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Research Article

Changes in Corneal Astigmatism After Pterygium Surgery in Different Grades

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Abstract

Purpose: To evaluate the effect of pterygium surgery in its different degrees on visual acuity and corneal astigmatism in patients treated at Clínica La Luz, during the period from July 2021 - January 2022.

Methods: In this prospective-interventional study of the 39 eyes of 38 patients with induced corneal astigmatism undergoing pterygium surgery in Clínica La Luz Eye Institute in Lima - Peru.

Results: The mean Best Corrected Visual Acuity (BCVA) was 0.37 ± 0.19 preoperatively and 1-month postoperative 0.32 ± 0.16 D with significant difference ($P < 0.05$). The mean preoperative astigmatism was 1.66 ± 1.51 D, at 1 month postoperative was 1.40 ± 1.42 D which was statistically significant ($P < 0.05$). No complications occurred during surgery or after follow-up.

Conclusion: Pterygium surgery to different degrees, while corneal keratectomy is well performed, can reduce astigmatism significantly. For what it is, it becomes safe and effective, offering better visual quality to the patient.

Keywords: *Pterygium; Refractive Index; Astigmatism; Corneal Curvatures; Conjunctival Autograft; Fibrin Tissue Adhesive*

Abbreviations

D: Diopter; SAI: Surface Asymmetry Index; SRI: Surface Regularity Index; UCVA: Uncorrected Visual Acuity; BCVA: Best Corrected Visual Acuity; LogMAR: Logarithm of Minimal Angle of Resolution; CAG-s: Conjunctival Autograft with Sutures; CAG-g: Conjunctival Autograft with Fibrin Glue; CRF: Conjunctival Rational Flap; AMT-s: Amniotic Membrane Transplantation with Either Suture; AMT-g: Amniotic Membrane Transplantation with Glue

Introduction

Pterygium is a fibrovascular subepithelial growth of degenerative tissue of the bulbar conjunctiva on the limbus that invades the surface of the cornea to different degrees, typically located in the interpalpebral conjunctiva, more frequently in the nasal area. It is a common pathology worldwide, commonly in countries with warm and tropical climates. Its etiology is multifactorial, with ultraviolet radiation being the main trigger together with changes in the tear film and imbalance of cytokines and growth factors [1]. At the same time, a higher incidence has been identified in the population group of 40 and 50 years old, inhabitants of rural areas, and it is the same in both sexes if they have the same exposure to UV radiation.

Coroneo MT proposed that, in the anterior segment, pterygium occurs due to albedo concentration, known as the albedo's hypothesis. The sunlight is concentrated at medial limbus entering the temporal limbus at 90 degrees. For this reason, medial pterygium is very frequently [2].

The main symptoms are: red eye, foreign body sensation and tearing. However, this entity can affect vision by two important mechanisms: by direct obstruction of the passage of light or by inducing irregular astigmatism and corneal distortion [3].

There is no definitive medical therapy for pterygium, although in the initial stages a conservative approach can be taken with ocular lubricants and sun protection, the gold standard treatment of pterygium is through surgical resection associated with conjunctival-limbar autograft. Surgical indications are visual impairment due to regular and irregular induced astigmatism, chronic inflammation, diplopia due to restriction of eye movements [4].

Even though numerous studies have evaluated the impact on corneal refractive status of different sizes of pterygium and of pterygium surgery, including astigmatism, keratometry and corneal topography [5-8]. Describe the significant reduction of astigmatism after pterygium surgery, which is why this work is focused on evaluating the follow-up of post-surgery patients at Clínica La Luz.

Methods

This is a prospective, descriptive-interventional study that was carried out in 39 eyes of 38 patients diagnosed with pterygium in different degrees with induced corneal astigmatism, between July 2021 and January 2022 at the Ophthalmological Institute of Clínica La Luz. The medical ethics committee of the research department of Clínica La Luz approved the use of information from medical records of all patients, who accepted entry to the study, in accordance with the guidelines of the Declaration of Helsinki.

Patients with pterygium from grade 2 to grade 4 were included. The pterygium was graded depending on the extent of corneal involvement using the slit lamp examination based on the American Academy Classification. It can be categorized according to the level of invasion of the pterygium head in the cornea as follows [3,4]:

- Grade 1: It reaches the sclerocorneal limbus.
- Grade 2: It is located in the middle of the region that goes from the sclerocorneal limbus to the pupillary edge.
- Grade 3: It reaches the pupillary edge.
- Grade 4: It exceeds the pupillary edge or covers the pupil.

