Original Article

A comparative study of preoperative and postoperative changes in corneal astigmatism after pterygium excision by different techniques

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Purpose: To study the changes in corneal astigmatism before and after pterygium excision as well as with differences between various surgical techniques (bare sclera, conjunctival autograft, amniotic membrane graft). **Methods:** The study population included 71 patients with primary pterygium who underwent surgery. The surgical techniques used differed among the study population. All the patients were preoperatively assessed for visual acuity, anterior and posterior segments, autorefraction, and autokeratometry. After surgery, the patients were assessed for visual acuity, autorefraction, and autokeratometry on day 5, 1 month, and 3 months and the results were analyzed. Paired and unpaired t-tests were used to compare the variables. The probability level of 0.05 was considered as statistically significant. **Results:** The reduction in the mean preoperative astigmatism of 3.47 ± 1.74 Diopters (D) to 1.10 ± 0.78 D 3 months after surgery was statistically significant ($P < 0.0001$). Bare sclera, conjunctival autograft, and amniotic membrane graft techniques exhibited changes in astigmatism amounting to 1.85 ± 0.88 D, 2.55 ± 1.26 D, and 2.67 ± 1.44 D, respectively. Pterygium excision surgeries using amniotic membrane graft and conjunctival autograft techniques were more effective than pterygium excision surgery using bare sclera technique in reducing astigmatism. **Conclusion:** Pterygium excision results in significant reduction in astigmatism which leads to improvement in visual acuity. Amniotic membrane graft and conjunctival autograft are better surgical techniques than bare sclera as far as reducing astigmatism is concerned.

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Pterygium causes visual problems due to induced corneal astigmatism (mostly with the rule) or direct encroachment onto the visual axis. The reasons for astigmatism are: (a) the pooling of the tear film and (b) the mechanical traction exerted on cornea and (c) the size of pterygium, especially the double-headed pterygium. This has been measured by keratometry, corneal topography, and refraction.[1-7] Corneal astigmatism can be reduced by pterygium excision surgery which involves the use of several techniques. We have studied the pre- and postoperative astigmatism changes as well as the changes due to the use of different surgical techniques—bare sclera, conjunctival autograft, and amniotic membrane transplantation.

Methods

Individuals of age 20–60 years with primary pterygium who presented to the outpatient department of our centre between April 2017 and March 2018 were included in this prospective interventional study. The study was approved by the Institutional Ethical Committee. Patients with recurrent pterygium, grade I pterygium, double-headed pterygium, and with a history of ocular morbidity were excluded from our study. Written informed consent was obtained from all patients after explaining the prognosis about recurrence of the pterygium and changes in astigmatism.

Grading Pterygium

Pterygium was graded depending on the extent of corneal involvement as follows**:** Grade I: Just crossing the limbus, Grade II: Midway between limbus and pupil, Grade III: Reaching up to the papillary margin, Grade IV: Crossing the papillary margin.

Study Group

All the patients were randomly divided into three groups as follows:

Group 1—Bare sclera (BS) technique
Group 2—Conjunctival autograft (CAG) technique
Group 3—Amniotic membrane graft (AMG) technique

To reduce interobserver bias, all preoperative investigations and postoperative evaluations were performed by a single ophthalmologist and all surgical procedures were performed by a single surgeon.

Surgical method

All the surgeries were performed under local anesthesia (peribulbar block). After standard sterile preparation and

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draping, a wire speculum was used to expose the eye. Pterygium head and pathologic fibrovascular tissue located under the conjunctiva were carefully dissected and removed with surgical blade and the residual tissue was scraped from the corneal surface with a crescent knife. In group 1 (BS), after pterygium excision, bare sclera bed was left behind to re-epithelialize. In group 2 (CAG), after excision, autograft taken from superotemporal conjunctiva was placed over the bare sclera in its correct anatomical orientation and anchored to the limbus and peripherally to the surrounding conjunctiva by 8-0 vicryl sutures. In group 3 (AMG), wet amniotic membrane was cut to the proper size to cover the bare area with the basement membrane facing up and the stroma facing down. It was sutured to the surrounding conjunctiva and episclera using interrupted 8-0 vicryl sutures.

All the patients were examined for uncorrected visual acuity (UCVA) and best corrected visual acuity (BCVA) in logarithm of minimal angle of resolution (Log MAR), refraction and keratometry using Accuref-K9001 Auto Refractometer (Shin-Nippon, Japan), Tonometry using Goldmann Applanation Tonomety, anterior segment examination using slit lamp, Fundus using slit-lamp biomicroscopy with 90 D lens both preoperatively and postoperatively on day 5, 1 month, and 3 months. Corneal astigmatism was derived from values obtained through keratometry. The 3-month results were considered to be final outcomes and were compared to the preoperative results.

