Impact of Pterygium Surgery on Corneal Topography

Pterjiyum Cerrahisinin Korneal Topografi Üzerine Etkileri

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ABSTRACT Objective: To evaluate the quantitative and qualitative effects of pterygium surgery on corneal topography. **Material and Methods:** Eighteen eyes of 17 patients with pterygium were included in the study. Computerized corneal topography were performed preoperatively, at one week- and one month-postoperatively. The quantitative parameters reviewed included central corneal power (sim K), corneal cylinder, surface regularity index (SRI), surface asymmetry index (SAI), horizontal length of the pterygium, surgically induced astigmatism (SIA), and positive astigmatic axis. Topography maps were also evaluated qualitatively. **Results:** The mean preoperative Sim K was statistically less than the mean Sim K at one week- (p= 0.014) and one month- postoperatively (p= 0.016). The mean SAI at one week-postoperatively was statistically higher than it was at one month-postoperatively (p= 0.017). The mean SRI at one week- postoperatively was higher than it was at one month- postoperatively (p= 0.006). Although there was a tendency towards decrease in corneal cylinder after surgery, this decrease was not statistically significant (p= 0.833). The horizontal length of the pterygium was positively correlated with the preoperative corneal cylinder, SIA at one week-, and SIA at one month- postoperatively (r= 0.741 p= 0.000; r= 0.771 p= 0.000, r= 0.669 p= 0.002, respectively). Preoperative corneal cylinder was positively correlated with SIA at one week- and one month- postoperatively (r= 0.937 p= 0.000, r= 0.966 p= 0.000, respectively). Corneal topography most frequently revealed regular astigmatic patterns before and after surgery. The distribution of spherical, regular astigmatic and irregular astigmatic patterns did not change by surgery (p= 0.949). **Conclusion:** Pterygium causes reversible changes on corneal topography in accordance with its horizontal length.

Key Words: Pterygium; surgery; corneal topography; astigmatism

ÖZET Amaç: Piterjiyum cerrahisinin kornea topografisine etkilerinin kalitatif ve kantitatif olarak değerlendirilmesi **Gereç ve Yöntemler:** Piterjiyumu olan 17 hastanın 18 gözü çalışmaya dahil edildi. Cerrahi öncesinde, cerrahi sonrası birinci hafta ve birinci ayda korneanın bilgisayarlı topografik ölçümleri yapıldı. Merkezi kornea kırıcılığı (sim K), korneal silendir, yüzey regülerite indeksi ("surface regularity index", SRI), yüzey asimetri indeksi ("surface asymmetry index", SAI) piterjiyumun horizontal uzunluğu, cerrahiye bağlı astigmatizma (SIA) ve pozitif astigmatik akstan oluşan kantitatif parametreler gözden geçirildi. Topografi haritaları üzerinde de niteliksel değerlendirme yapıldı. **Bulgular:** Cerrahi öncesi ortalama Sim K değeri, cerrahi sonrası birinci hafta (p= 0.014) ve birinci ay (p= 0.017) Sim K değerlerinden istatistiksel olarak küçüktü. Cerrahi sonrası birinci hafta ortalama SAI değeri, cerrahi sonrası birinci ay ortalama SAI değerinden istatistiksel olarak daha yüksekti (p= 0.017). Cerrahi sonrası birinci hafta ortalama SRI değeri, cerrahi sonrası birinci ay ortalama SRI değerinden daha yüksekti (p= 0.006). Cerrahi sonrası korneal silendirde azalma eğilimi olmasına karşın, bu azalma istatistiksel olarak anlamlı değildi (p= 0.833). Pterjiyumun horizontal uzunluğu ile cerrahi öncesi korneal silendir, cerrahi sonrası birinci ay ve birinci haftadaki SIA arasında pozitif korelasyon vardı (sırasıyla r= 0.741 p= 0.000; r= 0.771 p= 0.000, r= 0.669 p= 0.002). Cerrahi öncesi korneal silendir ile cerrahi sonrası birinci hafta ve birinci ay SIA arasında pozitif korelasyon vardı (sırasıyla r= 0.937 p= 0.000, r= 0.966 p= 0.000). Cerrahi öncesi ve sonrasında korneal topografide sıklıkla düzenli astigmatik paternler görüldü. Sferik paternler ile düzenli ve düzensiz astigmatik paternlerin dağılımında cerrahi ile değişiklik görülmedi (p= 0.949). **Sonuç:** Pterjiyum, horizontal uzunluğu ile orantılı olarak kornea topografisinde geri dönüşümlü değişikliklere neden olur.

