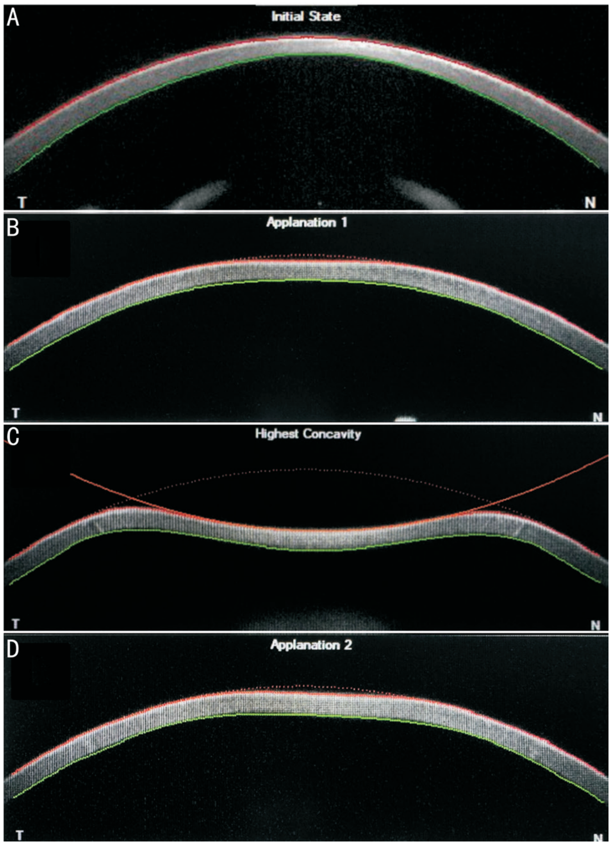

Figure 1 Corneal deformation images captured with a high-speed Scheimpflug camera during the Corvis ST measurement A: A horizontal cross-sectional image of the cornea before air-puff applanation; B: An image in the first applanation phase; C: An image at the highest concavity stage; D: An image in the second applanation phase.

(ARTh), stiffness parameter A1 (SP-A1), Corvis biomechanical index (CBI), IOPnct, and bIOP.

Statistical Analysis The data was statistically analyzed using the SPSS 24 (IBM SPSS Statistics, USA). The Shapiro-Wilk test was performed to examine the data distribution. When the data were normally distributed, intergroup analyses were carried out using independent *t*-tests, while the Mann-Whitney *U* tests were performed for non-normally distributed data. The Chi-square test was used to evaluate categorical differences between the groups. The relationship between the number of anti-VEGF injections and the measured variables was investigated using the Spearman's correlation. Statistical significance was defined as a *P* value less than 0.05.

RESULTS

Demographic and Clinical Characteristics A retrospective chart review of 18 patients with angioid streaks was performed, and clinical data, including demographic characteristics (gender, age, and systemic disorders associated with angioid streaks), were collected from all participants. The study included 18 eyes from 18 individuals with angioid streaks and 31 eyes from 31 healthy subjects. Pseudoxanthoma elasticum was diagnosed in three patients (16.6%) with angioid streaks; the other patients were defined as idiopathic. In 18 eyes with angioid streaks, 12 eyes underwent intravitreal anti-VEGF injections 6.72±4.01 times.

Table 1 Demographic and clinical characteristics of patients with angioid streaks (study group) and healthy subjects (control group)

mean±SD or median (IQR)

Variable	Study group	Control group	*P*
Number of eyes	18	31	
Age (y)	48.83±10.66	47.87±10.69	0.762[d]
Gender (male)	10 (55.5%)	12 (38.7%)	0.821[a]
MSE (D)	-1.18±1.27	1.38±1.06	0.585[d]
AL (mm)	23.3 (1.2)	22.8 (1.4)	0.122[c]
CCT (μm)	548.56±28.07	538.12±36.23	0.299[d]
IOP-GAT (mm Hg)	16.58±0.47	16.54±0.59	0.816[d]

MSE: Manifest spherical equivalent; D: Diopter; AL: Axial length; SD: Standard deviation; IQR: Interquartile range; CCT: Central corneal thickness; IOP-GAT: Intraocular pressure with Goldmann applanation tonometer. [a]Chi-square test; [c]Mann–Whitney *U* test; [d]Independent *t*-test.

Table 1 summarizes the demographic and clinical features of the study and control groups. There was no significant difference in age, gender distribution, MSE, AL, CCT, or IOP-GAT values between the two groups (all *P*>0.05).

