Earlier Corneal Topographical Changes After Different Pterygium Surgical Techniques: a Comparative Pentacam Scheimpflug Imaging Study

Şefik Can İpek (sefikcanipek@gmail.com)
Agri Ibrahim Cecen University: Agri Ibrahim Cecen Universitesi
Yusuf Cem Yilmaz
Agri Ibrahim Cecen University: Agri Ibrahim Cecen Universitesi
Hamidu Hamisi Gobeka
Agri Ibrahim Cecen University: Agri Ibrahim Cecen Universitesi
Muhammet Derda Özer
Yuzuncu Yil Universitesi Tip Fakultesi https://orcid.org/0000-0002-3954-270X

Research Article

Keywords: Pterygium, Conjunctival Autograft, Conjunctival Rotational Flap, Corneal Topography, Pentacam Scheimpflug imaging

Posted Date: March 10th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-280373/v1

Abstract

Purpose: To investigate earlier corneal topographical changes and visual acuity after different pterygium surgical techniques using the Pentacam Scheimpflug imaging system.

Methods: This study enrolled 98 patients with unilateral primary nasal pterygium. Pterygium surgery with either a conjunctival autograft (group 1) or an anchored conjunctival rotational flap (group 2), with fibrin tissue adhesive was performed under topical anesthesia. Baseline and one-month post-operative best-corrected visual acuity (BCVA) in logarithm of the Minimum Angle of Resolution (logMAR) and anterior corneal astigmatism (ACA), flat keratometry (Kf), steep keratometry (Ks) and posterior corneal astigmatism (PCA) were analyzed.

Results: Mean BCVA improved from baseline 0.119±0.113 to 0.082±0.086 logMAR in group 1, and from baseline 0.169±0.128 to 0.120±0.121 logMAR in group 2. There were no statistically significant differences between the two groups in pre-and post-operative ACA, PCA, Kf and Ks. ($p=0.686$; 0.9020.107; and 0.592, respectively). Intra-group analysis revealed statistically significant differences in both groups: ACA ($p<0.001$ for both groups), with a greater difference in group 1 (2.072), and Kf ($p<0.001$ for both groups), with a slightly greater change in group 2 (1.910). While there were no statistically significant Ks intra-group differences in both groups (group 1: $p=0.091$; group 2: 0.092), group 1 (0.0522) displayed more Ks changes. There were also no statistically significant intra-group PCA differences in both groups ($p=0.061$ for both groups). However, Group 2 (-0.020) displayed greater changes.

Conclusions: Significantly improved anterior corneal topographical changes highly associated with conjunctival autografting. However, the conjunctival rotational flap was associated with relatively greater posterior corneal topographical changes.

Introduction

Pterygium is characterized by an encroachment of a wing-shaped fibrovascular bulbar conjunctival connective tissue onto the cornea,[1] It is commonly accompanied by typical dysplasia of the conjunctival epithelium and elastoid degeneration of the collagen tissue. Pterygium pressure on the cornea, corneal flattening from tear accumulation around pterygium, and ultrastructural corneal distortion are among several presumptions regarding the mechanism of pterygium-induced corneal changes.[2]

Pterygium surgery may be needed before any planned refractive surgery due to the impact of pterygium on many corneal topographical parameters. Despite this, accurate prediction of refractive changes is sometimes required. The anterior and posterior corneal surfaces must be considered topographically, in order to comprehensively evaluate both corneal astigmatism and other topographical parameters after pterygium surgery. Very few studies, however, have investigated the effect of pterygium surgery on posterior corneal astigmatism,[3] including the comparison of surgical results by type of pterygium excisional surgery performed. Further, there has never been a comparison between commonly used pterygium surgical techniques, regarding post-operative corneal topographical changes. As a result, a

precise analysis of the surgically induced topographical changes, after a specific excision technique, is needed to assess the factors affecting the refractive outcome of the surgery.

Pentacam (Oculus Optikgeräte GmbH, Wetzlar, Germany) uses a rotating Scheimpflug imaging system, and has been applied for corneal assessment under various conditions.[4] It offers precise measurements of curvature and hence astigmatism on the anterior and posterior corneal surfaces.[5] To the best of our knowledge, no studies have been conducted using this device to investigate the effects of various pterygium surgical excision techniques on subsequent visual acuity and corneal topographical parameters, particularly posterior corneal astigmatism.

This study was therefore designed to investigate earlier changes in corneal topographical parameters and consequent visual acuity after pterygium surgery with the conjunctival autograft and the anchored conjunctival rotational flap techniques, both with fibrin tissue adhesive using the Pentacam Scheimpflug imaging system. Comparison of the data was also made between the two surgical techniques.

Materials And Methods

Study Patients and Preoperative assessment.