Anahtar Kelimeler: Pterjiyum; cerrahi; korneal topografi; astigmatizma

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Pterygium is a fibrovascular overgrowth with extension of connective tissue from the bulbar conjunctiva onto to the cornea.[1] The invasion of the cornea by the pterygium causes visual disturbance besides cosmetic disfigurement.[2] Pterygium may change the refractive status and curvature of the cornea even before reaching the optic zone.[1] This change is characterized by "with the rule astigmatism" caused by localized flattenning of the horizontal axis of the central cornea.[1,3-4] Advanced pterygium induces a greater amount of astigmatism and excision of the advanced pterygium changes the corneal astigmatism dramatically.[5-7] In this study, we evaluated the qualitative and quantitative topographical changes induced by pterygium surgery.

MATERIAL AND METHODS

In this prospective, randomized study, 18 eyes with primary nasal pterygium were included. The indication for surgery was either astigmatism or cosmesis. Patients with nasal pterygium extending greater than 2 mm to the cornea were included. Exclusion criteria included the history of ocular surgery/corneal trauma, contact lens use, dry eye, keratoconus or any other anterior segment problems. This study was conducted in compliance with institutional review board regulations and Declaration of Helsinki. Informed consent was obtained from all patients before the initiation of any study medication or study related procedures.

Before pterygium surgery, a complete ophthalmic examination was performed in all patients. The horizontal length -between the limbus and the advancing edge- of the pterygium was measured with the help of the slit-lamp. Corneal topography (Magellan Mapper, Nidek Technologies, Italy) was performed in all patients. Corneal topographic patterns were classified according to "Karabatsas classification".[8] The following parameters provided by the computerized corneal topography were reviewed:

- Sim K (Simulated keratometry, central corneal power) is obtained from the greatest power observed on the corneal surface from an average of rings 12-16 along every meridian. The power and axis orthogonal to the highest power were also reported as they are in traditional keratometry. Sim K2 is the power of the flat meridian orthogonal (90°) to Sim K1.
- SRI (surface regularity index) is a measure of local fluctuations in central corneal power.
- SAI (surface asymmetry index) measures the difference in corneal powers at every ring (180° apart) over the entire corneal surface.
- Corneal cylinder is the difference between Sim K1 and Sim K2.

Surgically induced astigmatism (SIA) was calculated by vector analysis method at one week- and one month-postoperatively.[9] Positive astigmatic axis was identified according to Sim K1, and astigmatism was classified according to the positive astigmatic axis as follows:

With the rule: Positive astigmatic axis from 60° to 120°.

Against the rule: Positive astigmatic axis from 0° to 30° and from 150° to 180°.

Oblique: Positive astigmatic axis from 31° to 59° and from 121° to 149º.

SURGICAL TECHNIQUE

After topical anesthesia with oxybuprocaine (Benoxinate, Liba, Turkey), 0.5 cc of lidocaine hydrochloride and epinephrine solution (Jetocain, Adeka, Turkey) was injected into the pterygium tissue. Pterygium was dissected from the cornea in a lamellar fashion with a 30° blade and then excised with scissors. The bare area was measured with a Castroviejo caliper. After injection of 0.5 cc lidocaine hydrochloride and epinephrine solution beneath the superior bulbar conjunctiva, free conjunctival autograft with the appropriate size was cut with scissors. The graft was slided into the recipient bed and secured to the adjacent conjunctiva and episclera with 8-0 absorbable sutures (polyglactin 910). Postoperatively, topical polymixin B sulfate/trimethoprim (Oftalmotrim, Alcon, Spain) was used four times a day for one week and fluoromethalone acetate (Flarex, Alcon, Belgium) was used four times a day for two weeks and twice a day for a month.

Statistical analysis was performed with SPSS for Windows 10.0 (Statistical Product and Servxice Solutions, Inc., Chicago, IL, USA) package program. In descriptive analysis, the counting variables are presented as counts and percentages; the measurement variables are given as average and standard deviation. Friedman test was applied in the comparative analysis of these variables. When the difference between variables was determined with Wilcoxon signed-ranks test, Bonferroni correction was performed. P values less than 0.05 were considered as statistically significant. To determine whether or not there were linear correlations between some parameters, scatter plot graphics and two tailed Pearson correlation analysis were used.