Corneal Tomographic Results Table 2 compares the corneal tomographic parameters of the study and control groups. All keratometry and topographic cylinder values were comparable between the study and control groups (all *P*>0.05). The mean CCT was slightly higher in the study group but was not statistically significant (548.56±28.07 μm in the study group, 538.12±36.23 μm in the control group; *P*=0.299). The mean BAD-D values were 1.18±0.64 in the study group and 1.20±0.58 in the control group (*P*=0.918). Corneal ectasia was not observed in any patient.

Corneal Biomechanical Results and Intraocular Pressure Values with Corvis ST The corneal biomechanical data of both groups is shown in Table 2. In patients with angioid streaks, statistically significant longer A1 time, lower A2 velocity, lower DA, DA ratio, and IR, higher SP-A1, and lower CBI values indicated higher corneal stiffness compared to those of the control group (*P*=0.016, *P*=0.048, *P*=0.017, *P*=0.039, *P*=0.033, *P*=0.001, and *P*=0.028, respectively; Figure 2). The mean A1 length and the median A1 velocity, A2 length, A2 time and HC-PD values were comparable between the two groups (all *P*>0.05). The median ARTh were lower in the study group, but these changes did not reach statistical significance (all *P*>0.05).

The IOP values measured with Corvis ST in both groups are summarized in Table 2. The median IOPnct was 17.2 [interquartile range (IQR): 8.0] mm Hg in the study group and 15.5 (IQR: 3.0) mm Hg in the control group (*P*=0.031; Figure 2).

Table 2 Comparison of corneal topographic, biomechanical, and IOP parameters of patients with angioid streaks (study group) and healthy subjects (control group) mean±SD or median (IQR)

Variable	Study group	Control group	*P*	Study group		*P*
				Injection (-)	Injection (+)	
Number of eyes	18	31		6	12	
K_{flat} (D)	43.5 (1.6)	43.5 (3.0)	0.926[c]	43.4 (1.8)	43.5 (1.9)	0.925[c]
K_{steep} (D)	44.1 (1.5)	43.9 (1.8)	0.844[c]	43.51±0.81	44.02±1.89	0.541[d]
K_{mean} (D)	43.9 (1.7)	43.8 (2.4)	0.992[c]	43.5 (1.5)	43.9 (2.1)	0.349[c]
K_{max} (D)	44.56±1.70	44.61±1.85	0.926[d]	44.18±1.02	44.78±1.97	0.664[d]
Topo-cyl (D)	0.6 (0.6)	0.8 (1.3)	0.513[c]	0.25 (0.5)	0.85 (0.5)	0.302[c]
CCT (μm)	548.56±28.07	538.12±36.23	0.299[d]	547.17±25.85	549.25±30.20	0.887[d]
BAD-D	1.18±0.64	1.20±0.58	0.918[d]	1.13±0.56	1.21±0.70	0.551[d]
A1 length (mm)	2.28±0.26	2.24±0.31	0.623[d]	2.38±0.25	2.23±0.26	0.276[d]
A1 time (ms)	7.4 (1.3)	7.1 (0.4)	0.016[c]	7.38±0.58	7.89±0.69	0.141[d]
A1 velocity (m/s)	0.14 (0.1)	0.14 (0.1)	0.132[c]	0.14 (0.1)	0.13 (0.1)	0.664[c]
A2 length (mm)	2.0 (0.3)	2.0 (0.6)	0.756[c]	2.10±0.38	2.08±0.35	0.899[d]
A2 time (ms)	21.4 (1.2)	21.4 (0.5)	0.500[c]	21.6 (11.0)	21.3 (1.0)	0.261[c]
A2 velocity (m/s)	-0.23 (0.1)	-0.25 (0.1)	0.048[c]	-0.24 (0.1)	-0.23 (0.1)	0.169[c]
HC PD (mm)	4.8 (0.7)	4.8 (0.4)	0.112[c]	4.70±0.45	4.52±0.48	0.211[d]
DA (mm)	0.96±0.12	1.05±0.13	0.017[d]	0.98±0.10	0.95±0.13	0.603[d]
DA ratio (2 mm)	4.2 (-4.2-5.1)	4.3 (3.2-5.4)	0.039[c]	4.2 (3.7-5.1)	4.2 (-4.1-4.6)	0.796[c]
IR (mm^{-1})	7.4 (1.7)	8.1 (0.9)	0.033[c]	7.85±0.97	7.34±1.08	0.346[d]
ARTh	413.52±183.99	447.86±122.81	0.437[c]	394.9 (222.7)	356.6 (233.1)	0.511[c]
SP-A1	112.6 (43.4)	97.0 (12.1)	0.001[c]	114.07±23.35	121.30±23.03	0.540[d]
CBI	0.2 (0.7)	0.5 (0.3)	0.028[c]	0.6 (0.7)	0.1 (0.6)	0.172[c]
IOPnct (mm Hg)	17.2 (8.0)	15.5 (3.0)	0.031[c]	16.41±4.31	20.07±4.85	0.139[d]
bIOP (mm Hg)	16.3 (7.4)	14.8 (2.8)	0.095[c]	15.73±3.24	18.52±4.23	0.177[d]

