

# Assessment of the Corneal Aberration and Elevation Changes after Pterygium Surgery

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## Abstract

**Aim:** To assess the changes in corneal higher order aberrations and changes in the elevation of the front and back corneal surfaces using the Oculus Pentacam.

**Study design:** It was a prospective study that included 63 eyes of fifty patients with primary pterygium.

**Place and duration of the study:** It was done between December 2012 and November 2013 in Elminya university hospital.

**Methodology:** All patients had pterygial excision with conjunctival autograft and intraoperative application of Mitomycin C 0.5%. Patients were examined with Oculus Pentacam to assess the corneal aberrations and elevation induced by pterygium preoperatively and six months after its excision.

**Results:** Eight eyes were in female patients (12.7%) and fifty five in male patients (87.3%). The mean age was  $47.2 \pm 5.3$  ranging from 38 to 56 years. The preoperative mean front corneal cylinder was  $3.9 \pm 2.7$  (0.8 to 10.6) and that of the posterior surface was  $0.2 \pm 0.15$  (0 to 0.6) and changed postoperatively to  $1.45 \pm 1.1$  (0.2 to 4) ( $p=0.001$ ) and  $0.19 \pm 0.1$  (0 to 0.5) ( $p=0.03$ ) respectively and both are statistically significant. The mean keratometric power of the anterior surface increased significantly from  $42.7 \pm 2.11$  D (39.9 to 48.7) preoperatively to  $44.7 \pm 1.9$  D (42.7 to 48.9) postoperatively ( $p=0.001$ ).

The root mean square (RMS) of total and higher order aberrations decreased postoperatively except for the spherical aberration ( $0.26 \pm 0.2 \mu\text{m}$  preoperatively versus  $0.43 \pm 0.17 \mu\text{m}$  postoperatively,  $p=0.001$ ). The RMS of postoperative coma and trefoil decreased significantly ( $-0.01 \pm 0.2 \mu\text{m}$  versus  $0.006 \pm 0.4 \mu\text{m}$ ,  $p=0.03$  for coma) and ( $-0.07 \pm 0.6 \mu\text{m}$  versus  $-0.15 \pm 0.3 \mu\text{m}$ ,  $p=0.04$  for trefoil). Regarding the corneal asphericity (Q-value), there was increased prolation of the anterior surface ( $-0.40 \pm 0.2$  vs  $-0.38 \pm 0.8$   $p=0.8$ ), but for the posterior surface there was mild oblation ( $-0.39 \pm 0.12$  vs  $-0.41 \pm 0.16$   $p=0.4$ ).

Analysis of the corneal elevation revealed that the front and back elevations decreased significantly six months postoperatively at the 7 mm zone ( $-68.1 \pm 25.1$ mm versus  $-44.8 \pm 46.6$  mm  $p=0.001$  for the front), and ( $-198.43 \pm 66.5$  mm versus  $-157.07 \pm 117.8$  mm  $p=0.017$  for the back).

**Conclusion:** Pterygium affects the corneal surface and induces elevation changes and aberrations that is why it should be removed to improve the visual performance of the patients. We should consider pterygial excision before any refractive surgery or lens surgery planned for those patients.

**Keywords:** Pterygium; Aberrations; Asphericity; Elevation

## Introduction

Pterygium is an elevated, superficial, external ocular mass that usually forms over the perilimbal conjunctiva and extends onto the corneal surface. Pterygia can vary from small, atrophic quiescent lesions to large, aggressive, rapidly growing fibrovascular lesions that can distort the corneal topography, and, in advanced cases, they can obscure the optical center of the cornea [1].

There are different pterygial excision surgeries but pterygium excision with conjunctival autograft has the lowest recurrence rates [2].

Many previous studies concentrated on studying the changes in the corneal curvature and astigmatism [3]. The progress in the corneal examination techniques gave us a valuable tool to assess the corneal elevation of both corneal surfaces and the corneal aberrations after different refractive surgeries.

## Purpose

To assess the changes in corneal higher order aberrations (HOA) and elevation of the front and back corneal surfaces following pterygial excision.

## Patients and Methods

In this prospective study, data were collected from patients undergoing pterygial excision in Elminya university hospital in the period between December 2012 and November 2013.

The study included 63 eyes of fifty patients, all had primary small pterygium. We excluded patients with history of trauma, previous ocular surgery, corneal diseases especially ectasia or corneal opacity, conjunctival diseases or scarring, or recurrent pterygia.

