Egyptian Journal of Clinical Ophthalmology "EJCO"
An International peer-reviewed journal published bi-annually
Volume 6, Issue 1, June 2023: pp: 27-39 www. ejco.sohag-univ.edu.eg

Original Article

CORNEAL TOPOGRAPHIC CHANGES AFTER PTERYGIUM SURGERY

Ezz Eldawla, M.(*), Ahmed, S., Mostafa, E. & Radwan, G.
[1]Ophthalmology dept., Faculty of Medicine, Sohag, Univ., Egypt.

*E-mail: mohammedezz44@yahoo.com

Received: 8/1/2023
Accepted: 13/5/2023
Doi: 10.21608/ejco.2023.305202

Abstract

Purpose: *To assess the corneal topographic changes pre and post excision of primary pterygium and to assess the collaboration between the size of the pterygium and these changes which obtained by Pentacam.* ***Patients and Methods***: *This study is prospective, non-randomized, and interventional. It involved 38 eyes of 38 individuals with primary nasal pterygium. The cases were classified into two groups in terms of the size of the pterygium. All patients were managed by surgical excision of pterygium with a bare sclera approach and intraoperative MMC application. Follow-up was done after one, three, and six months postoperatively. The following measurements were obtained using Pentacam: K1, K2, astigmatism, axis, anterior elevation map, and apical corneal thickness. Additionally, we studied the changes in UCVA, BCVA, refractive sphere, and cylinder.* ***Results***: *The mean age of all cases was 56.16±5.1 years (48-64 years). The mean astigmatism decreased significantly from -4.6±3.1 preoperatively to -1.32±0.7 postoperatively. Large sized pterygium group has significant higher astigmatic values preoperatively and postoperatively. The mean K1 increased significantly (p<0.05) postoperatively, while there was no marked variation in mean K2 during 3 and 6 months postoperatively (p>0.05). There was an obvious decrease in mean values of the anterior elevation map, apical corneal thickness, refractive sphere, and cylinder postoperatively. Both UCVA and BCVA improved significantly postoperatively.* ***Conclusion***: *pterygium leads to significant topographic and refractive changes that rise with the elevation in the pterygia size and enhance after pterygium surgery.*

Keywords: *Pterygium, Corneal topography, Astigmatism, Bare sclera*.

1. Introduction

Pterygium is a fleshy mass of thicker conjunctiva which often develops from the inside of the eyeball and obstructs vision. It covers a portion of the cornea [1]. The occurrence of pterygium was reported to be 10.2% worldwide, with low-altitude areas having the highest prevalence [2]. Pterygium is more common in the tropics and in an equatorial zone between 30° north and south latitudes. Recurrent sun exposure (UV rays), advanced age, male gender, and outdoor exercise are linked to an increased incidence [3]. Pterygium's pathophysiology is defined by fibrovascular growth and elastotic collagen degradation, with an epithelium-covered overlaying layer. Hematoxylin and eosin staining of the aberrant collagen in the region of elastotic degeneration reveals basophilia.

This tissue likewise exhibits stains characteristic of elastic tissue; however, it differs from real elastic tissue in that elastase does not break it down [4]. A computer-assisted diagnostic technique called corneal topography produces a three-dimensional map of the cornea's surface curvature [5]. A thorough, visual depiction of the cornea's form and power is produced through corneal topography. This kind of study very precisely describes the state of the corneal surface. These specifics are utilized to diagnose, monitor, and treat different eye disorders [6].

2. Patients and Methods

A prospective non-randomized interventional case series study was undertaken in the ophthalmology department, Sohag University Hospital during the period between June 2021 and June 2022. The study was approved by the Sohag Faculty of Medicine's ethics committee and adhered to the principles of the Helsinki Declaration. Thirty-eight eyes of thirty-eight individuals with primary pterygium were subjected to surgical excision of pterygium with bare sclera approach and intraoperative application of MMC, and were observed for six months post-operatively. Inclusion criteria included cases with primary pterygium and exclusion criteria included: **1)** cases with recurrent pterygium; **2)** cases with any other ocular disorder; **3)** cases who cannot do regular follow-up visits.

2.1. *Examination*

All patients underwent a thorough ophthalmological examination after providing the necessary consent, which included taking their full medical and ocular histories, measuring their best corrected visual acuity (BCVA) and uncorrected visual acuity (UCVA) using the Landolt C chart and converting the results to decimal form, checking their refraction, and performing a slit lamp examination. Posterior segment examination was done (by indirect ophthalmoscope) to exclude retinal pathology. Corneal topographic imaging was done using Pentacam (OCULUS, Wetzlar, Germany), from which the following measurements were collected from the central 3 mm optical zone of 3 composite refractive maps (anterior elevation map, anterior sagittal curvature map, and corneal thickness map): K1 (flat meridian), K2 (steep meridian), astigmatism, axis, the value of elevation of the anterior corneal surface in comparison with BFS and finally apical corneal thickness. The cases were classified into two groups in accordance with the size of the pterygium that was graded in terms of the advancing edge position from the limbus: group 1: equal or less than 3 mm from the limbus. Group 2: more than 3 mm from the limbus. And that was done just before surgery under the operating microscope using a Castroviejo caliper.

2.2. *Intervention*

The surgical procedure involved the administration of MMC and the removal of the pterygium. After topical anesthesia, 2% lidocaine hydrochloride was injected into the pterygium's body in sterile conditions. With the assistance of toothed forceps, the pterygium's head was grabbed. Excision with a No. 15 blade was started around 0.5 mm in front of the pterygium, and it was continued down clearly to the limbus (in some cases, avulsion of the head of the pterygium away from the cornea using toothed forceps can be done easily without the help of blade, especially in small pterygium with a raised edge). With a No. 15 blade, the remaining tissue above the corneal defect region was removed. As much as possible the fibrous subconjunctival tissue under the pterygium was removed without harming the underlying muscle sheath. A 0.2 mg/mL of MMC solution was administered topically utilizing a microsponge soaked in MMC beneath the conjunctiva over the muscular tendon insertion for 2 minutes following pterygium removal. The MMC was then thoroughly rinsed with 30 mL of balanced salt solution.