IOP: Intraocular pressure; SD: Standard deviation; IQR: Interquartile range; K_{flat}: Flat keratometry; K_{steep}: Steep keratometry; K_{mean}: Mean keratometry; K_{max}: Maximum keratometry; Topo-cyl: Topographic cylinder; CCT: Central corneal thickness; BAD-D: Belin-Ambrósio enhanced ectasia display total deviation; A1: First applanation; A2: Second applanation; HC PD: Highest concavity peak distance; DA: Deformation amplitude; DA ration (2 mm): Deformation amplitude ratio at 2 mm; IR: Integrated radius; ARTh: Ambrósio's relational thickness horizontal; SP-A1: Stiffness parameter at first applanation; CBI: Corvis biomechanical index; IOPnct: Intraocular pressure with non-contact tonometer; bIOP: Biomechanically corrected intraocular pressure. [c]Mann-Whitney *U* test; [d]Independent *t*-test.

However, the median bIOP value was similar in both groups (*P*=0.095).

Subgroup Analysis in Study Group To analyze the effect of anti-VEGF injection on the studied parameters, the study group was separated into two subgroups: injection(-) and injection(+). There were 6 eyes in the injection(-) group and 12 in the injection(+) group. In terms of corneal tomography and biomechanical variables, there was no statistically significant difference between the two subgroups (Table 2; all *P*>0.05). None of the studied parameters in the injection(+) group were significantly correlated with the number of injections (Table 3; all *P*>0.05).

DISCUSSION

In the present study, corneal tomographic features in patients with angioid streaks were comparable to those in healthy subjects. Corneal ectasia was also not observed in any eyes with angioid streaks. We have demonstrated a higher corneal

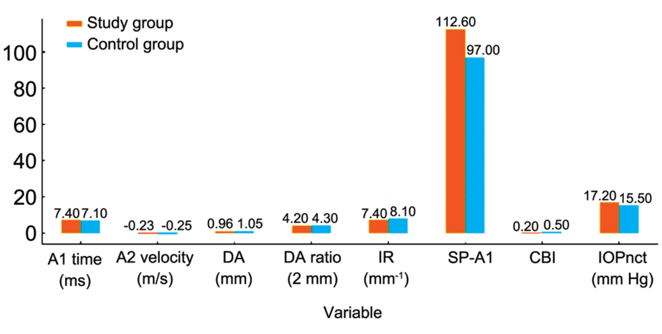

Figure 2 Bar graph demonstrating the significantly altered Corvis ST-derived biomechanical and IOP parameters in the angioid streaks group compared to the control group IOP: Intraocular pressure; A1: First applanation; A2: Second applanation; DA: Deformation amplitude; DA ration (2 mm): Deformation amplitude ratio at 2 mm; IR: Integrated radius; SP-A1: Stiffness parameter at first applanation; CBI: Corvis biomechanical index; IOPnct: Intraocular pressure with non-contact tonometer.

Table 3 Correlation analyses between the number of injections and studied parameters in patients with angioid streaks

Variable	Number of injections	
	Correlation coefficient	P^b
MSE	-0.440	0.067
AL	0.296	0.234
K_{flat}	0.006	0.980
K_{steep}	0.231	0.355
K_{mean}	0.194	0.441
K_{max}	0.205	0.415
CCT	0.049	0.847
BAD-D	0.136	0.562
A1 lenght	-0.129	0.611
A1 time	0.517	0.058
A1 velocity	-0.120	0.484
A2 lenght	0.170	0.500
A2 time	-0.261	0.295
A2 velocity	0.428	0.077
HC PD	-0.307	0.215
DA	-0.113	0.655
DA ratio (2 mm)	-0.395	0.105
IR	-0.225	0.369
ARTh	-0.375	0.125
SP-A1	0.362	0.140
CBI	-0.324	0.189
IOPnct	0.483	0.052
bIOP	0.448	0.063