Statistical analysis

Statistical analysis was performed using SPSS for Windows (Version 16.0, 2007; SPSS Inc, Chicago, IL, USA). Paired and unpaired *t*-tests were used to compare the variables. The probability level of 0.05 was set as the statistically significance value.

Results

A total of 75 patients were selected randomly and divided into three groups of 25 each. Two patients of group 1 were excluded from the study as recurrence was present. Two patients were lost to follow up—each one from group 2 and 3. Therefore, the final sample size of the study was 71 with 23 patients in group 1 (BS), 24 patients in group 2(CAG), and 24 patients in group 3 (AMG).

Of the 71 patients, 40 were male (56.34%) and 31 were female (43.66%). The mean age of the patients was 39.69 years. Of the 71 patients, grade II, III, and IV pterygiums were present in 38 (53.52%), 19 (26.76%), and 14 (19.72%) patients respectively, with the latter two grade pterygiums covering the visual axis of the eyes.

The pre- and postoperative mean UCVA (in LogMAR) were compared on day 5, 1 month, and 3 months. The preoperative mean UCVA of 0.56 ± 0.49 was significantly reduced to 0.47 ± 0.44 ($P < 0.001$), 0.32 ± 0.29 ($P < 0.0001$), and 0.32 ± 0.29 ($P < 0.0001$) on day 5, 1 month, and 3 months after surgery, respectively [Table 1].

The pre- and postoperative corneal astigmatism were also compared on day 5, 1 month, and 3 months. The changes in corneal astigmatism were statistically significant at all visits. The preoperative corneal astigmatism of 3.47 ± 1.74 D was reduced to 1.10 ± 0.78 D 3 months after surgery ($P < 0.0001$) [Table 2].

The amount of astigmatism varied with the grade of pterygium. The preoperative mean astigmatism was 2.19 ± 0.50 D, 3.80 ± 0.51 D, and 6.50 ± 0.61 D in eyes with grade II, II, and IV pterygiums, respectively. The amount of corneal astigmatism induced by pterygium increased with the grade of pterygium. The postoperative mean astigmatism at 3 months in eyes with grade II, III, and IV pterygiums were 0.66 ± 0.31 D ($P < 0.0001$), 1.20 ± 0.51 D ($P < 0.0001$), and 2.16 ± 0.90 D ($P < 0.0001$), respectively. Thus, a significant reduction in corneal astigmatism 3 months after surgery was observed for all the three grades of pterygium. But maximum change in astigmatism was seen in Grade IV >Grade III >Grade II. Change in astigmatism increases with increase in grade of pterygium [Table 3].

Postoperative astigmatism at 3 months had decreased significantly in all the three groups. The preoperative mean corneal astigmatism of 3.43 ± 1.73 D, 3.50 ± 1.77 D, and 3.48 ± 1.79 D of the groups 1 (BS), 2 (CAG), and 3 (AMG) were reduced to a 3-month postoperative corneal astigmatism of 1.58 ± 0.95 D ($P < 0.0001$), 0.95 ± 0.60 D ($P < 0.0001$), and 0.80 ± 0.51 D ($P < 0.0001$), respectively. [Table 4].

There was a significant difference between the outcomes of groups 1 and 3 ($P = 0.024$) and 1 and 2 ($P = 0.035$). However, there was no significant difference between the outcomes of

Table 1: Comparison of Pre and Postoperative Uncorrected Visual Acuity (UCVA)(in LogMAR)

	Mean	Std. Dev.	Std.Error	*P*
Preop.	0.56	0.49	0.058	-
Postop Day5	0.47	0.44	0.052	0.001(S)
Postop 1 month	0.32	0.29	0.034	0.0001(S)
Postop 3 months	0.32	0.29	0.034	0.0001(S)

PS=UCVA—Uncorrected visual acuity

Table 2: Comparison of Preoperative and Postoperative Corneal Astigmatism (in Diopter [D])

	Mean	Std. Dev.	Std. Error	*P*
Preop	3.47	1.74	0.20	
Postop Day 5	2.13	1.23	0.14	0.0001(S)
Postop 1 month	1.20	0.79	0.09	0.0001(S)
Postop 3 month	1.10	0.78	0.09	0.0001(S)