Ninety-eight patients with primary nasal pterygium were included in this comparative single-centered interventional study. All patients underwent pterygium surgery with either the conjunctival autograft (Group 1) or the anchored conjunctival rotational flap (Group 2), both with fibrin tissue adhesive at Agri Ibrahim Cecen University Faculty of Medicine, Department of Ophthalmology. The study procedure complied with the ethical standards set out in the Helsinki Declaration and received full approval from the Ethics Committee's Institutional Review Boards. (Number: 57212153-000-4577) Prior to the study, all participants provided informed written consent.

In this study, indications for pterygium surgery consisted primarily of factors such as cosmetic problems, ocular irritation and/or visual impairment due to pterygium. Patients with unilateral primary pterygium with a corneal extension of $\leq$ 4.5 mm were included in the study. However, patients with features that could influence corneal topography, including: prior ocular trauma or intraocular surgery and corneal scarring; contact lens wear; corneal ectasia (keratoconus);bilateral pterygium (ipsilateral temporal and nasal involvement); recurrent pterygium and pseudo-pterygium; media opacities such as dense cataract and corneal opacities or irregularity due to diseases other than pterygium; connective tissue disorders; systemic vasculitis; glaucoma; diabetes mellitus; and severe ocular surface disorders such as dry eye and Stevens-Johnson syndrome, were excluded in the study. Patients with severe pterygium involvement of the central cornea, which could hinder the reproducibility of the corneal topography, were also excluded from the study.

Baseline in-depth ophthalmological assessment was performed, including measurements of auto-refraction (Canon R-F10m; Canon Inc., Tokyo, Japan) and best-corrected visual acuity (BCVA) in logarithm

of the Minimum Angle of Resolution (logMAR), slit-lamp biomicroscopy (Haag-Streit BI 900; The USA) examination of the anterior and posterior segment structures, before and after full pupil dilation. Subjective grading of pterygium by a slit-lamp was performed by single clinician (HHG). Pterygium was initially graded in four stages, predicated on equivalent investigations[6] depending on the existence of fibrovascular tissue, from the nasal limbus to the visual axis as follows: grade 1 (< 2.0 mm), grade 2 (> 2.0 mm and < 4.0 mm), grade 3 (> 4.00 mm, excluding the visual axis) and grade 4 (including the visual axis). Besides, baseline and one-month post-operative corneal topography imaging using the Pentacam Scheimpflug imaging system was always performed by the same clinician (HHG).

Surgical Intervention

All pterygium surgical procedures were performed by two surgeons (SCI: The conjunctival autografting; and YCY: The anchored conjunctival rotational flap). After application of a 0.5 % proparacaine hydrochloride (Alcaine, Alcon Laboratories, Inc., Forth Worth, TX, USA) for topical anesthesia, a speculum was placed in the eye. The area surrounding the conjunctival component of the pterygium was defined with a Gentian violet followed by an injection of 0.5 mL of local anesthetic lidocaine HCL 20 mg/mL + epinephrine 0.0125 mg/mL (Jetokain, Adeka, Turkey) with a 25-gauge needle under the pterygium body. Pterygium was then excised at its base by a pair of Wescott's scissors, and the pterygium apex was scraped off the surface of the cornea. Any remaining abnormal subconjunctival fibrous tissue was excised completely with a crescent blade. No cauterization was performed. Either the superior temporal conjunctival autograft or the anchored conjunctival rotational flap was applied to cover the bare scleral bed (receptor zone).

The Conjunctival Autograft Technique

In this technique, after measuring the receptor zone with a caliper, the ipsilateral superotemporal conjunctival region was marked with Gentian violet approximately 1 mm larger than the measured receptor zone and a free autograft was dissected as thinly as possible from the Tenon’s capsule after subconjunctival injection of 0.2 ml of lidocaine HCl 20 mg/ml and epinefrine HCl 0.0125 mg/ml combination (Jetokain, Adeka, Türkiye). The limbal side of the autograft was extended to 1 mm of the limbal area to incorporate limbal stem cells and the dissected autograft was moved to the receptor zone.

The Anchored Conjunctival Rotational Flap Technique

In the anchored conjunctival rotational flap technique, the superior nasal conjunctiva with the pedicle adjacent to the pterygium excision area was marked as 1 mm larger than the scleral area adjacent to the receptor zone. Subconjunctival administration of 0.2 ml of 20 mg/ml lidocaine HCl and 0.0125 mg/ml epinefrine HCl combination (Jetokain, Adeka, Türkiye) was performed. Blunt dissection of the conjunctival tissue from the fornix to 1 mm from the limbus and the underlying the Tenon was performed using Westcott scissors. The flap was completed by cutting the limbal area and rotating at an angle of 90° around the scleral site, maintaining the inferior limbal anchoring point (1 mm pedicle). At this stage, the inferior edge of the flap faces the limbus, whereas superior edge faces the fornix. In order to prevent

corneal wound healing by conjunctival epithelium, the conjunctival tissue was excised 1 mm within the limbus.