2.3. *Postoperative treatment*

The same postoperative care regimen for all cases involved topical prednisolone acetate 1% with gatifloxacin 0.3% four times per day and carboxymethyl cellulose 0.5% drops four times a day for 2-3 weeks.

2.4. *Follow-up schedules*

On the second day following the operation, all patients had examinations. Following that, appointments for follow-up visits were made for one, three, and six months after surgery. Detailed ophthalmological examination was done involving: BCVA, UCVA, refraction, slit lamp examination with special emphasis on detection of recurrence of pterygium, examination of the posterior segment (by indirect ophthalmoscope) was performed to exclude any retinal pathology. Pentacam imaging: was done for all patients and measurements were taken like preoperatively.

2.5. *Statistical analysis*

The Statistical Package for Social Sciences (SPSS) version 17.0 (SPSS, Inc, Chicagho, Intl) was used to statistically evaluate the data that was gathered. To evaluate the statistical difference among the both groups in the predefined parameters, the independent t-test was applied. While the same group's statistical significance was evaluated utilizing the paired t-test. If the P value was less than 0.05 or less than 0.01, a significant difference was deemed significant and highly significant, respectively.

3. Results

The objective of this study is to assess the impact of pterygium surgery on corneal topography that involves: K1 (front), K2 (front), astigmatism (front), anterior elevation map, and pachymetric map and also to evaluate the impact of various grades of pterygium on them. Thirty-eight eyes with primary pterygium in 38 cases were involved in this research. Lt eye pterygium was recorded in 24 patients, while the Rt eye pterygium was recorded in 14 patients. There were 11 women (28.9%) and 27 men (71.1%), and the mean age ± SD was 56.16 ±5.1. Under the operating microscope, pterygia were graded according to the extent of the advancing edge from the limbus. 20 pterygia were grade I with pterygium size ≤3 mm (52.6 %) and 18 pterygia were grade II with pterygium size > 3mm (47.4 %). The BCVA and UCVA were significantly enhanced during the three follow-up visits compared to values before surgery, as the P-value was less than 0.05, as shown in tab. (1). Also, there was a statistically significant difference between the two groups regarding the UCVA and the BCVA; the mean of BCVA and UCVA was better in small-sized pterygium than large-sized pterygium group before surgery as well as during the three visits after surgery, tab. (2). The autorefractive obtained readings include: sphere and cylinder. The mean sphere preoperatively was 1.61±1.69 D with a statistically significant decrease after one month (mean ±SD = 0.39±1.32 D), three months (mean ±SD = 0.37±1.22 D), and six months (mean ±SD =0.39±1.19 D) after surgery as P value was less than 0.05, tab. (3). On the other hand, there was no statistically marked variation in the autorefractive sphere among both groups before surgery or during the three visits of follow-up where the P value was more than 0.05, tab. (4). The following topographic data were collected from the central 3 mm optical zone of 3 composite refractive maps (anterior elevation map, anterior sagittal curvature map, and corneal thickness map): K1 (front), K2 (front), astigmatism(front), axis of the steep meridian (front), the value of elevation of the anterior corneal surface in comparison with BFS and finally apical corneal thickness. There was a statistically marked elevation in the mean K1 during the three visits postoperatively in comparison to values before surgery as the mean K1 increased from 40±3.22 D preoperatively to 43.18±1.48 D, 43.56±1.22 D, and 43.63±1.22 D during one, three and six months after surgery, tab. (5) & fig. (1). In contrast to that, the only statistically marked variation in mean K1 among the both groups was preoperative, where the mean K1 in small sized pterygium group was 41.04±3.29 D, and the mean K1 in large sized pterygium group was 38.84±2.7 D with P value =0.02, tab. (6). As shown in tab. (5), the mean K2 increased during the three visits of follow-up, but the only statistically significant difference was during the first month after surgery, where the P value = 0.009, fig. (1). Statistically, tab. (6) showed a non-significant difference in mean K2 among the both groups preoperative and one month post-operative, where the P value was more than 0.05 while the mean K2 was higher in large-sized pterygium group during the third and sixth month after surgery with P value less than 0.05. The mean astigmatic value preoperatively was -4.6±3.1 D, as shown in tab. (5) there was a statistically marked reduction in the astigmatic value during the three visits of follow-up with mean values -1.72±1.29 D, -1.44±0.81 D and -1.32±0.7 D respectively (P value <0.0001). The mean astigmatism was -2.98±1.84 D in small sized pteryg-ium group preoperatively, while it was -6.23 ±3.4 D in large sized pterygium group, and that variation was significant statistically (P value <0.0001). Similarly, there was a statistically marked variation in the mean of astigmatic values among both groups during the three follow-up visits. A reduction in the mean value of astigmatism has been observed by 2.02 D in small sized pterygium group and by 4.53 D in large sized pterygium group by six months postoperatively tab. (6). The mean value of ant. elevation map decreased after surgery, but that decrease was statistically significant only during the third- and sixth-month after surgery as the P value was 0.01 and 0.002, respectively, tab. (7) & fig. (2). In contrast, there was a statistically marked difference in the mean values of ant. elevation map between the both groups only during the third month as well as the sixth month after surgery, and these values were higher in large sized pterygium group, tab. (8) & fig. (3). Statistically, table 7 showed statistically marked variation in the mean values of corneal thickness during the three visits after surgery as the mean of corneal thickness decreased from 520.58±38.01 um preoperatively to 514.42±30.36 um, 513.21±30.67 um and 513±27.71 um during the three visits of follow up respectively, tab. (7) & fig. (4) but there was no statistically significant difference in mean values of corneal thickness among the both groups preoperatively nor postoperatively, tab. (8) & fig. (3). Preoperatively, there were 26 pterygia had with-the-rule astigmatism, and 6 pterygia had against-the-rule astigmatism as well as 6 pterygia had oblique astigmatism. One month after surgery, 20 eyes had with-the-rule astigmatism, and 8 pterygia had against-the-rule astigmatism as well as 10 pterygia had oblique astigmatism. On the third month of follow-up, 22 eyes had with-the-rule astigmatism, and 10 pterygia had against-the-rule astigmatism as well as 6 pterygia had oblique astigmatism. On the sixth month of follow-up,26 eyes had with-the-rule astigmatism, and 6 pterygia had against-the-rule astigmatism as well as 6 pterygia had oblique astigmatism, tab. (9).

