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Original article

Changes of Corneal Astigmatism Before and After Pterygium Excision

Sara N. Shawky, Mohamed H. El Hatew, Mohamed G. Masoud

Abstract:

Background: Pterygium can induce significant astigmatic changes, affecting visual acuity. Surgical excision is often recommended, yet its precise impact on astigmatism using modern diagnostic tools remains underexplored. **Aim:** This study aimed to precisely evaluate the effect of pterygium excision on astigmatic changes using an auto refractometer and Pentacam. **Patients and Methods:** This interventional, single-arm study was conducted at the ophthalmology outpatient clinics of Benha University Hospitals. A random sample of 25 patients aged 29–70 years with primary pterygium was included. Exclusion criteria were ocular surface disease, prior eye surgery, use of topical anti-glaucoma drops, non-cooperation, or mental conditions interfering with data interpretation. Each patient underwent a complete ocular examination including visual acuity, fundus examination, and astigmatism assessment via auto refractometer and Pentacam. All surgeries were performed by a single surgeon with follow-up at three months postoperatively. **Results:** The median preoperative mean astigmatism decreased significantly from 2.4 D to 0.7 D postoperatively. Median spherical refraction decreased non-significantly from +0.88 D to +0.63 D, while cylindrical refraction declined significantly from -2 D to -0.75 D. Flat keratometry (FK1) increased significantly from 42.45 D to 43.95 D; steep keratometry (FK2) showed a slight non-significant decrease from 45.01 D to 44.99 D. Median uncorrected visual acuity improved from 0.3 to 0.7, and best-corrected visual acuity from 0.6 to 0.8. **Conclusion:** Pterygium excision significantly improves visual acuity and reduces astigmatism, highlighting the importance of surgical intervention in affected patients.

Keywords: Pterygium, Autorefractometer, Pentacam.

Ophthalmology Department, Faculty of Medicine Benha University, Egypt.

Corresponding to:
Dr. Sara N. Shawky.
Ophthalmology Department, Faculty of Medicine Benha University, Egypt.
Email: Saranagy164@gmail.com

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Introduction

Pterygium is a degenerative condition of the sub-conjunctival tissue that causes the superficial layer of the corneal stroma and Bowman's membrane to be destroyed. The condition is characterized by the proliferation of vascularized granulation tissue as it invades the cornea. The corneal opacity, visual impairment, and significantly induced astigmatism are the results of this change in the cornea. Pterygium appears more frequently as individuals age [1]. It is prevalent in humid climates and may be a reaction to prolonged exposure to ultraviolet (UV) radiation and persistent dryness [2].

It is thick and vascular in the early stages. But when it stops growing, it becomes thin and pale, but it never goes away. Consolidation takes place when the advancement is stopped, leading to the creation of thick fibrous tissue and severe corneal astigmatism. Pterygium invasion may result in a considerable amount of corneal astigmatism. Astigmatism may be either regular or irregular, depending on the size of the pterygium. It is possible to see pigment iron lines, also known as Stocker's line, before a corneal pterygium forms. [3].

Surgical excision is the only effective therapy for pterygium, and there are many ways to do this. This group includes beta irradiation, excision with conjunctival autografting or amniotic membrane transplantation, and the exposed sclera. Conservative therapy approaches, such as topical anti-inflammatory drugs and artificial tears or lubricants, may be used to temporarily relieve symptoms. Refraction, keratometry, corneal topography, and computerized video may all be used to evaluate the impact of pterygium on corneal refractive state. -keratoscopy [4].

Subjects and Methods

Patient criteria:

Our study was interventional study, single arm which included 25 patients calculated using G*power software version 3.1.9.2 based on a study reported mean astigmatism of 2.8 ±3.9 and 0.8 ±1.4 before and after surgery, respectively. The patients were admitted to the Ophthalmology Department in Benha University Hospitals and Written consent was taken from patients after thorough explanation of the study and its goals in an easy language. The study duration was from July 2023 to June 2024 (Approval code number: MS 11-10-2022). The present study gained approval from the Research Ethics Committee of Benha University and confirmed to principles outlined in the Declaration of Helsinki.