MSE: Mean squared error; AL: Axial length; K_{flat}: Flat keratometry; K_{steep}: Steep keratometry; K_{mean}: Mean keratometry; K_{max}: Maximum keratometry; Topo-cyl: Topographic cylinder; CCT: Central corneal thickness; BAD-D: Belin-Ambrósio enhanced ectasia display total deviation; A1: First applanation; A2: Second applanation; HC PD: Highest concavity peak distance; DA: Deformation amplitude; DA ration (2 mm): Deformation amplitude ratio at 2 mm; IR: Integrated radius; ARTh: Ambrósio's relational thickness horizontal; SP-A1: Stiffness parameter at first applanation; CBI: Corvis biomechanical index; IOPnct: Intraocular pressure with non-contact tonometer; bIOP: Biomechanically corrected intraocular pressure. [b]Spearman's correlation.

stiffness in those with angioid streaks than in healthy subjects. The median IOPnct value significantly increased in the study group compared to that in the control group. In contrast, the bIOP value, in which CCT and biomechanical properties are considered[17], was similar in both groups.

Patients with angioid streaks and other connective tissue disorders generally presented with myopic refractive errors and could be candidates for laser-assisted refractive surgery. These patients are more prone to vision-threatening complications following refractive surgery due to thinner cornea, abnormal preoperative corneal tomography, and biomechanical weakening of the cornea, frequently associated with several connective tissue disorders[6]. Due to developments in assessing corneal tomography and biomechanics, screening for refractive surgery eligibility has improved[18]. These technological advancements enable accurate assessment of the risk of ectasia in patients with connective disorders, and refractive surgery can be performed with safe results in those with minimal ocular findings[6]. In this study, corneal tomographic parameters, including keratometric values, CCT, and BAD-D values of the eyes with angioid streaks, were similar to those of healthy individuals. The BAD-D provides an overall perspective of the tomographic features of the cornea by combining the elevation and pachymetric data, which is the most precise risk factor for identifying moderate cases of ectasia or susceptibility[19-20]. It is recommended that the BAD-D value should be below 1.45 before refractive surgery[19]. In this study, the mean value of BAD-D in patients with angioid streaks was 1.18 and 1.20 in the control group. Furthermore, the biomechanical evaluation with the Corvis ST in our study demonstrated that the patients with angioid streaks had stiffer corneas than the control group. The CBI value was developed to detect subclinical keratoconus and corneal ectasia, which provides the overall status of corneal biomechanics. The CBI is calculated according to four main parameters, including the DA ratio (2 mm), IR, ARTh, and SP-A1[15]. In case of a higher corneal stiffness, a reduction in the CBI is expected[15]. Ectasia cases could be distinguished from healthy eyes with 100% specificity and 94.1% sensitivity, with a cut-off value of 0.5[15]. In our study, the median CBI value was 0.2 in eyes with angioid streaks and 0.5 in the healthy subjects. In light of these findings, we can conclude that corneal refractive surgery may be considered a treatment choice in patients with angioid streaks. However, it should be kept in mind that using a microkeratome or femtosecond laser platform may cause breaks in the Bruch's membrane and subretinal hemorrhage due to suction. Thus, surface ablation may be preferred as the primary treatment option for patients with angioid streaks.

Age, refractive error value, CCT, AL, IOP, and corneal curvature may influence the biomechanical results measured with the Corvis ST[14,17,21]. To minimize the effect of these factors, the control group was designed to be similar to the study group in terms of age, MSE, AL, CCT, and IOP. In a soft cornea, a reduction in the length and the duration of applanation as well as an increase in the velocity of applanation are expected[14]. Moreover, a decrease in the HC-PD, the ARTh, and the SP-A1 values and an increase in the DA, the DA ratio, the IR values are expected in a soft cornea[15]. In our study, all Corvis ST-related parameters with significant changes (higher A1 time, lower A2 velocity, lower DA and DA ratio, lower IR, higher SP-A1, and lower CBI) have indicated higher corneal stiffness in patients with angioid streaks than those in the control group. The corneal biomechanics of patients with angioid streaks have been the subject of few investigations in the literature, and inconsistent results have been reported[10-11]. Yildirim *et al*[10] have examined the corneal biomechanics of eyes with angioid streaks using ORA. The authors reported similar corneal hysteresis (CH) and significantly higher corneal resistant factor (CRF) values in patients with angioid streaks compared to those in age-matched healthy subjects. In line with our Corvis ST findings, a higher CRF value also indicates increased corneal stiffness, which leads to a slower corneal deformation process[22]. However, in another study investigating the corneal biomechanical properties using ORA and Corvis ST in eyes with angioid streaks, there was no difference in CH and CRF, as well as in the biomechanical parameters measured with Corvis ST[11]. The authors of this study have attributed the different results to their study population, which includes older individuals, compared to the previous research.