Table 1: Comparison between mean values of UCVA and BCVA pre and postoperatively.

	UCVA (in decimal)	BCVA (in decimal)
Preoperative	0.18±0.10	0.28±0.18
1 month	0.24±0.15	0.38±0.19
3 month	0.29±0.22	0.45±0.22
6 month	0.31±0.22	0.47±0.22
P1	0.001	0.0001
P2	0.0003	<0.0001
P3	<0.0001	<0.0001

The data is presented as mean±SD, **P1: compared 1 month to preoperative, **P2**: compared 3 months to preoperative, **P3**: compared 6 months to preoperative, **UCVA** = uncorrected visual acuity, **BCVA** = best corrected visual acuity.*

Table 2: Comparison between mean values of UCVA and BCVA between the two groups

	Small-sized pterygium group	Large-sized pterygium group	*p*-value**
UCVA (in decimal)			
Preoperative	0.22±0.11	0.14±0.07	0.016
1 month	0.32±0.16	0.14±0.07	<0.0001
3 month	0.40±0.24	0.17±0.07	0.0005
6 month	0.41±0.25	0.21±0.13	0.005
BCVA(in decimal)			
Preoperative	0.35±0.19	0.20±0.14	0.01
1 month	0.50±0.15	0.26±0.15	<0.0001
3 month	0.57±0.20	0.32±0.17	0.0001
6 month	0.56±0.20	0.36±0.18	0.003

The data is presented as mean±SD, ****p-value was calculated by independent sample t-test, **UCVA** = uncorrected visual acuity, **BCVA** = best corrected visual acuity.*

Table 3: Comparison between mean values of the refractive sphere and cylinder pre and postoperatively

	Sphere (D)	cylinder (D)
Preoperative	1.61±1.69	-3.67±2.25
1 month	0.39±1.32	-1.62±1.22
3 month	0.37±1.22	-1.45±0.99
6 month	0.39±1.19	-1.36±0.87
P1	<0.0001	<0.0001
P2	<0.0001	<0.0001
P3	<0.0001	<0.0001

The data is presented as mean±SD, * **P1: compared 1 month to preoperative, **2**: compared 3 months to preoperative, * **P3**: compared 6 months to preoperative.*

Table 4: Comparison between mean values of refractive sphere and cylinder between the two groups

	Small-sized pterygium group	Large-sized pterygium group	*p*-value**
Sphere (D) Preoperative			
1 month	1.24±1.68	2.02±1.65	0.15
3 month	0.15±0.65	0.67±1.77	0.25
6 month	0.14±0.62	0.64±1.64	0.23
	0.15±0.62	0.67±1.58	0.2
Cylinder (D) Preoperative			
1 month	-2.99±2.10	-4.42±2.22	0.04
3 month	-0.99±0.43	-2.33±1.43	0.001
6 month	-1.01±0.49	-1.94±1.19	0.005
	-0.9±0.46	-1.28±1.42	0.004

****The data is presented as mean±SD, **p-value** was calculated by independent sample t-test*

Table 5: Comparison between mean values of k1, k2, and astigmatism pre and postoperatively

	K1 (D)	K2 (D)	Astigmatism (D)
Preoperative	40±3.22	44.6±1.95	-4.6±3.1
1 month	43.18±1.48	45.2±1.83	-1.72±1.29
3 month	43.56±1.22	45±1.48	-1.44±0.81
6 month	43.63±1.22	44.92±1.26	-1.32±0.7
P1	<0.0001	0.009	<0.0001
P2	<0.0001	0.1	<0.0001
P3	<0.0001	0.1	<0.0001

The data is presented as mean±SD, * **P1: compared 1 month to preoperative, * **P2:** compared 3 months to preoperative, * **P3:** compared 6 months to preoperative.*

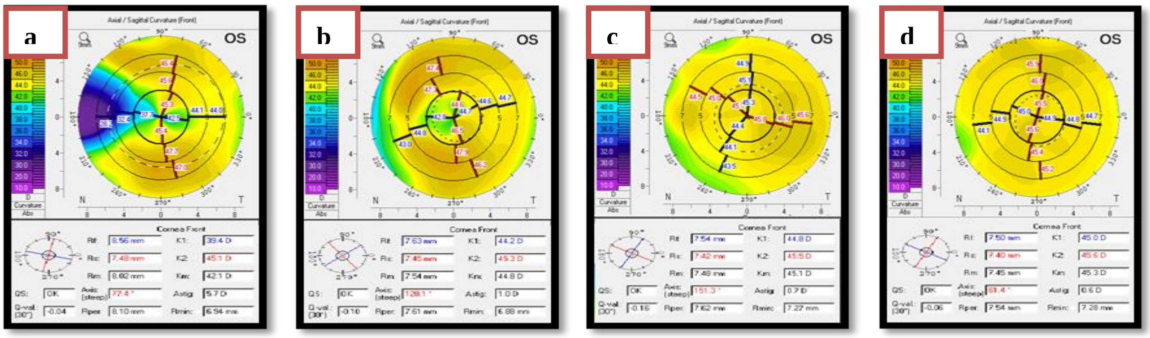

Figure 1: Keratometric map of lt. eye with nasal pterygium; **a.** preoperative, **b.** 1 month postoperative, **c.** 3 months postoperative, **d.** 6 months postoperative. Notice the increase in K1 and k2 with the decrease in astigmatism over time as well as the change of axis over time