The patient criteria in our study included both sexes, their ages range from 29 to 70 years old, who had primary pterygium with no history of corneal ulcer or scars. They were cooperative patients with good mental conditions, aware and can express clear data for interpretation. The study excluded individuals with ocular surface disease like keratitis, dryness, sever allergies, keratoconus, corneal scar or opacity, previous trauma, previous ocular surgeries, patients with topical medication as anti-glaucomatous drops.

Pterygium excision technique:

Patients were examined before surgery included Slit lamp biomicroscope, Objective refraction using autorefractometer, Vision assessment, Corneal topography using Pentacam® HR (OCULUS, Wetzlar, Germany).

All procedures were performed by the same surgeon using peribulbar anesthesia instead of topical anesthesia. Vannas scissors were used to make a conjunctival incision near the pterygium's margin, and the pterygium head was released by making a longer incision. The leading edge of the pterygium was scraped off using a no.15 Bard-Parker blade, and then the limbus was accessed by dissecting it with a crescent knife. Westcott scissors were used for a blunt dissection of the pterygium-occupied region. To provide a clear scleral bed, the pterygium was cut with scissors along the previously marked location, and

Tenon's capsule was then removed. After gently removing a sponge soaked in mitomycin C (MMC) 0.02% after three minutes, the surgical site was irrigated with a balanced salt solution to eliminate any remaining MMC, exposing the scleral bed.

Follow up:

postoperative care was provided to patients with an eye patch for 24 hours in addition to applying frequent lubricants, antibiotic and steroid eye drops in tapering dose for one month.

All patients were subjected to follow-up assessment visits every two weeks postoperative. In every visit vision assessment: slit lamp biomicroscopy examination was conducted, and the uncorrected and best-corrected visual acuity was determined in conjunction with the Snellen chart.

Assessment of corneal astigmatism using keratometry values obtained by autorefractometer and Pentacam®HR (OCULUS, Wetzlar, Germany) before and three months after pterygium excision.

Statistical Design:

The data were analyzed using SPSS software, version 28 (IBM Corp., Armonk, NY, USA), the Statistical Package for the Social Sciences. Categorical variables were described using absolute frequencies. The Shapiro–Wilk test was applied to assess the normality assumption for parametric tests. Quantitative variables were described using means and standard deviations for normally distributed data, and medians with interquartile ranges for non-normally distributed data. Comparisons between two sets of quantitative data were conducted using the Mann–Whitney U test for non-normally distributed variables. The Spearman rank correlation coefficient was used to evaluate the strength and direction of the relationship between two variables. The percentage change in outcome parameters was calculated using the formula: (Postoperative value−Preoperative value)/ Preoperative value×100(\text{Postoperative value} - \text{Preoperative value}) / \text{Preoperative value} \times 100(Postoperative value−Preoperative value)/Preoperative value×100.

For within-group comparisons over two time points, the Wilcoxon signed-rank test was used for non-normally distributed variables, and the paired samples t-test was used for normally distributed variables. A p-value < 0.05 was considered statistically significant, while values ≤ 0.001 were considered highly significant.

Results

This study comprised 25 patients, with a mean age of 50 years and a variation of ages from 29 to 70 years. Male represented 56% of them. Thirteen patients had lesions in the left eye. (52%) (Table 1).

Median preoperative mean astigmatism was 2.4 which significantly decreased to 0.7 postoperatively with statistically significant change postoperatively as compared to preoperative value (Table 2).

Median preoperative spherical refraction was +0.88 which non-significantly decreased to +0.63 postoperatively with statistically non-significant change postoperatively as compared to preoperative value (table 3).

Median preoperative cylindrical refraction was -2 which significantly decreased to -0.75 postoperatively with statistically significant change postoperatively as compared to preoperative value (Table 3).

Mean preoperative front K1 was 42.45 which significantly increased to 43.95 postoperatively with statistically significant change postoperatively as compared to preoperative value (Table 4).

Mean preoperative front K2 was 45.01 which non-significantly decreased to 44.99 postoperatively with statistically non-significant change postoperatively as compared to preoperative value (Table 4).

Median preoperative UCVA was 0.3 which significantly increased to 0.7 postoperatively with statistically significant change postoperatively as compared to preoperative value (Table 5).