RESULTS

Eighteen eyes of 17 patients were included in the study. Of the 17 patients, nine were males (52.9%) and eight (47.1%) were females. The mean age was 55.58 ± 11.90 (33-76) years. The mean horizontal length of the pterygium was 2.83 ± 0.92 (2.0-5.0) mm.

The mean Sim K was preoperatively, 43.86 ± 1.42 (41.64-46.89) D at one week- and 43.59 ± 1.78 (40.64-47.37) D at one month- postoperatively (p= 0.016). The mean preoperative Sim K 43.05 ± 2.03 (39.01-46.01) D was statistically less than the mean Sim K at one week- (p= 0.014) and one month- postoperatively (p= 0.016). The mean SAI was 0.50 ± 0.47 (0.09-1.42) preoperatively, 0.53 ± 0.61 (0.12-2.33) at one week- and 0.40 ± 0.46 (0.06-1.57) at one month- postoperatively (p= 0.027). The mean SAI at one week-postoperatively was statistically higher than it was at one month-postoperatively (p= 0.017). The mean SRI was 0.83 ± 0.73 (0.00-2.31) preoperatively, 1.18 ± 0.71 (0.15–2.44) at one week- and 0.74 ± 0.80 (0.00-2.10) at one month- postoperatively (p= 0.005). The mean SRI at one week- postoperatively was higher than it was at one month-postoperatively (p= 0.006). The mean corneal cylinder was 2.21 ± 2.42 (0.00-7.47) D preoperatively, 0.96 ± 0.64 (0.13-2.67) D at one week- and 0.99 ± 0.93 (0.00-4.26) D at one month- postoperatively. Although there was a tendency towards a reduction in corneal cylinder after surgery, this reduction was not statistically significant (p= 0.833) (Table 1).

TABLE 1: Sim K, SAI, SRI and corneal cylinder during the study.

Parameters	Preoperative	Postoperative week 1	Postoperative month 1	p value
Sim K	43.05 ± 2.03[a]	43.86 ± 1.42[b]	43.59 ± 1.78[b]	
	(39.01 – 46.01)	(41.64 – 46.89)	(40.64 – 47.37)	0.016
SAI	0.50 ± 0.47[a]	0.53 ± 0.61[b]	0.40 ± 0.46[a]	
	(0.09 – 1.42)	(0.12 – 2.33)	(0.06 – 1.57)	0.027
SRI	0.83 ± 0.73[a]	1.18 ± 0.71[b]	0.74 ± 0.80[a]	
	(0.00 – 2.31)	(0.15 – 2.44)	(0.00 – 2.10)	0.005
Corneal	2.21 ± 2.42	0.96 ± 0.64	0.99 ±0.93	
cylinder	(0.00 – 7.47)	(0.13 – 2.67)	(0.00 – 4.26)	0.833

Sim K: Central Corneal Power
SAI: Surface Asymmetry Index
SRI: Surface Regularity Index
[a,b]: Different letters in the same row indicates statisticall significance.

The horizontal length of the pterygium was positively correlated with the preoperative corneal cylinder, SIA at one week-, and SIA at one month-postoperatively (r= 0.741 p= 0.000; r= 0.771 p= 0.000, r= 0.669 p= 0.002, respectively). Horizontal length of the pterygium was positively correlated with SAI preoperatively and at one week- and one month- postoperatively (r= 0.830 p= 0.000, r= 0.606 p= 0.008, r= 0.690 p= 0.002). Horizontal pterygium length was positively correlated with SRI preoperatively and at one week- and one month- postoperatively (r= 0.825 p= 0.000, r= 0.563 p= 0.015, r= 0.725 p= 0.001). Horizontal length was positively correlated with central corneal power difference at one week- and one month- postoperatively (r= 0.560 p= 0.016, r= 0.519 p= 0.027, respectively). Preoperative corneal cylinder was positively correlated with SIA at one week- and one month- postoperatively. (r= 0.937 p= 0.000, r= 0.966 p= 0.000, respectively) (Table 2).