Table 6: Comparison between mean values of k1, k2 and astigmatism between the two groups

	Small-sized pterygium group	Large-sized pterygium group	*p*-value**
K1(D)			
Preoperative	41.04±3.29	38.84±2.7	0.02
1 month	43.48±1.58	42.84±1.4	0.18
3 month	43.52±1.55	43.6±0.81	0.83
6 month	43.59±1.6	43.67±0.70	0.84
K2(D)			
Preoperative	44.03±2.22	45.23±1.50	0.05
1 month	44.52±1.68	45.57±1.88	0.08
3 month	44.48±1.63	45.58±1.07	0.01
6 month	44.51±1.53	45.38±0.69	0.02
Astigmatism(D)			
Preoperative	-2.98±1.84	-6.23±3.4	0.0006
1 month	-1.04±0.55	-2.6±1.36	0.0001
3 month	-0.97±0.53	-1.9±0.75	<0.0001
6 month	-0.96±0.6	-1.7±0.59	0.0002

The data is presented as mean±SD. ****p-value was calculated by independent sample t-test*

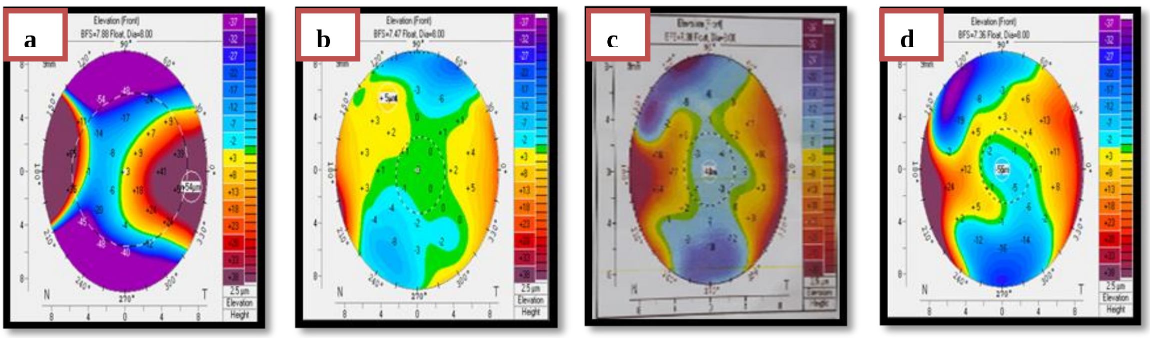

Figure 2: Ant. elevation map of lt. eye with nasal pterygium; **a.** preoperative, **b.** 1 month postoperative, **c.** 3 months postoperative, **d.** 6 months postoperative. Notice the decrease of ant, elevation values over time.

Table 7: Comparison between mean values of ant, elevation map, and corneal thickness pre and postoperatively**.**

	Ant. Elevation map(mm)	Corneal thickness(um)
Preoperative	4.84±3.99	520.58±38
1 month	3.68±4.73	514.42±30.4
3 month	2.84±3.09	513.21±30.7
6 month	2.58±2.83	513±27.7
P1	0.19	0.02
P2	0.01	0.008
P3	0.002	0.008

** The data is presented as mean±SD, * **P1:** compared 1 month to preoperative, * **P2:** compared 3 months to preoperative, * **P3:** compared 6 months to preoperative*

Table 8: Comparison between mean values of ant, elevation map and corneal thickness between the two groups

	Small-sized pterygium group	Large-sized pterygium group	*p*-value**
Ant. Elevation map (mm)			
Preoperative	5.1±2.07	4.56±5.45	0.7
1 month	2.4±1.96	5.11±6.35	0.09
3 month	1.8±1.20	4.0±4.05	0.03
6 month	1.6±1.31	3.67±3.63	0.03
Corneal thickness(um)			
Preoperative	512.5±19.67	529.56±50.49	0.19
1 month	513.6±16.70	515.33±41.13	0.86
3 month	513.6±15.39	512.78±42.21	0.9
6 month	512.9±14.74	513.1±37.80	0.98

** The data is presented as mean±SD, *****p*-value*** *was calculated by independent sample t-test*

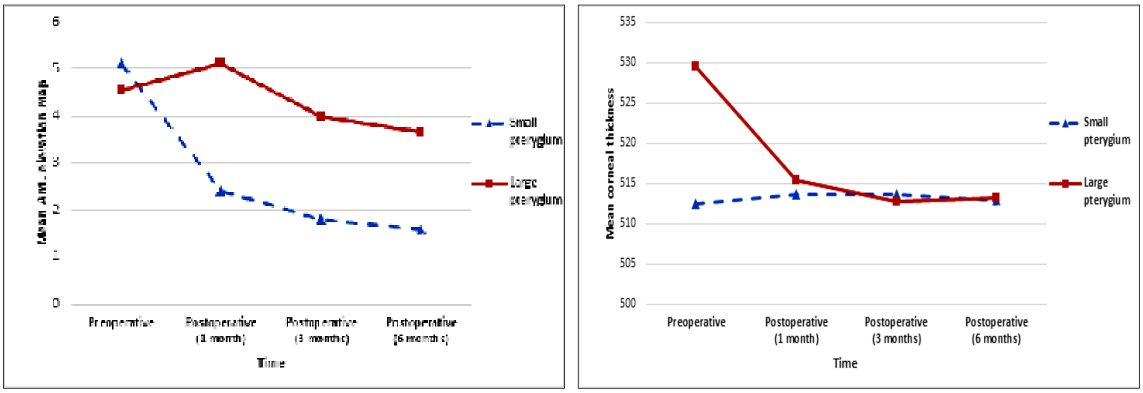

Figure 3: Changes in mean ant, elevation map over time in both groups(to the left) and changes in mean corneal thickness over time in both groups(to the right)