Median preoperative BCVA was 0.6 which significantly increased to (0.8) postoperatively with statistically significant change postoperatively as compared to preoperative value (Table 5).

Table 1: Baseline data of patients studied.

	N=25	%/ range
Gender		
Female	11	44%
Male	14	56%
Side of Lesion		
Right	12	48%
Left	13	52%
Age (year) [mean ± SD]	50.0 ± 12.26	29 – 70

Data is presented as mean ± SD or frequency (%), SD: Standard deviation.

Table 2: Mean astigmatism preoperative and postoperative among studied patients.

	Preoperative	Postoperative	Wx	p
Median (IQR)	2.4(0.55 – 3.4)	0.7(0.45 – 1.25)	-3.044	0.002*
Range	0.2 – 8.9	0 – 3.4		

IQR: interquartile range, Wx: Wilcoxon signed rank test and *: p<0.05 is statistically significant.

Table 3: Autorefraction preoperative and postoperative among studied patients.

	Preoperative	Postoperative	Wx	p
	Sphere (n=20)			
Median (IQR)	+0.88(-1, +2.69)	+0.63(-0.94, +2.19)	-1.837	0.066
Range	-8, +5.50	-8, +5		
	Cylindrical (n=23)			
Median (IQR)	-2.0(-3.75, -1)	-0.75(-1.5, -0.5)	-3.926	<0.001**
Range	-9.75, -0.25	-4.5, -0.25		

Wx: Wilcoxon signed rank test, IQR: interquartile range and **p≤0.001 is statistically highly significant.

Table 4: Corneal astigmatism preoperative and postoperative among studied patients.

	Preoperative	Postoperative	t	p
	K1			
Mean ± SD	42.45 ± 2.77	43.95 ± 1.46	-3.478	0.002*
Range	35.5 – 47.1	41.9 – 47.1		
	K2			
Mean ± SD	45.01 ± 1.56	44.99 ± 1.42	0.238	0.814
Range	42.1 – 48	42.4 – 47.7		

Data is presented as mean ± SD, t: paired sample t test, SD: Standard deviation and *: p<0.05 is statistically significant.

Table 5: Visual acuity preoperative and postoperative among studied patients:

	Preoperative	Postoperative	Wx	p
		UCVA		
Median (IQR)	0.3(0.05, 0.68)	0.7(0.35, 0.8)	-2.95	0.003*
Range	0.03, 1	0.03, 1		
		BCVA		
Median (IQR)	0.6(0.4 – 0.75)	0.8(0.7 – 1)	-4.042	<0.001**
Range	0.3, 1	0.5, 1		

WX: WILCOXON SIGNED RANK TEST, *: P<0.05 IS STATISTICALLY SIGNIFICANT, **P≤0.001 IS STATISTICALLY HIGHLY SIGNIFICANT, IQR: INTERQUARTILE RANGE,UCVA: UNCORRECTED VISUAL ACUITY AND BCVA: BEST-CORRECTED VISUAL ACUITY.

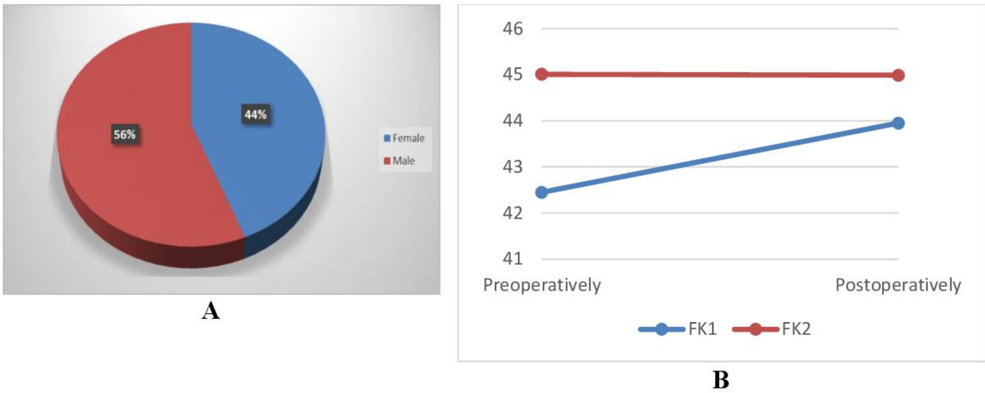

Figure 1: A): Pie chart showing distribution of patients according to gender, B): Line graph showing Corneal astigmatism preoperative and postoperatively among studied patients.