Application of the Fibrin Tissue Adhesive

The autograft and anchored flap were everted and one of the two parts of the fibrin tissue adhesive was applied throughout the autograft and anchored flap surfaces. Weck-cel was then used to dry the receptor zone. After that, the second component of the fibrin tissue adhesive was added over the receptor zone. The autograft and anchored flap were delicately moved and positioned over the receptor zone by "*bed sheet maneuver*." Attention was paid to both sides of the conjunctiva to be properly positioned and to adequately cover the receptor zone. Complete bonding of both tissues was allowed for one minute, and the patient was then told to blink several times to verify graft adherence.

All eyes were wrapped in bandages with an antibiotic ointment after surgery. Post-operative treatment including Zylet (5 mg loteprednol etabonate (0.5%) + 3 mg tobramycin (0.3%)) (Bausch & Lomb Inc. Florida, USA) eye drops (4X1) and artificial tear lubricant (Refresh Tears) (8x1) was prescribed for 4 weeks. Routine post-operative follow-up examination was performed on days 1, 7 and 30. The fibrovascular tissue encroachment from the surgical site ≥ 1 mm onto the cornea was acknowledged as recurrence. Further, the autograft and/or flap edema, that is, edema > 1 central corneal thickness, and granuloma formation, were evaluated by the same surgeon (HHG) using a slit-lamp biomicroscopy throughout the study period. The baseline and one-month post-operative data of BCVA and corneal topographical parameters, including anterior corneal astigmatism, flat keratometry (Kf), steep keratometry (Ks) and posterior corneal astigmatism (Fig. 1), were collected for statistical analysis.

Statistical Analysis

Categorical data were described using observed frequencies and percentages, and continuous variables were summarized by their means and standard deviations (or medians and interquartile ranges in case of serious deviations from normality) with statistical package (SPSS Inc., version 25.0, Chicago, IL, USA). The assumption of normality in quantitative variables was visually examined with the individual probability charts in the groups and time points to be compared and statistical analysis was performed using the Shapiro Wilk test. The comparison of changes in quantitative variables with time between groups was therefore made using the non-parametric Brunner-Langer model (F1-LD-F1 design), R 3.5.2 software (R software, version 3.5.2, package: nparLD, R Foundation for Statistical Computing, Vienna, Austria; http://r-project.org). As a result of the Brunner-Langer model, when the time-dependent change in the groups was not similar (interaction < 0.1), the time comparison in each group was performed separately by Brunner Langer (LD-F1 design). The Mann-Whitney U test was used to compare the baseline and the difference between one month and the baseline values for each group. In all study, p values < 0.05 were considered to be statistically significant.

Results

Mean ages were 46.94 ± 10.34 years in all 98 pterygium patients, 47.78 ± 8.48 years in 46 (46.9 %) group 1 and 46.19 ± 11.77 years in group 2 (P = 0.441). Male-to-female ratios were 24:22 and 35:17 in groups 1and 2, respectively. In groups 1 and 2, the ratios of the right and left eyes were 22:24 and 31:21, respectively. Only one eye of each patient was studied. The mean BCVA improved from baseline 0.119 ± 0.113 to 0.082 ± 0.086 logMAR in group 1, and from baseline 0.169 ± 0.128 to 0.120 ± 0.121 logMAR in group 2. During the study, no intra- or post-operative complications were observed with respect to any of the surgical techniques.

Pterygium grade and surgical technique

As for pterygium grade, 16, 51 and 31 patients had pterygium with grade 1, 2 and 3, respectively. No patients with grade 4 pterygium were present. Analysis of pterygium surgical techniques in relation to pterygium grade has been demonstrated in Table 1.

Table 1
Analysis of pterygium surgical techniques in relation to pterygium grade

			Pterygium grade			**Total**
			1	2	3	
Surgical Technique	Group 1	Number of Patients	6	25	15	46
		% Within Surgical Technique	13.0	54.3	32.6	100.0
		% Within Pterygium Grade	37.5	49.0	48.4	46.9
	Group 2	Number of Patients	10	26	16	52
		% Within Surgical Technique	19.2	50.0	30.8	100.0
		% Within Pterygium Grade	62.5	51.0	51.6	53.1
Total		Number Of Patients	16	51	31	98

Group 1: Conjunctival autograft technique with fibrin tissue adhesive; Group 2: Anchored conjunctival rotational flap technique with fibrin tissue adhesive

Analysis of the Corneal Topographic Parameters (Table 2)

Anterior Corneal Astigmatism

Although there was no statistically significant difference in pre- and post-operative anterior corneal astigmatism between groups 1 and 2 ($p = 0.686$), there was a statistically significant intra-group difference in both groups ($p < 0.001$ for both groups), with a greater anterior corneal astigmatism difference in group 1 (2.072) compared to Group 2 (1.696).