The protocol of the study was approved by the institutional review board and medical ethics committee of El-minya university hospital. Written consent was taken from all patients participated in that work.

All patients had pterygial excision with conjunctival autograft with intraoperative application of Mitomycin C 0.5% for one minute.

The patients were examined preoperatively and 6 months postoperatively using the oculus pentacam to assess the corneal elevation map changes and wavefront higher order aberration changes on the corneal surface.

Four maps refractive maps with best fit sphere of 9 mm were used to evaluate corneal elevation changes.

We measured the higher order aberrations as spherical aberrations, coma, and trefoil.

We assessed the corneal elevation changes in the front and back surfaces at the 4 mm and 7 mm zones from the center.

The corneal anterior and posterior elevation and changes were obtained at the center (8 points 4mm from the center, at 0°, 45°, 90°, 135°, 180°, 225°, 270°, and 315° semi-meridians), and peripheral regions (14 points 7 mm from the center at 15°, 45°, 60°, 90°, 120°, 135°, 165°, 195°, 225°, 245°, 270°, 295°, 315°, and 345° semi-meridians). In all mathematical analyses, we set 0° at a point on the right and moved counter clockwise in both eyes.

Collected data were tabulated and analyzed using the SPSS (statistical package for social sciences) program for windows version

20. Variables were calculated as mean and standard deviation. Preoperative and postoperative parameters as well as the preoperative versus postoperative changes were analyzed using the paired 2-sided t test. A p value less than 0.05 was considered statistically significant.

## Surgical technique

All cases had pterygium excision under surface anesthesia with benoxinate 1% four times with five minutes intervals, then soaking the fornices with cotton bud soaked with benoxinate for 10 minutes.

Dissection started from the upper part of the pterygium body separating the conjunctiva from it. The dissection is continued till the limbus using the conjunctival scissor then the dissection is continued on the corneal surface to remove its head using dissector.

After complete removal of the pterygium the episcleral vessels were gently cauterized, then Mitomycin C 0.5% applied for one minutes then washed copiously with 150 ml of balanced salt solution. The bare area was measured with a caliper.

With a marker pen the upper temporal conjunctiva was marked 1 mm larger than the measured bare scleral area. Subconjunctival BSS was injected to dissect the conjunctiva from the Tenon's casule. The conjunctival graft was advanced till 1 mm of the limbal area to include limbal stem cells. The dissected graft is sutured to the bare area with 10/0 nylon sutures. Then therapeutic contact was applied for three days. Antibiotic and steroid eye drops was prescribed for two weeks.

## Results

Sixty three eyes of fifty patients with primary pterygium met the inclusion criteria of this prospective study.

The studied patients included 55 (87.3%) eyes that were in male patients. The mean age was  $47.2 \pm 5.3$  ranging from 38 to 56 years.

The changes in the corneal parameters are recorded in Table 1, including the front and back corneal astigmatism, mean keratometric readings, and the corneal asphericity (Q- value).

	Corneal astigmatism		Mean keratometric value		Asphericity (Q-value)	
	Front	Back	Front	Back	Front	Back
Preoperative	$3.96 \pm 2.7$ (0.8 to 8)	$0.4 \pm 0.15$ (0 to 0.6)	$42.67 \pm 2.11$ (39.9 to 47.7)	$-6.48 \pm 0.21$ (-7 to -6.2)	$-0.4 \pm 0.65$ (-2.64 to 1.22)	$-0.42 \pm 0.2$ (-1.09 to -0.1)
Postoperative	$1.45 \pm 1.1$ (0.2 to 4)	$0.19 \pm 0.1$ (0 to 0.5)	$44.7 \pm 1.9$ (42.7 to 48.9)	$-6.6 \pm 0.2$ (-6.4 to -7.4)	$-0.38 \pm 0.8$ (-2.38 to 1.18)	$-0.41 \pm 0.16$ (-0.9 to -0.2)
p value	0.001	0.03	0.001	0.65	0.8	0.4

**Table 1:** Preoperative and postoperative changes in the corneal parameters.

There was statistically significant improvement in both front and back corneal cylinders.

The keratometric readings showed statistically significant steepening of the front corneal surface after pterygium excision.

On studying the corneal asphericity (Q-value), there was statistically non-significant increased prolation of the anterior surface, but for the posterior surface there was mild oblation.

The root mean square (RMS) of the spherical aberration increased postoperatively but for postoperative coma and trefoil decreased significantly (Table 2).