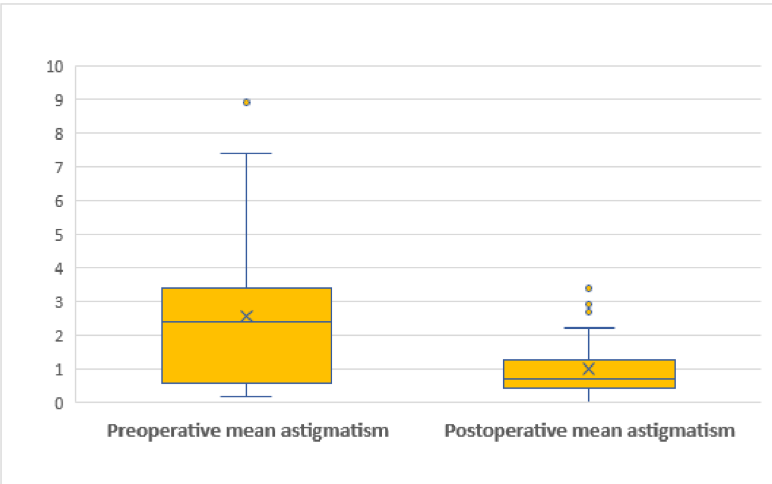

Figure 2: Boxplot showing Mean astigmatism pre and postoperatively among studied patients.

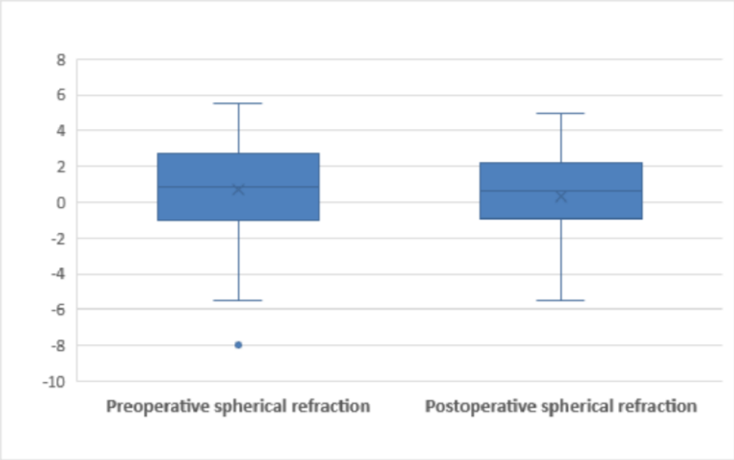

Figure 3: Boxplot showing spherical refraction pre and postoperatively among studied patients.

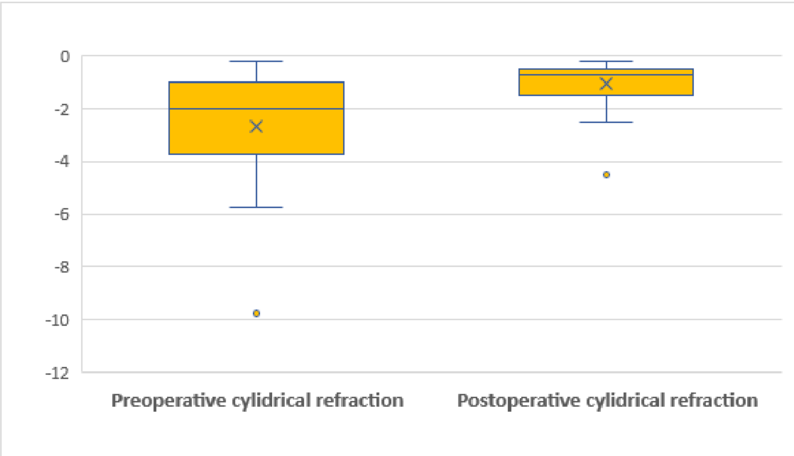

Figure 4: Boxplot showing cylindrical refraction preoperative and postoperatively among studied patients.