Ophthalmological examination was performed evaluating Best-corrected distance visual acuity (BCVA) using Snellen chart converted to LogMar (preoperative and 30 days postoperative), biomicroscopy, Goldman applanation tonometry and funduscopy, corneal topogra-

phy where surface asymmetry index was included (SAI), surface regularity index (SRI) and preoperative and postoperative astigmatism one month after surgery.

The Surface Asymmetry Index (SAI) measures the mean of the difference in diopters of corneal power between corresponding points on the corneal topographer that mires 180° apart. Usually, normal corneas have a SAI less than 0.5. The Surface Regularity Index (SRI) is an indicator of corneal optical quality. It is calculated using an approximative average virtual pupil of 4.5 mm and the local regularity of the surface of the cornea. It has low normal values.

All eyes underwent pterygium excision with conjunctival autograft transplantation with fibrin glue, performed by the same surgeon, there were no complications during follow-up.

Different exclusion criteria were established, among which were: history of ocular surgery, eye trauma, and presence of any corneal abnormality that might affect the astigmatic value such as scarring and corneal dystrophies.

Surgical technique

First, asepsis and antisepsis are performed, topical anesthesia with Proxymetacaine Hydrochloride 0.5% is placed. Subsequently, subconjunctival anesthesia with Lidocaine without Epinephrine 1% is used, inserting blunt scissors through the conjunctiva in the neck of the pterygium with care, Tenon's capsule and the adjacent fibrovascular tissue are dissected using Westcott scissors, once the complete resection of the pterygium has been carried out. The corneal and limbal surface is regularized using a No. 15 scalpel. The limbo-conjunctival autograft was obtained from the same eye, it was extracted from the superior bulbar conjunctiva, preserving 2 mm of perilimbic area and calculating the size of the defect of excision of the pterygium. The donor tissue was placed in the area of the defect, then tissue glue (lyophilized thrombin) was used to join the edges of the conjunctiva and finally we verified the union of the edges, especially in the plica semilunaris.

Postoperative management

A topical antibiotic ointment (tobramycin 0.3% + dexamethasone 0.1%) was administered before covering the eye with an eye pad. The next day, the eye was uncovered and was indicated the following prescription: topical antibiotic (tobramycin 0.3% + dexamethasone 0.1%) 4 times a day, topical steroid (prednisolone acetate 1%), 4 times a day, and topical sodium hyaluronate 0.4%, 4 times a day drops. Everything was given for 30 days.

Statistical analysis

It starts with a global test called the Quade test, for the LogMAR and statistical comparison test. When this test is significant, it is compared in pairs to detect where the significance is detected with the Quade test, the pairwise test is: "Pairwise comparisons using posthoc-Quade test". For the calculations, the program R version 4.0.5 (https://www.r-project.org/) was used.

Results

In this study, 39 eyes of 38 patients were randomly included, of which 24 were male (63.2%) and 14 were female (36.8%), with an age ± SD 59 ± 11.8, all met the inclusion criteria. There were 32 eyes (82.1%) with pterygium grade 2, 6 eyes (15.4%) with pterygium grade 3 and 1 eye (2.6%) with pterygium grade 4, all of them were nasal side. The clinical and demographic characteristics are described in table 1.

		Frequency	Percentages	
Gender	Male	24	63.2%	
	Female	14	36.8%	
Pterygium grade	2	32	82.1%	
	3	6	15.4%	
	4	1	2.6%	
Laterality	Right eye	19	48.7%	
	Left eye	20	51.3%	
Mean	**sd**	**min**	**max**	**n**
59	11.8	29	81	38

Table 1: *Clinical and demographic characteristics.*

Comparison of pre and postoperative best corrected visual acuity (BCVA) (in LogMAR)

The mean BCVA (± SD) preoperative was 0.37 ± 0.19, at 1 month of the postoperative was 0.32 ± 0.16. Which was not statistically significant (Table 2).

Comparison of preoperative and postoperative corneal astigmatism (in Diopter [D])

The mean astigmatism preoperative was 1.66 ± 1.51, at 1 month postoperative it was 1.40 ± 1.42. Which was statistically significant (Table 2).