	Preoperative	Postoperative	p value
Total RMS	$6.29 \pm 3.18$	$4.13 \pm 2.28$	0.001
HOA	$2.4 \pm 1.18$	$1.24 \pm 0.57$	0.001

Spherical aberrations	0.26 ± 0.2	0.43 ± 0.17	0.001
Coma	0.006 ± 0.46	-0.015 ± 0.28	0.03
Trefoil	-0.15 ± 0.32	-0.07 ± 0.61	0.04

**Table 2:** The changes of the corneal aberrations.

Analysis of the corneal elevation revealed that the front and back elevations decreased significantly six months postoperatively at the 7 mm zone (Table 3).

	Anterior elevation		Posterior elevation	
	At 4 mm	At 7 mm	At 4 mm	At 7 mm
Preoperative	-3.52 ± 25.92	-44.84 ± 46.59	3.42 ± 56.05	-157.07 ± 117.85
Postoperative	-3.46 ± 10.37	-68.14 ± 25.14	-8.96 ± 32.01	-198.4 ± 66.5
p value	0.9	0.001	0.13	0.017

**Table 3:** Changes in the elevation of the anterior and posterior corneal surfaces.

## Discussion

Pterygium is a common disease especially in those patients with long periods of sunlight exposure. It induces optical irregularities and distortion other than invading the visual axis [3].

Patients included in this study were with primary pterygia and had pterygium excision with application of Mitomycin C 0.5% and conjunctival autografting. All patients were examined preoperatively and 6 months postoperatively with pentacam.

Surgical treatment of the pterygium usually improves corneal irregularity and visual performance [4] and reverses most of the corneal topographic changes [5].

In this study, corneal astigmatism reduced significantly after pterygium excision in front and back corneal surfaces. The preoperative mean front corneal cylinder was 3.9 ± 2.7 (0.8 to 10.6) and that of the posterior surface was 0.2 ± 0.15 (0 to 0.6) and changed postoperatively to 1.45 ± 1.1 (0.2 to 4) (p=0.001) and 0.19 ± 0.1 (0 to 0.5) (p=0.03) respectively.

The pterygium excision resulted in corneal steepening as the mean keratometric power of the anterior surface changed significantly from 42.7 ± 2.11 D (39.9 to 48.7) to 44.7 ± 1.9 D (42.7 to 48.9) (p=0.001), but that of the posterior corneal surface from -6.5 ± 0.21 D (-6.2 to -7) to -6.6 ± 0.2 D (-6.4 to -7.4) (p=0.65) and this was not statistically significant. This is also met by the studies done by Yilmaz et al. and Razmjoo et al. who found improved astigmatism and increased steepening [5,6].

Root mean square of total aberrations and HOAs were found to be significantly reduced in the treated patients (4.13 ± 2.28 versus 6.29 ± 3.18 for total RMS and 1.24 ± 0.57 versus 2.4 ± 1.18 for HOA and p=0.001 for both).

This was met by the studies done by Pesudos and Figueiredo, Zare et al., Gumus et al., Razmjoo et al., and Ozgurhan et al. They reported that the RMS of the total aberrations and HOAs were reduced postoperatively especially for coma and trefoil [4,6-9].

The most affected aberrations in this study were trefoil and coma (-0.01 ± 0.2 µm versus 0.006 ± 0.4 µm p=0.03 for coma) and (-0.07 ± 0.6 µm vs -0.15 ± 0.3 µm, p=0.04 for trefoil).

Regarding the spherical aberrations, they were the only aberration which increased significantly after pterygium excision (0.43 ± 0.17 µm versus 0.26 ± 0.2 µm, p=0.001). This is clearly explained by the increased corneal steepening and asphericity after surgery.

Regarding changes in the corneal elevation of both front and back corneal surfaces measured in this study, there was statistically significant reduction in the front and back corneal elevations at 7 mm zone being the mostly affected after pterygium excision (-68.1 ± 25.1 mm versus -44.8 ± 46.6 mm p=0.001 for the front), and (-198.43 ± 66.5 mm versus -157.07 ± 117.8 mm p=0.017 for the back).

From previous data, it can be concluded that; pterygium induced astigmatism can be improved after its excision, pterygium surgery makes the cornea more steep and hence increases the spherical aberrations. On the other hand it reduces trefoil and vertical coma, peripheral abnormal corneal elevations can be reduced postoperatively, and pterygium surgery reduces corneal irregularities and it should be done prior to any planned refractive surgery for those patients as it affects many corneal parameters.

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