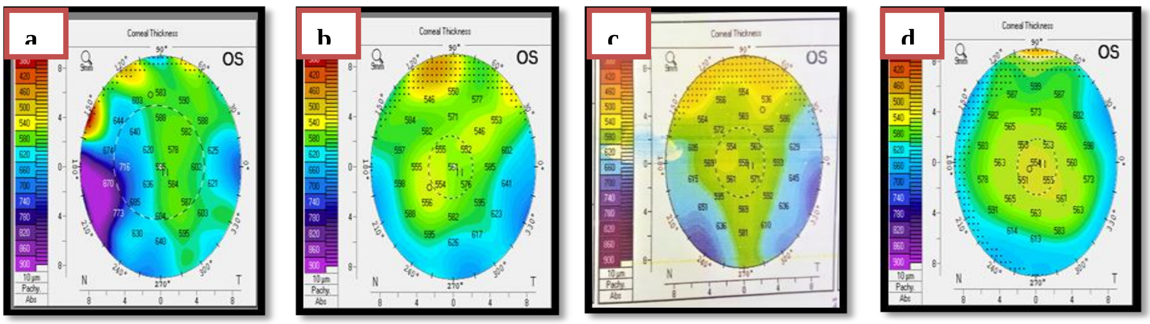

Figure 4: Pachymetric map of lt. eye with nasal pterygium; **a.** preoperative, **b.** 1 month postoperative, **c.** 3 months postoperative, **d.** 6 months postoperative. Notice the decrease of corneal thickness over time.

Table 9: Change in axis of astigmatism over time

Time	Type of astigmatism	Number (%)
Preoperative	ATA* Oblique WTA**	6 (15.79%) 6 (15.79%) 26 (68.42%)
1 month postoperative	ATA Oblique WTA	8 (21.05%) 10 (26.32%) 20 (52.63%)
3 months postoperative	ATA Oblique WTA	10 (26.32%) 6 (15.79%) 22 (57.89%)
6 months postoperative	ATA Oblique WTA	6 (15.79%) 6 (15.79%) 26 (68.42%)