Comparison of preoperative and postoperative topographic astigmatism, SRI, SAI (in Diopter [D])

The mean preoperative SAI was 1.83 ± 1.07, at 1-month postoperative it was 1.60 ± 1.01. Which was statistically significant (Table 2).

The mean preoperative SRI was 1.23 ± 0.57, at 1-month postoperative it was 1.00 ± 0.53. Which was statistically significant (Table 2).

Variable	Mean	SD	Min	Max	Median	qnt_25	qnt_75
Astig_post	1.40	1.42	0.02	8.36	0.95	0.57	1.94
Astig_pre	1.66	1.51	0.28	9.12	1.26	0.74	2.16
LOGMAR_AV_post	0.32	0.16	0.00	0.60	0.30	0.20	0.40
LOGMAR_AV_pre	0.37	0.19	0.00	0.90	0.40	0.20	0.50
SAI_post	1.60	1.01	0.46	6.61	1.54	1.13	1.86
SAI_pre	1.83	1.07	0.56	7.23	1.59	1.24	2.12
SRI_post	1.00	0.53	0.38	3.25	0.95	0.65	1.18
SRI_pre	1.23	0.57	0.47	3.54	1.22	0.87	1.39
dif_astig	0.26	0.16	0.02	0.76	0.24	0.15	0.32
dif_logmar	0.06	0.07	0.00	0.30	0.00	0.00	0.10
dif_SAI	0.23	0.36	-1.50	1.16	0.24	0.12	0.36
dif_SRI	0.23	0.13	0.03	0.53	0.22	0.12	0.32
* dif: Difference between pre - post treatment							

Table 2: *BCVA: Comparison of Pre and Postoperative Best Corrected Visual Acuity, LogMAR: Logarithm of Minimal Angle of Resolution, D: Diopters, SAI: Surface Asymmetry Index, SRI: Surface Regularity Index.*

Discussion

Pterygium is associated with refractive disturbances, which include changes in the sphere and cylinder [9]. The present study made it possible to determine the evolution of astigmatism induced by the different degrees of pterygium in the stage before and after surgical management.

Several studies have shown a slightly higher incidence in men than women, which may just have a higher rate of UV radiation [2]. The same as what was obtained in this work where the predominant casuistry was the male gender 24 (63.2%).

Through topographic follow-up, the change in corneal astigmatism before and after pterygium excision was compared in 39 eyes of 38 patients, in which 82.1% presented pterygium grade 2, 15.4% grade 3 and 2.6% grade 4. The lesion occurs more frequently at the nasal limbus with a characteristic wing-shaped appearance [10].

Surgery is the primary treatment of pterygium. A successful pterygium excision surgery can improve the visual acuity during which astigmatism could be reduced and also pterygium is removed from the visual axis [11]. Maheswari., *et al*. found significant improvements in visual acuity in all the grades of pterygium ($P < 0.05$) after pterygium excision surgery [8]. Similarly, Misra., *et al*. observed that the mean BCVA could be improved from 0.1 preoperatively to 0 LogMAR at 1 month ($P = 0.001$) after pterygium surgery [12]. In our study also, we have found that visual acuity improved significantly after pterygium excision surgery. UCVA significantly improved from 0.37 ± 0.19 preoperatively to 0.32 ± 0.16 postoperatively (at 1 month; $P < 0.05$).

In the study by Mohite., *et al*. there was a significant reduction in mean keratometric astigmatism from 3.046 ± 1.20 D to 1.486 ± 0.63 D ($P < 0.001$) after pterygium surgery [5]. So, they concluded that pterygium-induced corneal astigmatism decreases after pterygium surgery. A similar study carried out by Cinal., *et al*. and they determined that pterygium surgery induces a partial reversal of pterygium-related corneal topographic changes, though some changes might be due to scarring [7].

These results were equivalent to our study as we have also found a substantial decrease in mean corneal astigmatism after pterygium surgery. The preoperative mean astigmatism of 1.66 ± 1.51 D was significantly ($P < 0.05$) reduced to 1.40 ± 1.42 D postoperatively at 1 month which can be attributed to the fact that the regularity and symmetry of corneal surface improved after pterygium surgery, thus reducing astigmatism [13].