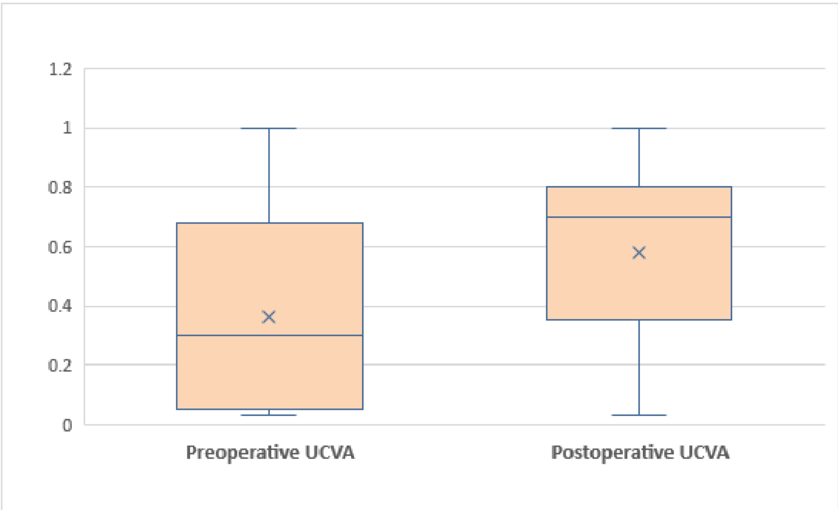

Figure 5: Boxplot showing UCVA preoperative and postoperatively among studied patients.

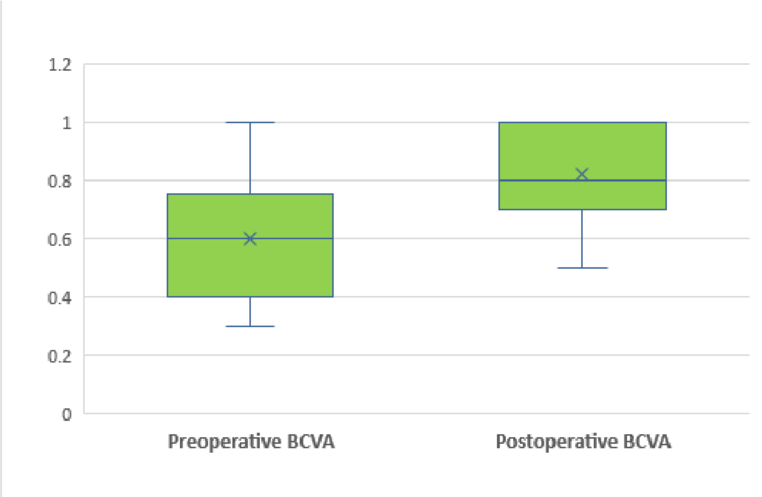

Figure 6: Boxplot showing BCVA preoperative and postoperative among studied patients.

Discussion

A pterygium develops when the bulbar conjunctival tissue grows transversely over the limbus and onto the cornea, forming a degenerative triangle with fibrovascular subepithelial layers. When this condition invades the cornea, it destroys the outer layers of stroma and Bowman's membrane and causes hyalinization and elastic degeneration of the subconjunctival tissue. Some of the changes that can be seen through histopathology include an increase in the number of skin cells, inflammation, and activated fibroblasts. Additionally, there are changes in the extracellular matrix, including the buildup of elastin, glycosaminoglycans, and collagen. The size of the lesion determines the classification into three distinct types. Type 1 affects the cornea to a depth of less than 2 mm, Type 2 affects the cornea to a depth of 2-4 mm, which can cause astigmatism and interfere with the tear film, and Type 3 affects the visual axis to a depth of more than 4 mm [1].

The quality of the picture created on the anterior corneal surface, the eye's most potent image-forming interface, is a major determinant of a good retinal image. When pterygium invasion penetrates the pupillary margin, the visual axis is obstructed, resulting in a noticeable reduction in visual acuity. Although pterygium does not directly impact the visual axis, it may impair vision by increasing higher-order aberrations (HOAs), astigmatism, or corneal deformation [5].