**ATA:* *against the rule of astigmatism, **WTA: with the rule of astigmatism.*

4. Discussion

Pterygium is known as an ocular surface disease with fibrovascular tissue growth creeping over the cornea associated with inflammation and vascularization [7]. The mean age in our study was 56.16 ±5.1 years (48–64 y) demonstrated that pterygium development increased with age, and this agreed with some previous studies [8-10]. In the current study, 28.9% of patients were females, and 71.1% were males indicating that pterygium prevalence increases among males. That finding was in line with Salih and Sharif, that demonstrated that the incidence of pterygium is higher in males than females; that was explained that outdoor workers are more common to be males, so they are more susceptible to exposure to environmental effects [11]. However, some researchers found a higher incidence among women, and that was illustrated that women are more concerned about cosmetic effect of pterygium [12,13]. Other researches revealed no difference between males and females [13]. Our study involved a relatively good sample size, as well as a relatively long postoperative follow-up in assessing the alterations in corneal topography after pterygium surgery, the approach for excision of the pterygium head was the same in all study patients without any sutures. In contrast, patients with primary pterygium were only involved in the current study to avoid any confounding alterations that may be due to recurrent pterygium. Shrivastava et al. noticed a marked enhancement in mean UCVA (in logMAR units) from 0.52± 0.32 before surgery to 0.43±0.29 after surgery ($p < 0.0001$) [13]. In the research performed by Yagmur et al., the mean preoperative VA (in decimal) was 0.41 ±0.30 that enhanced to 0.63±0.26 postoperatively ($p < 0.001$) [14]. Other studies observed the same results [15,16]. We had comparable outcomes with the preoperative UCVA (in decimal) of 0.18±0.10 significantly improved to 0.31±0.22 at the end of six months postoperatively ($p < 0.0001$). Similarly, Maheshwan recorded that BCVA (in decimal) elevated from 0.53 preoperatively to 0.68 postoperatively ($p=0.01$) [17], and these results were in line with our observations as mean BCVA enhanced from 0.28±0.18 before surgery to 0.47±0.22 at the end of 6 months postoperatively ($p<0.0001$). Misra and colleague as well as Ahmed Anwar et al., found similar observations [18,19]. Additionally, our study observed that the BCVA, the UCVA, and the pterygium size collated significantly inversely. Same result was showed by B Seitz and colleagues [6]. Furthermore, we found that the mean values of UCVA and that of BCVA are more improved after the excision of small-sized pterygia than the excision of large-sized ones. This agreed with the results of the study conducted by Samiha M. and Coworkers [20]. Kheirkhah and colleagues were the first researchers who have evaluated the impact of pterygium excision on back, and front corneal surfaces using pentacam .they found that front corneal astigmatism reduced from a mean before surgery value of 3.97±4.49 D to 1.23±1.88 D at 1 month postoperatively (p<0.001) [21]. That outcome was in line with another research performed by Burcu Kazanci et al. using pentacam too and found that the front corneal astigmatism showed statistically significant improvement 6 months after surgery [22]. Also, many other researchers demonstrated that pterygium-induced astigmatism decreased after surgical pterygium excision [23-25]. Similarly, we found that the degree of corneal front astigmatism (within central 3 mm) decreased significantly after surgical excision of pterygium as the mean values of corneal front astigmatism decreased from -4.6±3.1 preoperatively to -1.72±1.29 D, -1.44±0.81 D and -1.32±0.7 D at 1, 3, and 6 months postoperatively respectively with p-value less than 0.0001. Han and colleagues reported that there is a strong correlation between pterygium-induced astigmatism and the horizontal length of pterygium [26]. This observation was consistent with our study as mean values of corneal front astigmatism preoperatively in large sized pterygium group (-6.23± 3.4 D) was significantly higher than that of small sized pterygium group (-2.98± 1.84 D) (p =0.0006). Furthermore, our study revealed that the pterygium size was significantly impacting the change in corneal front astigmatism in addition to the postoperative degree of corneal front astigmatism, as shown in table (6), where the mean values of corneal front astigmatism was greater in large sized pterygium group through the 3 visits of postoperative follow up and that was statistically significant. Mohammed Salih and coworkers reported that the pterygium extension had the greatest marked colleration with corneal astigmatism, followed by the total area of pterygium [27]. F H Oner et al. found that pterygia with length ≥3.00 mm were linked significantly to greater astigmatism. Additionally, they found that corneal astigmatism was not significantly related to pterygium morphology [28]. Lesions that are within 3.2 mm of the visual axis or that extend beyond 45% of the corneal radius, create rising degrees of induced astigmatism [29]. Kampitak noted that pterygium extension larger than 2.2 from corneal limbus could producing corneal astigmatism more than 2 D, and that could be considered the limit of surgery [30]. Karay Gumus observed that earlier pterygium excision reserve the changes of visual parameters and avoid permanent changes to the cornea [31]. Michael and colleagues using pentacam reported that anterior flat k increased significantly after two weeks of pterygium excision from 42.9 ±1.6 D to 43.5±1.3 D (p=0.02), and the anterior steep k elevated from 44.1 D preoperatively to 44.4 D two weeks postoperatively then decreased from two weeks postoperatively to 44.2 D one month postoperatively and did not statistically change afterword [32]. This study was in line with our study as we observed that the flattest meridian (k1) of corneal front surface (within central 3 mm) was statistically steeper after excision of pterygium as the mean values of k1 increased from 40±3.22 D preoperatively to 43.18± 1.48 D, 43.56±1.22 D, and 43.63±1.22 D during the three visits postoperatively at 1, 3 and 6 months respectively (p <0.0001). Meanwhile, the mean values of the steepest meridian (k2) of the anterior corneal surface (within central 3 mm) increased significantly from 44.6±1.95 D before surgery to 45.2±1.83 D one month postoperatively (p=0.009), then decreased from one month to three (45±1.48 D) and six months (44.92±1.26 D) postoperatively and these values were non statistically higher than that before excision of pterygium. Another study conducted by BURCU who reported results agreed with ours; his study evaluated the alterations in k1 and k2 before and 6 months after surgery using pentacam, where mean k1 (corneal front) preoperatively was 41.9 D and increased to 43.02 D six months post-operatively, and that difference was statistically significant (p<0.01). On the other hand, the mean preoperative k2 (corneal front) was 42.84 D and increased to 44.14 D six months postoperatively, but that difference was not statistically significant (p 0.93) [22]. Our research found that the mean values of corneal front k1 (flat meridian) were lower in large sized pterygium group than that of small sized pterygium group preoperatively and during the three visits of postoperative follow-up, but that difference was statistically significant only preoperatively with p-value =0.02. on the other hand, mean values of corneal front k2 (steepest) were higher in large sized pterygium group than that of small sized one preoperatively and during the three visits at 1, 3 and 6 months postoperatively, but that difference was statistically significant only postoperatively along the 3 visits of follow up which indicating that large sized pterygia excision produce more steepening of the steepest meridian (k2). Kheitkanh et al. study documented that the radius of the front corneal best_fit_sphere (BFS) reduced from 7.99± 0.29 mm before surgery to 7.77±0.25 mm at one month after surgery without any alteration in later follow-up visits at three and six month after surgery. Furthermore, they found that these postoperative changes in mean values of radii of the front corneal best_fit_sphere (BFS) had statistically significant positive colleration with the size of pterygium [21]. Our research also demonstrated a statistically significant reduction in mean values of radii of the front corneal best_fit_sphere (BFS) (within central 3 mm) from 4.84±3.99 mm preoperatively to 2.84±3.09 mm and 2.58± 2.83 mm three and six months after pterygium excision respectively (p-value <0.05). But, unlike Kheirkhah study, we found that the postoperative changes in mean values of radii of the front corneal BFS were in favor of small-sized pterygia, as shown in table 8 in which the mean values of radii of the front corneal BFS were higher in small sized pterygium group preoperatively and that difference was not statistically significant but postoperative these values were significantly higher in large sized pterygium group at one, three and six months of postoperative follow up visit, as shown in table 8. In the current work, the mean values of apical corneal thickness decreased significantly after pterygium excision at one, three, and six months of follow-up visits postoperatively, as shown in table 7. this result was in line with Michael Korchak et al. who obtained corneal tomography data using pentacam and reported that apical corneal thickness significantly decreased two months postoperatively (p=0.014) [32]. On the other hand, these results were in contrary to Sabreen and coworkers study, which found no significant difference regarding postoperative values of apical corneal thickness from preoperative values [33]. Anuradha Raj et al. using AS_OCT demonstrated that central corneal thickness was not influenced by the horizontal length of pterygium (p=0.54) [34]. This is relevant to this study's finding that there is no colleration between pterygium size and apical corneal thickness, as there was no statistically significant difference in mean values of apical corneal thickness among both groups preoperatively, tab. 8). Furthermore, there was no marked variation in the mean values of apical corneal thickness among both groups during the three visits postoperatively, as shown in table 8. Our study found that the mean preoperative refractive sphere and cylinder were 1.61±1.69 D and -3.67±2.25 D, respectively, and both significantly decreased to 0.39±1.32 D and -1.62± 1.22 D respectively at the end of one month after excision. Similarly, Bansari V. et al. using a refractometer reported that the mean refractive sphere and cylinder preoperatively were 1.06±1.39 D and -1.02± 0.89 D, respectively, which decreased after surgery to 0.08±0.23 D and -0.17± 0.26 D on a postoperative day one [35]. Similar result was reported by Popat KB et al. using keratometer where mean astigmatism decreased from -6.20±3.58 D preoperatively to -1.20±1.27 postoperatively on 45th day revealing 5.09±3.32 D of alteration in astigmatism that was statistically significant ($p<0.05$) [36]. Maheshwari S. and Richard et al. found similar results [17,37]. Qasim KF and coworkers used an auto-refractometer and found that the larger the size of the pterygium, the higher the degree of induced astigmatism in the cornea [38]. In the study conducted by Bilal khan and colleagues, preoperative mean astigmatism obtained by auto-refractometer in eyes with small-sized pterygium was -3.43± 1.34 D while it was -4.83±1.62D in eyes with large-sized pterygium. that preoperative mean astigmatism decreased significally to -1.5±2.18 D and -1.56±3.61 D, respectively one month postoperatively [39]. In our study, we found similar results as we found that large-sized pterygia induce astigmatism higher in degree than that induced by small-sized pterygia, and that difference was statistically significant. Additionally, we observed that refractive astigmatism during the three visits of post-operative follow-up was higher in large-sized pterygia, and that was statistically significant during the three visits, tab. (4). Significant changes in corneal refractive status are induced by pterygium, and these changes rise with the elevation in the grade of the pterygium and enhance after pterygium excision [17]. We observed that pterygium could cause all types of astigmatism axis. However, with-the-rule astigmatism was the most prominent form. Also, we found that the excision of pterygium leaded to changes in the axis of astigmatism. Table 9 shows that preoperatively 68.42%of the eyes with pterygium had WTA, and 31.58% had ATA as well as oblique astigmatism equally. We noticed that the axis of astigmatism altered from with-the-rule astigmatism preoperatively to against-the-rule and oblique astigmatism postoperatively. This observation was consistent with a study of Salih and Sharif [27], as well as Oh and Wee study, the latter explained this phenomenon by the flattening effect caused by pterygium in the nasal side of the cornea, which was removed after the excision of pterygium [27]. Ozdemir and colleagues observed that astigmatic axes return to with-the-rule type after 3 months postoperatively. This is relevant for our research, also that revealed that the percentage of eyes which had with-the-rule astigmatism returned to the same preoperative percentage at 6 months postoperatively [21] (see table 9).