Flat K (Kf)

There was no statistically significant difference between groups 1 and 2 ($p = 0.107$) in pre- and post-operative Kf. The intra-group difference, on the other hand, was statistically significant in both groups ($p < 0.001$ for both groups), with group 2 (1.910) displaying a slightly higher change compared to group 1 (1.630)

Steep K (Ks)

There was no statistically significant difference in pre- and post-operative Ks between groups 1 and 2 ($p = 0.592$), and so did intra-group differences in both groups (group 1: $p = 0.091$; group 2: 0.092). However, group 1 (0.0522) was associated with far more Ks reduction relative to group 2 (-0.0442).

Posterior Corneal Astigmatism

No statistically significant difference in pre- and post-operative posterior astigmatism between groups 1 and 2 was identified ($p = 0.902$), and so did intra-group differences in both groups ($p = 0.061$ for both groups). However, group 1 (-0.020) was associated with slightly less reduction in posterior corneal astigmatism relative to group 2 (-0.030).

Table 2
Mean values of corneal topographical parameters for the total and the respective study groups.

Parameters		Total (N = 98)	Group 1 (N = 46)	Group 2 (N = 52)
		Mean + Standard Deviation (Min-Max)		
Anterior Corneal Astigmatism	Pre-operative	3.65 ± 2.52 (0.30–10.80)	3.71 ± 2.63 (0.60–10.80)	3.60 ± 2.43 (0.30–9.40)
	Post-operative	1.78 ± 1.37 (0.10–5.90)	1.64 ± 1.32 (0.10–5.90)	1.90 ± 1.41 (0.20–5.40)
	P-Value*		**< 0.001**	**< 0.001**
Kf	Pre-operative	41.33 ± 1.78 (38.00-45.10)	41.22 ± 1.64 (38.20–45.10)	41.42 ± 1.91 (38.00-44.60)
	Post-operative	43.11 ± 1.17 (40.00-45.60)	42.85 ± 1.14 (40.40–45.20)	43.33 ± 1.17 (40.00-45.60)
	P-Value*		**< 0.001**	**< 0.001**
Ks	Pre-operative	44.97 ± 1.80 (41.00-49.20)	44.92 ± 1.97 (41.50–49.10)	45.02 ± 1.65 (41.00-49.20)
	Post-operative	44.97 ± 1.75 (41.10–49.10)	44.87 ± 1.94 (41.40–49.10)	45.06 ± 1.57 (41.10–49.00)
	P-Value*		**0.091**	**0.092**
Posterior Corneal Astigmatism	Pre-operative	0.41 ± 0.32 (0.10–1.90)	0.40 ± 0.32 (0.10–1.40)	0.41 ± 0.33 (0.10–1.90)
	Post-operative	0.38 ± 0.27 (0.10–1.70)	0,38 ± 0.27 (0.10–1.30)	0.38 ± 0.28 (0.10–1.70)
	P-Value*		**0.061**	**0.061**

*Group 1: Patients undergoing conjunctival autograft technique; Group 2: Patients undergoing anchored conjunctival flap technique; Kf: Flat keratometry; Ks: Steep keratometry; N:Number of patients; *: The Mann-Whitney U test*

Discussion

Pterygium is common in dry climates with the highest incidence between the ages of 20 and 40 years. It has the highest prevalence rate (0.7%-31%) among individuals over the age of 40 years in different populations, depending on location, altitude and ethnicity.[7] In addition to corneal topographical changes, pterygium creates optical irregularities and distortions other than intrusion into the visual axis.[1] Pterygium patients frequently consult physicians for discomfort, ocular surface inflammation, red eyes, and/or when their vision is affected. The indications for pterygium surgery include visual impairment due to significant alterations in the refractive state and corneal curvature prior to entry into the optical zone,[8] ocular motility restriction and diplopia, symblepharon, chronic inflammation and cosmetic effects.[9]

It has been long known that pterygium has an effect on corneal topography. Nevertheless, changes in the corneal topographical parameters attributable to pterygium are more or less reversible after surgery.[10] Besides, corneal refractive status has recently been documented with different results following pterygium surgery.[11–15] Ozdemir et al.,[16] reported early significant improvement in pterygium-induced corneal topographical parameters. Normal corneal topography patterns are, however, established in the late post-operative period. Different pterygium surgeries have been associated with post-operative steeper cornea and high mean refractive power.[11,13] It is however uncertain to what extent a particular pterygium surgical technique may have an impact on both anterior and posterior corneal topographical parameters. Moreover, substantial reduction in pterygium-induced astigmatism after different surgical techniques has been reported before.[17–19]