Where the real wavefront differs from the ideal wavefront by a measurement in micrometers is called the wavefront aberration. Wearing corrective lenses makes it easy to correct low-order aberrations like astigmatism, but HOAs cannot be corrected with glasses. Coma and trefoil are two of the HOAs that pterygium is known to induce, according to earlier research. A larger pterygium is associated with more severe corneal astigmatism and ocular wavefront aberrations. Comparing pterygium-afflicted eyes to normal contralateral eyes may help shed light on the parameter changes brought on by the condition, since the cornea is symmetrical on both sides of the face [3].

Therefore, this study aims to precisely demonstrate the effect of pterygium excision on the astigmatic changes using advanced technology.

This interventional study was conducted at the ophthalmology outpatient clinics of Benha University Hospitals, involving a random sample of 25 participants. Eligible patients were aged 29-70 years with primary pterygium and no history of corneal ulcers or scars. Exclusion criteria included ocular surface disease, prior surgeries, use of topical anti-glaucoma medication, uncooperative behavior, and mental conditions affecting data interpretation. The study involved comprehensive patient history, informed consent, and a full ocular examination, including visual acuity, fundus examination, and astigmatism assessment using autorefractometer and Pentacam. The surgical procedure was performed by a single surgeon, with follow-up evaluations conducted three months postoperatively.

Our study found that the most prevalent gender was male. This is consistent with a study that was led by Rezvan et al, [6] to evaluate the risk factors for pterygium and pinguecula in a sample of more than 40 people from Shahroud. Pterygium was found to be significantly more common in males (11.4% vs. 8.0%) and remained relatively stable with age, according to their report [6].

Furthermore, another study included 20 eyes with primary pterygium in 17 patients. Three patients had bilateral pterygia. There were 8 males (47.1%) and 9 females (52.9%)[7].

Our study detected that the mean age of patients was 50.0 ± 12.26 years. On the contrary, a study was conducted by Jain and Pandey, [8] this study aims to assess the effects of pterygium removal followed by autologous graft surgery on visual acuity and astigmatism. A total of 64 eyes belonging to 64 patients with a pterygium diagnosis were included in this study. All the patients who were going to have their pterygium removed had clinical symptoms, and best corrected visual acuity (BCVA) checked before the procedure. A mean age of 34.16 ± 8.24 years was determined by the study's participants [8].

Additionally, another study was led by Fekadu et al, [9] in 2019 in Gambella town, Southwest Ethiopia, to find out how common pterygium is and what factors contribute to it among adults. The researchers used a systematic random sampling method to choose 402 people to take part in the study. The response rate was 99.50% out of 400 participants. The participants in the study had an average age of 39.9±9.8 years [9].

Moreover, Shukla et al[10], also reported in their study that the mean age of the patients was 32.58 ± 9.67 years [10].

Our study detected that the median pre-operative mean astigmatism was 2.4 D, and it significantly decreased to 0.7 D post-operatively (p= 0.002). This finding aligns with a study that was conducted by Garg et al, [11] in order to compare the effects of different surgical procedures on corneal astigmatism (bare sclera, conjunctival autograft, amniotic membrane graft) and to determine the efficacy of pterygium excision. There were seventy-one surgical patients diagnosed with primary pterygium who made up the study population. All the people who were part of the research had different surgical procedures. On days one, three and five after surgery, we compared the corneal astigmatism before and after the procedure. There was a statistically significant change in corneal astigmatism at every appointment. Three months following surgery, the corneal astigmatism was 3.47 ± 1.74 D before the procedure was reduced to 1.10 ± 0.78 D (P < 0.0001) [11].

Moreover, a study was conducted by Abo Al-Majd et al, [7] to use the naked sclera approach to measure astigmatism changes before and after pterygium surgery. Twenty eyes from seventeen individuals with primary nasal pterygium were included in this investigation. After surgery, the average astigmatic value was -3.4±2.4. The astigmatic value decreased statistically significantly in the first week and third month after surgery, with mean values of -2.3± 2.3 and -2.2± 2.1, respectively (p values = 0.05 and 0.00). [7].

Additionally, a study was led by Kheirkhah et al,[12] to study changes in corneal astigmatism before and after pterygium excision by using Pentacam (Oculus, Wetzlar, Germany). The study was carried out with 96 eyes. The authors compared the astigmatism changes preoperatively and one , three, and six months after surgery . They found corneal astigmatism decreased from 3.97 ± 4.49 D preoperatively to 1.23 ± 1.88 D at one month ($p < 0.001$) [12].