5. Conclusion

Pterygia lead to impairment of visual acuity by causing topographic and refractive alterations. Excision of pterygium leads to changes in astigmatism, keratometric power, apical corneal thickness, as well as values of the anterior elevation map. Refractive and topographic values vary with pterygium size. Furthermore, topographic and refractive results after the excision of pterygium are better in small-sized pterygia than in large ones.

References

1. El-Sersy, T. Role of pterygium in ocular dryness. ***J Egypt Ophthalmol Soc***. 2014; doi:10.4103/2090-0686.150654.
2. Nangia, V., Jonas, J., Nair, D., et al. Prevalence and associated factors for pterygium in rural agrarian central India. The central India eye and medical study. ***PLoS One***. 2013; 8 (12); doi: 10.1371/ Journal Pone.0082439
3. Moran, D. & Hollows, F. Pterygium and ultraviolet radiation: A positive correlation. ***Br J Ophthalmol***. 1984; doi: 10.1136/BJO.68.5.343
4. Di Girolamo, N., Chui, J., Coroneo, M., et al. Pathogenesis of pterygia: role of cytokines, growth factors, and matrix metalloproteinases. ***Prog Retin Eye Res***. 2004; 23 (2): 195-228.
5. Kanclerz, P., Khoramnia, R. & Wang, X. Current developments in corneal topography and tomography. ***Diagnostics***. 2021; doi:10.3390/***Diagnostics*** 11081466