The current study investigated and compared post-operative corneal topographical parameters between baseline and one-month data. Similar to Ozdemir et al.,[16] there were early significant changes in pterygium-induced corneal topographical parameters. The mean age (46.94 ± 10.34 years) of pterygium patients, most of whom (51 %) had grade 2 pterygium, was consistent with the previous reports. Patients undergoing pterygium surgery had primarily cosmetic problems, ocular irritation and/or visual impairment due to pterygium. As regards pterygium surgical techniques, both were comparably associated with significantly improved post-operative BCVA. Pterygium patients usually have normal pre-operative BCVA. Still, they frequently have subjective visual complaints that improve post-operatively and correlate with corneal topographical parameters.

To the best of our knowledge, this is the first study to investigate the impact of specific pterygium surgical techniques on posterior corneal astigmatism using the Pentacam Scheimpflug imaging system, in addition to the anterior corneal topographical parameters. Post-operative assessment of posterior corneal changes using Pentacam Scheimpflug tomography showed no significant posterior corneal changes after different pterygium surgical techniques with sutures, i.e. bare sclera technique (36 eyes), amniotic membrane transplantation (34 eyes), or free conjunctival autograft (26 eyes), using 0.02 % mitomycin C.[3] However, there was a significant change in the orientation of posterior astigmatism, from against-the-rule to with-the-rule astigmatism, suggesting a strong influence on the axis of astigmatism. Further, significantly reduced corneal astigmatism in the anterior and posterior corneal surfaces has been documented in another study in which 152 eyes underwent conjunctival autograft with 10 − 0 absorbable polyglycolic sutures and 11 eyes underwent amniotic membrane transplantion.[20] In the same study, significant corneal steepening as the mean keratometric power of the anterior surface was also recorded. But, there was no significant post-operative change in the posterior corneal surface. Correspondingly, post-operative improvement in corneal astigmatism and increase in corneal steepening have also been reported by Yilmaz et al.,[12] in which bare sclera, mitomycin C excision, limbal-conjunctival autograft and conjunctival autograft techniques were performed, and by Razmjoo et al.,[21] in which pterygium excision with conjunctival autograft was performed using mitomycin C.

Similar changes in corneal topographical parameters after pterygium surgery were observed in the current study, which were accompanied by significant changes, particularly on the anterior corneal surface. Comparison of the conjunctival autograft and the anchored conjunctival rotational flap techniques revealed non-significant differences in pre- and post-operative anterior corneal astigmatism as well as Kf values. However, intra-group analysis of these parameters revealed statistically significant differences in both groups, with the conjunctival autograft technique being associated with a greater change in anterior corneal astigmatism and slightly less change in Kf compared to the anchored conjunctival rotational flap technique. On the other hand, despite the evident changes in Ks and posterior corneal astigmatism, their differences in pre- and post-operative values between the two techniques were not statistically significant. This was also the same for intra-group differences. However, the conjunctival autograft technique was associated with a much higher reduction in Ks and slightly lower reduction in posterior corneal astigmatism compared to the anchored conjunctival rotational flap technique. With regard to these findings, the conjunctival autograft technique seems to be particularly effective in the correction of pterygium-induced anterior corneal distortions. On the other hand, pterygium-induced posterior corneal distortions are likely to improve significantly using the conjunctival rotational flap technique. Other clinical implications of such techniques have been described elsewhere in this study.

Horizontal corneal flattening seems to be the most frequent topographical corneal shape associated with pterygium.[14,22] However, this change often tends to decrease after pterygium surgery,[11] as has also been demonstrated in the current study in which significant changes in Kf and Ks were observed after surgery. Corneal astigmatism in the eyes with pterygium represents the combined effects of naturally occurring astigmatism and pterygium-induced astigmatism.[13,23,24] In the current study, significant change in corneal astıgmatism, particularly anterior corneal astigmatism was revealed after both pterygium excisional techniques.

Several reports on horizontal pterygium-induced corneal flattening mechanisms have been published.[22] However, the specific pathophysiology of corneal flattening has yet to be clarified. The tear meniscus formation between the corneal apex and the elevated pterygium, which causes an apparent flattening of the normal corneal curvature in the area that may be measured by corneal topography, is considered to be one of the potential mechanisms.[25]

Another potential mechanism of pterygium-induced corneal distortion is the tensile strength of the contractile elements inside the pterygium that mechanically distort and flatten the cornea.[23] It may therefore be deduced that pterygium with a higher tensile strength or a larger amount of contractile tissue may potentially be associated with more severe pterygium-induced corneal distortion. Sub-epithelial fibrosis below the pterygium head may have a direct traction effect on the underlying stroma, resulting in localized corneal flattening. There is, however, a high discrepancy with this mechanism because there are no myofibroblast cells in the head and body of the pterygium tissue specimen.[25] Myofibroblast cells, on the other hand, have recently been detected in the fibrovascular tissue around the head and body of

pterygium using immunostaining with cell specific markers and ultrastructural assessment.[26] This finding could illuminate the pterygium-induced traction effect.