Anti-VEGF injections for CNV may be the underlying cause of stiffer corneas in patients with angioid streaks in our patient cohort. In a previous study investigating the effect of intravitreal bevacizumab on corneal biomechanics using ORA and Corvis ST, the CRF and A1 time values were significantly higher 3mo after the injection[23]. The authors attributed the increase in corneal stiffness to the possible increased levels of connective tissue growth factor following anti-VEGF injection, which promotes fibrosis and scarring in different tissues, including the cornea[24]. To clarify this point, we performed a subgroup analysis according to the status of the anti-VEGF injection. There was no difference between the injection(-) and the injection(+) groups regarding biomechanical and tomographic parameters. Furthermore, the number of injections showed no significant correlation with the Corvis ST-related parameters. Similarly, Asano *et al*[11] found no difference in corneal biomechanics between the injection(-) and the injection(+) subgroups in patients with angioid streaks.

Since the cornea and sclera are both composed of interconnected collagen fibers, the biomechanical properties of the cornea may reflect those of the sclera[25-26]. The increased stiffness in the sclera may be related to the underlying mechanism of breaks in the Bruch's membrane in angioid streaks. Angioid streaks seem to occur in response to forces applied to the Bruch's membrane, such as trauma, shearing forces related to ocular muscle traction, and pressure on the eyes[27-28]. In a rigid eye, an external force to the eye may be directly dissipated to the posterior segment, which may lead to the development and growth of breaks in the Bruch's membrane. Nakagawa *et al*[29] have also found a positive correlation between the CRF and frequency of anti-VEGF injections that reflects the angioid streak's disease activity.

Corneal biomechanics significantly impact the errors in IOP measurement, along with the corneal curvature and thickness in applanation tonometry[22,30]. Thus, the evaluation of corneal biomechanics may help assess the IOP accuracy[7]. In our study, the median IOP-GAT demonstrated a tendency toward higher values in eyes with angioid streaks, but it was not statistically significant. In the study group, the median IOPnct was significantly higher than that in the control group, while the median bIOP was similar in both groups. Yildirim *et al*[10] measured IOP in eyes with angioid streaks using ORA, which provides measurements of Goldmann-correlated IOP (IOPg) and corneal compensated IOP (IOPcc), which is less influenced by corneal biomechanics. Similar to our results, the authors noted a greater IOPg value in eyes with angioid streaks without a statistically significant difference in the IOPcc values compared to those in healthy subjects. The difference between the IOPcc and IOPg readings has been attributed to increased corneal biomechanics in patients with angioid streaks[10]. These data have supported our findings. The increased corneal biomechanics may explain why eyes with angioid streaks have a higher IOPnct value. The IOP is no longer greater in eyes with angioid streaks when the impact of the cornea is eliminated by the bIOP measurement. The bIOP is calculated with a correction algorithm less affected by age, the CCT, and biomechanical parameters[17]. These results suggest that the bIOP value may be essential for obtaining accurate IOP values that are crucial for the diagnosis or follow-up of glaucoma in individuals with angioid streaks.

The first drawback is the small number of patients with angioid streaks. Nonetheless, this study has the highest number of patients with angioid streaks in the studies conducted so far. Future multicenter studies with larger cohorts are warranted to validate our findings. In addition, intravitreal injections may have affected ocular biomechanics. The second limitation is the absence of baseline Corvis measurements prior to anti-VEGF administration, which precluded direct comparison with post-injection values and limited our ability to draw more definitive conclusions regarding this relationship. Further studies are needed to better elucidate the effects of anti-VEGF injections on corneal biomechanics. Finally, this study is cross-sectional, so the parameters were studied at a single time. Therefore, longitudinal studies are required to understand how biomechanical parameters change as the disease progresses.

Normal corneal tomographic properties and increased corneal stiffness have been demonstrated in eyes with angioid streaks. These findings are clinically important, as they suggest that patients with angioid streaks do not exhibit a predisposition to corneal ectasia, and thus, refractive laser surgery may be considered in this population. However, due to the underlying retinal pathology, procedures involving high vacuum suction applied to the globe, such as flap-based or lenticular refractive surgeries, may pose additional risk by inducing retinal stress. For this reason, surface ablation techniques should be preferred in such cases. Moreover, when IOP is measured using conventional methods such as Goldmann applanation tonometry or pneumotonometry, values may appear falsely elevated secondary to increased ocular rigidity. Therefore, in the diagnosis and follow-up of glaucoma in patients with angioid streaks, it is essential to consider this biomechanical influence and to employ devices capable of incorporating biomechanical assessments in order to obtain more accurate IOP values. Furthermore, these biomechanical results may provide insight for future studies on the disease pathogenesis and new treatment options for angioid streaks.

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