6. Seitz, B., Gütay, A., Küchle, M., et al. Pterygiumgrösse, Hornhauttopographie und Visus - eine prospektive klinische Querschnittstudie [Impact of pterygium size on corneal topography and visual acuity - a pro-spective clinical cross-sectional study]. ***Klin Monbl Augenheilkd***. 2001; 218 (9): 609-615.
7. Tomidokoro, A., Miyata, K., Sakaguchi, Y., et al. Effects of pterygium on corneal spherical power and astigmatism. ***Ophthalmology***. 2000; 107 (8): 1568-1571.
8. Ghoz, N., Britton, J., Ross, A., et al. Management of primary pterygium with intra-lesional injection of 5 flurouracil and bevacizumab (Avastin). ***Eye***. 2019; doi:10.1038/S41433-019-0493-0
9. Rezvan, F., Khabazkhoob, M., Hooshmand, E., et al. Prevalence and risk factors of pterygium: A systematic review and meta-analysis. ***Surv Ophthalmol***. 2018; 63 (5): 719-735.
10. Young, A., Cao, D., Chu, K., et al. The evolving story of pterygium. ***Cornea***. 2018; 37: S55-S57.
11. Mohammad-Salih, P. & Sharif, A. Analysis of pterygium size and induced corneal astigmatism. ***Cornea***. 2008; 27 (4): 434-438.
12. Mcglacken-Byrne, A., Bao, B., Drinkwater, J., et al. Gender and ethnic differences in pterygium prevalence: an audit of remote Australian clinics. ***Clin Exp Optom***. 2021; 104 (1): 74-77.
13. Pan, Z., Cui, J., Shan, G., et al. Prevalence and risk factors for pterygium: a cross-sectional study in Han and Manchu ethnic populations in Hebei, China. ***BMJ Open***. 2019; doi:10.1136/BMJOpen-2018-025725
14. Yagmur, M., Özcan, A., Sari, S., et al. Visual acuity and corneal topographic changes related with pterygium surgery. ***J Refract Surg***. 2005; 21 (2):166-170.
15. Yousuf, M. Role of pterygium excision in pterygium induced astigmatism. ***J K Pract***. 2005; 12: 91-92
16. Mohite, U., Dole, N., Jadhav, S. Effectiveness of pterygium surgery on corneal astigmatism. ***Med Pulse Int J Ophthalmol***. 2017; 3: 12-17.
17. Maheshwari, S. Pterygium-induced corneal refractive changes. ***Indian J Ophthalmol***. 2007; 55 (5): 383-386.
18. Misra, S., Craig, J., McGhee, C., et al. A prospective study of pterygium excision and conjunctival autograft with human fibrin tissue adhesive: effects on vision, Refraction, and corneal topography. ***Asia-Pacific J Ophthalmol (Phila)***. 2014; 3 (4): 202-206.
19. Anwar, A., Elkhouly, S., El-Fallal, H., et al.Visual and refractive outcome after pterygium excision by different techniques. ***Egypt J Ophthalmol (Mansoura Ophthalmic Center)***. 2022; 2 (3): 154-168.
20. Samiha, M., Abo Al-Majd,K., Wafaa Madbouly, W., et al. Topographic changes before and after pterygium surgery. ***Int J Med Arts***. 2022; 4 (1): 2058-2067.
21. Kheirkhah, A., Safi, H., Nazari, R., et al. Effects of pterygium surgery on front and back corneal surfaces and anterior segment parameters. I***nt Ophthalmol***. 2012; 32 (3): 251-257.
22. Kazanci, B., Çorak Eroğlu, F., Şen, E. The effect of limbal autograft location at primary pterygium excision on anterior and posterior corneal astigmatism: a comparative prospective study. ***Int Ophthalmol***. 2022; 42 (7): 2235-2243.
23. Garg, P., Sahai, A., Shamshad, M., et al. A comparative study of preoperative and postoperative changes in corneal astigmatism after pterygium excision by different techniques. ***Indian J Ophthalmol***. 2019; 67 (7): 1036-1039.
24. Errais, K., Bouden, J., Mili-Boussen, I., et al. Effect of pterygium surgery on corneal topography. ***Eur J Ophthalmol***. 2008;18 (2): 177-181.
25. Kam, K. & Young, A. Fifteen-year results of a randomized controlled trial comparing 0.02% mitomycin C, limbal

conjunctival autograft, and combined mitomycin C with limbal conjunctival autograft in recurrent pterygium surgery. ***Graefes Arch Clin Exp Ophthalmol***. 2019; 257 (12): 2683-2690.

26. Han, S., Jeon, H., Kim, M., et al. Quantification of astigmatism induced by pterygium using automated image analysis. ***Cornea***. 2016; 35 (3): 370-376.

27. Avisar, R., Loya, N., Yassur, Y., Weinberger D. pterygium-induced corneal astigmatism. ***Isr Med Assoc J***. 2000; 2 (1): 14-5. PMID: 10892364.

28. Oner, F., Kaderli, B., Durak, I., et al. Analysis of the pterygium size inducing marked refractive astigmatism. ***Eur J Ophthalmol***. 2000; 10 (3): 212-214.

29. Lin, A. & Stern, G. Correlation between pterygium size and induced corneal astigmatism. ***Cornea***. 1998; 17 (1): 28-30.

30. Kampitak, K. The effect of pterygium on corneal astigmatism. ***J Med Assoc Tha***i. 2003; 86 (1): 16-23.

31. Gumus, K., Erkilic, K., Topaktas, D., et al. Effect of pterygia on refractive indices, corneal topography, and ocular aberrations. ***Cornea***. 2011; 30 (1): 24- 29.

32. Levinger, E., Sorkin, N., Sella, S, et al. Posterior corneal surface changes after pterygium excision surgery. cornea. 2020; 39 (7): 823-826.

33. Omar, S., Abdalla, Ali, A., et al. Corneal topographic changes after two different grafting pterygium surgery techniques. ***The Egyptian J. of Hospital Medicine***. 2020; 81 (2): 1396-1400.

34. Raj, A., Dhasmana, R. & Bahadur, H. Morphometric evaluation and measurements of primary pterygium by anterior segment optical coherence tomography and its relation with astigmatism. ***Ther Adv Ophthalmol***. 2021; doi:10.1177/25158414211020145

35. Vadodaria, B., Thakre, A., Maheshgauri, R., et al. Changes in keratometry and refractive status pre and post pterygium surgery. ***IP Int J Ocul Oncol Oculoplasty***. 2019; 5 (4): 205-216.

36. Garg, P., Sahai, A., Shamshad, M., et al. A comparative study of preoperative and postoperative changes in corneal astigmatism after pterygium excision by different techniques. I***ndian J Ophthalmol***. 2019; 67 (7): 1036-1039.

37. Lindsay, R. & Sullivan, L. Pterygium-induced corneal astigmatism. ***Clin Exp Optom***. 2001; 84 (4): 200-203.

38. Kadhim Farhood, Q., Oph, F., Oph, M., et al. Pterygium and induced astigmatism. ***Kufa Med Journal***. 2012; 15 (1): 341-345.

39. Singh, P., Sarkar, L., Sethi, H., et al. A randomized controlled prospective study to assess the role of subconjunctival bevacizumab in primary pterygium surgery in Indian patients. Indi***an J Ophthalmol***. 2015; 63 (10): 779-784.

40. Khan, B., Sohail, T., Faridi, U., et al. Relation between different grades of pterygium and amount of induced corneal astigmatism: Different Grades of Pterygium. ***Pakistan Biomedcal J***. 2021; 4 (2): 59-63.