Altan-yaycioglu., *et al*. have tried different surgical techniques as conjunctival rational flap (CRF), amniotic membrane transplantation with suture (AMT-s), fibrin glue (CAG-g) and with glue (AMT-g) on the postoperative astigmatism [14]. They found that astigmatism changes were directly related to the preoperative size of the pterygium and were not related to the surgery technique. Gangadhar., *et al*. made similar findings, pterygium-induced astigmatism was confronted by using conjunctival autograft and amniotic membrane graft [15]. They reported that quick excision of pterygium diminish the pterygium-induced astigmatism and that the type of grafting does not have a meaningful result on change in astigmatism. However, the two studies did not include the differentiation results among conjunctival autograft and amniotic membrane graft, the findings were similar to our results of no significant difference with conjunctival autograft in terms of change in corneal astigmatism.

Bahar., *et al*. [16] mentioned critical reduction in corneal astigmatism at the central 3 mm after pterygium surgery. Tomidokoro., *et al*. [17] analyzed 119 eyes and concluded that surgery reduced SRI and SAI even so it increased spherical power of the cornea from 43 ± 1.18 to 45.2 ± 1.6 D and decreases corneal astigmatism with no transformation in the axis [1,7]. In addition, the surgically produced changes in spherical power and corneal astigmatism remarkably correlated with the pterygium preoperative extension due could not be repaired completely especially in cases with larger pterygium. Pterygium modifies visual parameters and they may also have some structural ef-

fects on cornea. As an illustration, it was documented that deep corneal changes in the Descemet membrane and endothelium are infrequently produced by long standing nasal pterygium [18,19].

Stern and Lin documented amelioration in topographic indices in 16 eyes, they reported corneal astigmatism to reduce from 5.93 ± 2.46 D to 1.92 ± 1.68 D [20,21].

Yagmur., *et al*. studied the outcome of pterygium surgery in 30 eyes and established topographic astigmatism to reduce from 4.65 ± 3.02 to 2.33 ± 2.26 D. If the SAI, the SRI of normal corneal surfaces is relatively low and higher values of SRI indicate surface of less optical quality [22].

Soriano., *et al*. [23] reported a decrease in corneal astigmatism at the central 3 mm from 2.41 to 1.29 diopters after pterygium surgery. In the present study, corneal astigmatism at 3 mm decreased from 1.66 to 1.40 diopters following surgery with no change in the axis, but in some cases, astigmatism up to 2 diopters persisted.

This finding has been reported by others [12,15]. It is not clear if it can be attributed to the corneal and pterygium features per se or to the surgical method used.

Similarly, in the present study, mean topographic astigmatism (SAI) significantly decreased from 1.83 ± 1.07 D to 1.60 ± 1.01 D ($P < 0.05$). Meanwhile, mean topographic astigmatism (SRI) significantly decreased from 1.23 ± 0.57 D to 1.00 ± 0.53 D ($P < 0.05$) following 1-month surgery. We have found no effect of surgery on the axis of pterygium induced astigmatism. As in some other reports [11], we found no correlation between the preoperative and postoperative degree corneal astigmatism, in some patients the corneal astigmatism of even 3 diopters persisted, in other cases the postoperative astigmatism increased compared to the preoperative one.

This finding has also been described by other authors [1,11,12]. Bahar., *et al*. [16] reported it as an "unexpected effect of surgery on the shape of the cornea". This may be due to the individual corneal characteristics of the patients, since all cases have undergone the same surgical procedure.

In our study, a decrease in SAI and SRI was determined, indicating better optical quality. As reported in previous studies, the improvement in BCVA and UCVA after surgery [12,24,25] can be explained by a decrease in corneal astigmatism and, consequently, better optical quality.

Conclusion

Our study confirms that topographic astigmatism, SAI, corneal flattening and SRI greatly decreased by successful pterygium surgery. After surgical treatment, the corneal topographic changes produced by the pterygium are practically reversible. Notwithstanding, our study has a small sample size; a bigger sample size would have helped in a more appropriate analysis. Otherwise, one month of follow-up in the study. Long-term complications could have been better studied in a longer follow-up. Nevertheless, specific prediction of refractive changes is in some cases needed particularly in refractive or cataract surgery.

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Declaration of Competing Interest

The authors declare that there is no conflict of interest

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