The conjunctival autografting first described by Kenyon et al.,[27] in 1985 is considered to be the most effective method for the pterygium treatment. But, compared to this technique, the conjunctival rotational flap technique[28] has some clinical benefits. The conjunctiva and Tenon’s capsule orientation is readily identifiable in this technique. There is also no need for a suture on the pedicle, hence reducing surgery time. Besides, there is a lower incidence of flap edema compared to that of conjunctival autograft, which may be attributable to the retention of the vascular network in the limbus around the pedicle.[29] Notably, the flap technique demonstrated comparable post-operative changes in corneal topographical parameters and BCVA improvement to the conjunctival autograft technique in the current study. The conjunctival rotational flap differs from the conjunctival autograft technique due to flap orientation. The comparable post-operative corneal topographical modifications between these two different techniques suggest that flap orientation is not associated with undesirable corneal topographical impacts as long as it is not "inverted." But guaranteeing the potential effect of the limbal barrier in condition of the limbal-conjunctival autograft makes flap orientation crucial.

In addition to the surgical technique,[12] pre-operative astigmatism,[12,13] age and ethnicity of the patient, clinical characteristics of pterygium[30] and the type of suture material have an impact on post-operative modifications in corneal topography and subsequent recurrences.[31,32] However, no intra- or post-operative complications such as the flap and/or graft edema, and early recurrence were observed in the current study in which all pterygium surgeries were using fibrin tissue adhesive. All patients were of Turkish descent, predominantly with grade 2 pterygium and no sutures were used in the current study that could have a negative impact not only on the anterior but also on the posterior corneal topographical parameters. Moreover, cauterization and classical adjuvant drugs such as 5-FU or MMC[33] were not used in the current study. Potentially associated complications related to these materials and processes were hence avoided.

In the current study limitations, despite the relatively larger study participants, there was a lack of an appropriate randomization method as well as a control group. The conjunctival flap or autograft procedures are performed more frequently in recurrent cases in clinical practice. Thus, only primary nasal pterygium investigation may be subject to additional limitation. The current study has shown significant topographical changes even in a short post-operative period. However, investigating the corneal topographical changes only one month after surgery may be another limitation to the current study. After all, cornea has been demonstrated to stabilize one month after pterygium surgery by time-range analysis.[34] Additional long-term prospective studies with more participants incorporating not only different pterygium surgical techniques but also different topographical devices for the anterior and posterior corneal topographical assessment may be worthwhile.

In conclusion, considerably more changes in anterior corneal astigmatism and Ks were identified after successful conjunctival autograft technique. The anchored conjunctival rotational flap technique was accompanied by relatively greater changes in posterior corneal astigmatism and Kf. Thus, the former technique may be indicated in pterygium patients with relatively higher pre-operative anterior corneal topographical distortions measured by Pentacam Scheimpflug imaging system. Those characterized by significant pre-operative posterior corneal topographical changes, however, may respond well with the latter technique.

Declarations

Ethics approval and consent to participate

The local ethics committee approved the study, and the required procedures were applied after the participants' written informed consent. The consent of participants for publication of their data was acquired.

Conflict of interest

The authors declare that they have no conflicts of interest

Funding

There is no financial support in this article. The authors have no commercial relationship.

Authors' Contributions

All authors performed the data collection, were involved in all parts of the production of the paper.

Data Availability

The data supporting our findings will be participated upon request

Acknowledgments

The authors would like to thank Timur KÖSE, Assc Prof., (Ege University-Izmir) for his insightful suggestions and careful reading of the manuscript statistical analysis.

Disclosure Statement

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials mentioned in this article.