In Yagmur M et al,[13] study on 30 eyes of 26 patients reported the changes of the mean astigmatism values before and after pterygium excision. The mean astigmatism significantly decreased from 4.65+/-3.02 preoperatively to 2.33+/-2.26 postoperatively (P=.003)) [13].

Furthermore, Cinal et al,[14] reported in their study the effect of pterygium surgery on the corneal astigmatism values using a computerized corneal topography system. The study was performed on 27 patients with primary pterygium before and after pterygium excision surgery. Astigmatism value was found to be 2.30 ± 2.08 D (0.2 - 7.63) preoperatively and 0.82 ± 0.74 D (0.06 - 2.79) postoperatively. The difference between these two values was statistically significant (t = -3.46, P = 0.002) [14]..

In our study using oculus pentacam, we demonstrated the preoperative front K1 was 42.45 which significantly increased to 43.95 postoperatively with statistically significant change postoperatively as compared to preoperative value (p=0.002). Although, the preoperative front K2 was 45.01 which non-significantly decreased to 44.99 postoperatively with statistically non-significant change postoperatively as compared to preoperative value (p value =0.8).

This was in agreement with a prospective, non-randomized, and interventional study performed conducted by Eldawla et al,[15] on 38 eyes of 38 individuals with primary pterygium underwent surgical excision of pterygium with a bare sclera approach and intraoperative MMC application. They found that mean K1 increased significantly (p < 0.05) postoperatively, while there was no marked variation in mean K2 during three and six months postoperatively (p>0.05) using pentacam) [15] .

A study was conducted by Lawan et al, [16] to use an autorefractometer to measure the impact of pterygium excision on the degree of corneal-induced astigmatism. Mitomycin C was administered intraoperatively to a select group of patients who had pterygium excision utilizing the bare sclera approach. The mean diopter cylinder (DC) values for preoperative and postoperative astigmatism were 2.12 ± 1.09 and 0.72 ± 0.50, respectively (P <0.001). [16].

Additionally, Kheirkhah et al,[12] . reported in their study that the refractive cylinder (52 eyes) reduced from 2.62 ± 2.22 D preoperatively to 1.06 ± 1.57 D at 1 month (p = 0.05) [12] .

Furthermore, a study was led by Saleem et al,[17] to detect the cylindrical error before and after pterygium excision, by using automated refraction. The preoperative cylindrical error decreased from 4.32± 1.88 D to 2.11 ± 1.96D postoperatively (P-value<0.05) [17].

Our study revealed that the median pre-operative cylindrical refraction was -2 D, which significantly decreased to -0.75 D postoperatively with statistically significant change postoperatively as compared to preoperative value (P-value<0.001).

Our study found that the median pre-operative BCVA was (0.6) and it significantly increased to (0.8) post-operatively with statistically significant change post-operatively as compared to pre-operative value (p<0.001).

On the same way, a study was led by Errais et al, [18] to evaluate the effect of successful pterygium surgery on corneal topography. Computerized corneal topography was performed on 20 eyes with pterygium before and 3 months after successful pterygium excision surgery. BCVA was 0.73+/-0.20 preoperatively and 0.89+/-0.16 postoperatively (p=0.008) [18].

Furthermore, a study was conducted by Bahar et al, [19] to evaluate the effect of pterygium surgery on visual acuity. The study included 54 patients (55 eyes) with primary pterygium before and after pterygium excision using bare sclera technique combined with intraoperative mitomycin C. Best corrected visual acuity was 20/40 preoperatively and 20/25 postoperatively ($P < 0.01$) [19].

Conclusion

In conclusion, surgical excision of pterygium was found to significantly improve visual acuity and reduce astigmatism in patients. Over the follow-up period, patients exhibited notable enhancements in both uncorrected and best-corrected visual acuity, along with significant decreases in mean astigmatism values. These findings suggest that surgical intervention is an effective treatment for improving refractive status and visual outcomes in individuals affected by pterygium, particularly in those with significant preoperative astigmatism.

Conflict of interest

None of the contributors declared any conflict of interest

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