The mean of the positive astigmatic axes was 85.6 ± 29.29 (20-143) degrees preoperatively, 90.33 ± 46.23 (1-178) degrees at one week-, and 84.72 ± 40.52 (3-167) degrees at one month- postoperatively (p= 0.944). The mean difference between preoperative and one week-postoperative astigmatic axes was 4.72 ± 47.6 (-142 -109) D (clockwise change). The mean difference between preoperative and one month- postoperative astigmatic axes was -0.88 ± 43.8 (-140 -98) (counterclockwise change).

TABLE 2: Correlation of horizontal length of the pterygium with Sim K, SAI, SRI and corneal cylinder during the study.

Preoperative					
	Horizontal L	**Sim K**	**SAI**	**SRI**	**Corneal Cyl**
Horizontal L	1	r= -0.311	r= 0.830	r= 0.825	r= 0.741
		p= 0.209	p= 0.000	p= 0.000	p= 0.000
Sim K		1	r= -0.242	r= -0.342	r= -0.308
			p= 0.333	p= 0.164	p= 0.214
SAI			1	r= 0.850	r= 0.935
				p= 0.000	p= 0.000
SRI				1	r= 0.698
					p= 0.001
Corneal Cyl					1
Postoperative Week 1					
	Horizontal L	**Sim K**	**SAI**	**SRI**	**Corneal Cyl**
Horizontal L	1	r= 0.122	r= 0.606	r= 0.563	r= 0.240
		p= 0.630	p= 0.008	p= 0.015	p= 0.336
Sim K		1	r= 0.149	r= 0.318	r= -0.101
			p= 0.554	p= 0.199	p= 0.690
SAI			1	r= 0.738	r= 0.048
				p= 0.000	p= 0.850
SRI				1	r= 0.164
					p= 0.516
Corneal Cyl					1
Postoperative Month 1					
	Horizontal L	**Sim K**	**SAI**	**SRI**	**Corneal Cyl**
Horizontal L	1	r= -0.875	r= 0.690	r= 0.725	r= 0.685
		p= 0.736	p= 0.002	p= 0.001	p= 0.002
Sim K		1	r= -0.163	r= -0.081	r= -0.286
			p= 0.518	p= 0.748	p= 0.250
SAI			1	r= 0.855	r= 0.627
				p= 0.000	p= 0.005
SRI				1	r= 0.562
					p= 0.015
Corneal Cyl					1

Horizontal L: Horizontal lenght
Corneal Cyl: Corneal cylinder
Sim K: Central Corneal Power
SAI: Surface Asymmetry Index
SRI: Surface Regularity Index

With the rule astigmatism was the most common type of astigmatism both before and after surgery (Table 3). The distribution of corneal astigmatism types was not changed statistically by the surgery (p= 0.694).

Corneal topography revealed most frequently regular astigmatic patterns before and after surgery. All three spherical corneas ended up spherical after surgery (Table 4). The distribution of spherical, regular astigmatic and irregular astigmatic patterns did not change by surgery (p=0.949). Data loss in accordance with the location of pterygium was seen in all corneal topography maps (Figure 1 a,b,c).

DISCUSSION

Although pterygium is a relatively common disease, our knowledge on the effects of pterygium on corneal topography is scarce.[1,10] There are three different hypotheses explaining the corneal topographic changes induced by pterygium: Hansen and Norn stated that pterygium presses on the nasal cornea while Mark et al and Gridley and Perlman described that the pterygium pulls the cornea and causes a distortion.[11-13] On the other hand Oldenburg et al claimed that corneal meridian is flattened due to localized pooling of tears in advance of the pterygium and added that there are no myofibroblasts indicating contractile capabilities in the pterygium tissue.[14]

Some studies it is reported that an improvement in SAI and SRI is observed after the excision of the pterygium.[5,15-17] Some authors declared a decrease in regular and irregular corneal astigmatism after pterygium surgery.[3,15-19] The presence of pterygium and its removal significantly influence the corneal refraction including spherical power, astigmatism, asymmetry, and irregularity, with the larger pterygium exerting the greater influence.[1] In this study we found that the Sim K value increased however the SAI and SRI values decreased following pterygium surgery. Cinal et al. revealed a positive correlation between preoperative astigmatism and SIA value, as well as between the length of the

TABLE 3: Distribution of corneal astigmatism values.