References

1. Lin A, Stern GA. Correlation between pterygium size and induced corneal astigmatism. *Cornea*. 1998;17:28-30.
2. Walland MJ, Stevens JD, Steele ADM. The effect of recurrent pterygium on corneal topography. *Cornea*. 1994;13:463-464.
3. Kheirkhah A, Safı H, Molaei S, et al. Effects of pterygium surgery on front and back corneal astigmatism. *Can J Ophthalmol*. 2012 Oct;47(5):423-8.
4. Rüfer F, Schröder A, Arvani MK, et al. Central and peripheral corneal pachymetry: Standard evaluation with the Pentacam *Klin Monbl Augenheilkd.* 2005;222:117-122
5. Uçakhan OO, Gesog˘lu P, Ozkan M, et al. Corneal elevation and thickness in relation to the refractive status measured with the Pentacam Scheimpflug system. *J Cataract Refract Surg.* 2008;34:1900-1905.
6. Nejima R, Masuda A, Minami K, et al. Topographic changes after excision surgery of primary pterygia and the effect of pterygium size on topograpic restoration. *Eye Contact Lens*. 2015;41(1):58-63.
7. Varma R, Vajaranant TS, Burkemper B, et al. Visual impairment and blindness in adults in the United States: demographic and geographic variations from 2015 to 2050. *JAMA Ophthalmol*. 2016;134:802-809.
8. Starck T, Kenyon KR, Serrano F. Conjunctival auto-graft for primary and recurrent pterygia: surgical technique and problem management. *Cornea*. 1991;10:196-202
9. Yaycıoğlu RA, Aydın Akova Y. Amnion membran transplantasyonunun oftalmolojide yeri. *T Klin Oftalmoloji.* 2003;12:227-236.
10. Oltulu R, Demirel S, Sarac O, et al. Evaluation of corneal and anterior chamber changes following pterygium surgery using a Pentacam Scheimpflug system: a prospective study. *Semin Ophthalmol.* 2013;28:206-209.
11. Bahar I, Loya N, Weinberger D, et al. Effect of pterygium surgery on corneal topography: A prospective study. 2004;23:113-117.
12. Yilmaz S, Yuksel T, Maden A. Corneal topographic changes after four types of pterygium surgery. *J Refract Surg.* 2008;24:160-165
13. Oh JY, Wee The effect of pterygium surgery on contrast sensitivity and corneal topographic changes. *Clin. Ophthalmologe.* 2010;4:315-319.
14. Errais K, Bouden J, Mili-Boussen I, et al. Effect of pterygium surgery on corneal topography. *Eur J Ophthalmol.* 2008;18:177-181.
15. Wu PL, Kuo CN, Hsu HL, et al. Effect of pterygium surgery on refractive spherocylinder power and corneal *Ophthal Surg Lasers Imaging.* 2009;40:32-37.
16. Ozdemir M, Cinal A. Early and late effects of pterygium surgery on corneal topography. *Ophthalmic Surg Laser Imaging*. 2005;36:451-456.
17. Stern GA, Lin A. Effect of pterygium excision on induced corneal topographic abnormalities. 1998;17:23-27.

18. Fong KS, Balakrishnan V, Chee SP, et al. Refractive change following pterygium surgery. *CLAO J.* 1998;24:115-117.
19. Levinger E, Sorkin N, Sella S, et al. Posterior Corneal Surface Changes After Pterygium Excision Surgery. Cornea. 2020;39:823-826.
20. Omar IAN, Attaallah HR. Assessment of the Corneal Aberration and Elevation Changes after Pterygium Surgery. *J Clin Exp Ophthalmol.* 2016;7:561.
21. Razmjoo H, Vaezi M, Peyman A, et al. The effect of pterygium surgery on wavefront analysis. *Adv Biomed Res.* 2014;3:196.
22. Yasar T, Ozdemir M, Cinal A, et al. Effects of fibrovascular traction and pooling of tears on corneal topographic changes induced by pterygium. *Eye*. 2003;17:492-496.
23. Mohammad-Salih PA, Sharif AF. Analysis of pterygium size and induced corneal astigmatism. 2008;27:434-438.
24. Avisar R, Loya N, Yassur Y, et al. Pterygium-induced corneal astigmatism. *Isr Med Assoc J.* 2000;2:14-15.
25. Oldenburg JB, Garbus J, McDonnell JM, et al. Conjunctival pterygia. Mechanism of corneal topographic changes. 1990;9:200-204.
26. Touhami A, Di Pascuale MA, Kawatika T, et al. Characterisation of myofibroblasts in fibrovascular tissues of primary and recurrent pterygia. *Br J Ophthalmol.* 2005; 89: 269-274
27. Kenyon KR, Wagoner MD, Hettinger ME. Conjunctival autograft transplantation for advanced and recurrent pterygium. 1985;1461-1470.
28. Krachmer JH, Mannis MJ, Holland EJ, et al. Cornea. Philadelphia: Mosby; 1998. p. 1
29. Kim SH, Oh JH, Do JR, et al. A comparison of anchored conjunctival rotation flap and conjunctival autograft techniques in pterygium surgery. 2013;32:1578-1581.
30. Tomidokoro A, Miyata K, Sakaguchi Y, et Effects of pterygium on corneal spherical power and astigmatism. *Ophthalmology.* 2000;107:1568-1571.
31. Chui J, Di Girolamo N, Wakefield D, et al. The pathogenesis of pterygium: current concepts and their therapeutic implications. *Ocul Surf.* 2008;6:24-43.
32. Kandavel R, Kang JJ, Memarzadeh F, et al. Comparison of pterygium recurrence rates in Hispanic and white patients after primary excision and conjunctival autograft. 2010;29:141-145
33. Alsmman AH, Radwan G, Abozaid MA, Mohammed UA, Abd Elhaleim NG. Preoperative subconjunctival combined injection of bevacizumab and mitomycin C before the surgical excision of primary pterygium: clinical and histological results. *Clin Ophthalmol.* 2017;11:493-501
34. Maheshwari S. Pterygium-induced corneal refractive changes. *Indian J Ophthalmol*. 2007;55:383-386.

Figures

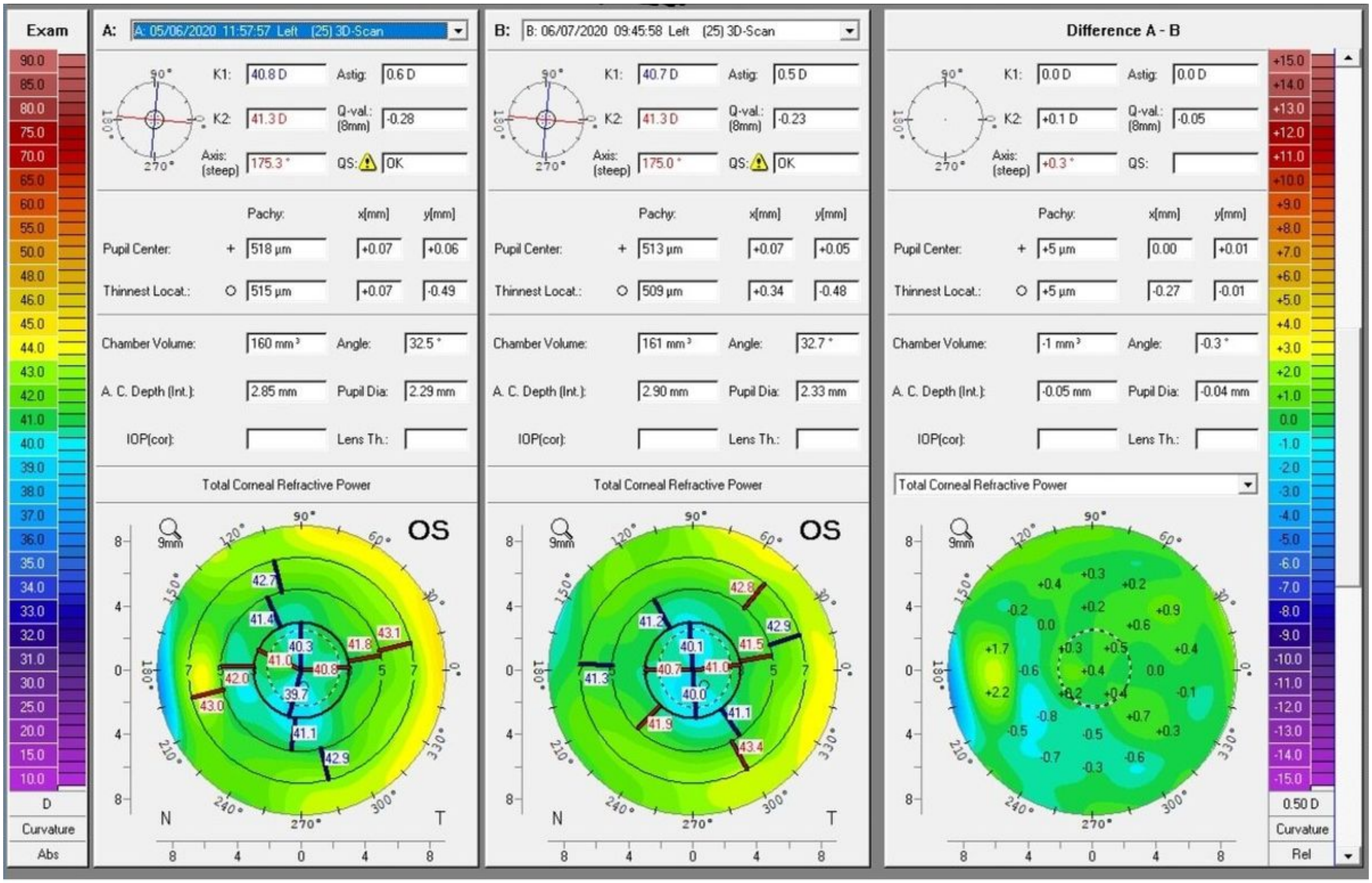

Figure 1

The comparative illustration of a primary nasal pterygium patient demonstrating early corneal topographical changes using a Penatacam Scheimpflug camera. Significant changes in the anterior topographical corneal parameters of the left eye, including flat and steep keratometry as well as anterior corneal astigmatism, were observed 1 month after pterygium surgery.