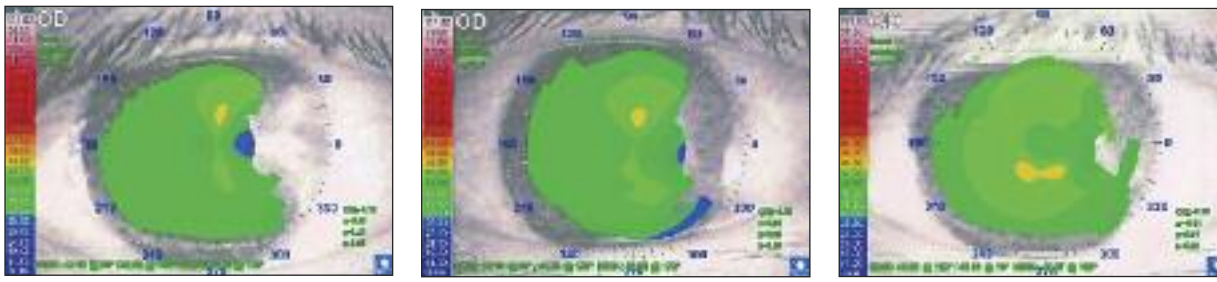
Cases (n=18)	**With the rule astigmatism n (%)**	**Against the rule astigmatism n (%)**	**Oblique astigmatism n (%)**
Preoperative	14 (77.8)	2 (11.1)	2 (11.1)
Postoperative week 1	10 (55.5)	5 (27.9)	3 (16.6)
Postoperative month 1	12 (66.7)	4 (22.2)	2 (11.1)

n: patient number

TABLE 4: Distribution of corneal topography patterns.

Cases (n=18)		Regular astigmatism n (%)				Irregular astigmatism n (%)	
	Spheric n (%)	PSBT	PABT	Oval	OABT	PI	LS
Preoperative	3 (16.6)	9 (50)	3 (16.6)	1 (5.6)	1 (5.6)	1 (5.6)	-
Postoperative week 1	3 (16.6)	6 (33)	4 (22.4)	1 (5.6)	1 (5.6)	2 (11.2)	1 (5.6)
Postoperative month 1	3 (16.6)	4 (22.4)	6 (33)	1 (5.6)	2 (11.2)	1 (5.6)	1 (5.6)

n: patient number
PSBT: Prolate symmetric bow-tie
PABT: Prolate asymmetric bow-tie
OABT: Oblate asymmetric bow-tie
PI: Prolate irregular
LS: Localized steep



a b c

FIGURE 1: Corneal topography maps of a case during the study: a- preoperative, b- postoperative week1, c- postoperative month 1.

pterygium and SIA.[2] However there was no correlation between preoperative and postoperative astigmatism. Despite this, a positive linear correlation between preoperative astigmatism and the difference between the presurgical and postsurgical astigmatism is reported in a study.[20] In advanced pterygium, a positive correlation was reported between the length of the pterygium and corneal astigmatism in 10 eyes.[5] Alison et al. stated that pterygium invading more than the 45% of the corneal radius or 2.5 mm of the visual axis cause high degrees of astigmatism.[21] In the presented study, we found a positive correlation between the length of the pterygium and preoperative and postoperative astigmatism, SRI and SAI. However, there was no correlation between preoperative and postoperative astigmatism. Cinal et al. reported a 74% rate of with the rule astigmatism preoperatively.[2] After the surgery, the rate of the with the rule astigmatism, oblique astigmatism and against the rule astigmatism were found as 22%, 41% and 37%, respectively. Budak et al. reported a decrease in with the rule astigmatism after pterygium surgery.[22] Ozdemir et al. reported a 77.8% rate of with the rule astigmatism preoperatively.[23] Postoperatively, this rate was measured as 55.5% at one week, and 66.7% at one month.

Cinal et al. stated that the cornea was flattened by the cornea especially at the nasal quadrant where the pterygium was located.[2] The changes induced by surgery was especially evident in this flattened area. In half of our patients we observed prolate symmetric bow-tie pattern (50%).

Similar to the presented studies,[2,14,22,23] we also detected an increase in the corneal power after the surgery. The mean sim K was increased from 43.05 ± 2.03 D preoperatively to 43.59 ± 1.78 D at one month- postoperatively.

Pterygium decreases central corneal power, but increases SRI and SAI. It mostly causes regular astigmatism (prolate symmetric bow-tie pattern) in corneal topography. With the rule astigmatism is the most common type of astigmatism both before and after surgery. The changes induced by pterygium on corneal topography maps are reversible.

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