Table 3: Comparison of Pre-and Post-Operative Corneal Astigmatism (in Diopter) with Grade of Pterygium

Grade of pterygium	Preoperative Astigmatism (D)	Postoperative Astigmatism (D) (at3months)	*P*
	Mean±SD	Mean±SD	
II	2.19±0.50	0.66±0.31	0.0001(S)
III	3.80±0.51	1.20±0.51	0.0001(S)
IV	6.50±0.61	2.16±0.90	0.0001(S)

groups 2 and 3 ($P = 0.751$). Thus, we concluded that astigmatism was better reduced when the pterygium excision surgery was performed using the amniotic membrane graft and conjunctival autograft techniques rather than the bare sclera technique [Table 5].

Discussion

Pterygium causes refractive changes by inducing astigmatism or by involving visual axis which leads to visual impairment.[8] Our study was designed to study the change in corneal astigmatism after pterygium excision surgery as well as to compare the changes in astigmatism that are a result of using different surgical techniques.

Surgery is the primary treatment of pterygium. Visual acuity can be improved by successful pterygium excision surgery during which astigmatism is reduced and pterygium is removed from the visual axis.[8] The study by Maheswari *et al*. found significant improvements in visual acuity after pterygium excision surgery in all the grades of pterygium ($P < 0.05$). Similarly, Misra *et al*. observed that the mean BCVA significantly improved from 6/7.5 preoperatively to 6/6 at 1 month ($P = 0.001$) after pterygium surgery.[9] In our study also, we have found that visual acuity was improved significantly after pterygium excision surgery. UCVA significantly improved from 0.56 ± 0.49 preoperatively to 0.32 ± 0.29 postoperatively (at 3 months; $P < 0.0001$).

Several studies have proved that pterygium excision surgery significantly reduces pterygium-induced astigmatism. 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.[1] So, they concluded that pterygium-induced corneal astigmatism can be reduced by pterygium surgery. A similar study was carried out by Cinal *et al*. and they concluded that pterygium surgery causes partial reversal of pterygium-related corneal topographical changes, though some changes might remain due to scarring.[10]

Table 4: Comparison of Preoperative and Postoperative Corneal Astigmatism (in Diopter) at 3 months in Different Groups

	Preop astigmatism	Postop astigmatism	*P*
	Mean±SD	Mean±SD	
Group 1 (BS)	3.43±1.73	1.58±0.95	0.0001(S)
Group 2 (CAG)	3.50±1.77	0.95±0.60	0.0001(S)
Group 3 (AMG)	3.48±1.79	0.80±0.51	0.0001(S)

PS=BS-Bare sclera, CAG=Conjunctival autograft, AMG=Amniotic membrane graft

Table 5: Comparison of Postoperative Change in Corneal Astigmatism at 3 months between the Three Groups

	Group 1 (*n*=23) (BS)	Group 2 (*n*=24) (CAG)	Group 3 (*n*=24) (AMG)
	Mean±SD	Mean±SD	Mean±SD
Change in corneal astigmatism (D)	1.85±0.88	Mean±SD 2.55±1.26	Mean±SD 2.67±1.44

P value: group 1& group 2=0.035(S), group 2 & group 3=0.751 (NS), group 1 & group 3=0.024 (S) PS=BS=Bare sclera, CAG=Conjunctival autograft, AMG=Amniotic membrane graft

These results were comparable to our study as we have also found significant reduction in mean corneal astigmatism after pterygium surgery. The preoperative mean astigmatism of 3.47 ± 1.74 D was significantly ($P < 0.0001$) reduced to 1.10 ± 0.78 D postoperatively at 3 months which can be attributed to the fact that the regularity and symmetry of corneal surface improved after pterygium surgery, thus reducing astigmatism.[11]

Pterygium grade also affects the corneal astigmatism. Several studies conducted previously prove that the amount of induced corneal astigmatism increases with the increase in the size of pterygium. Gumus *et al*. found a significant correlation between the size of pterygium and induced corneal astigmatism.[5] Seitz *et al*. concluded that with the size of pterygium extending from 2.5mm, the preoperative astigmatism increases.[12] In our study, mean astigmatism was more in higher grades of pterygium. Preoperative mean astigmatism was minimum in grade II pterygium, that is, 2.19 ± 0.50 D and maximum in grade IV pterygium 6.50 ± 0.61 D. These results were comparable with results of the above-mentioned studies.

Our study also compared the change in corneal astigmatism after different techniques for pterygium surgery, that is, bare sclera (group 1), conjunctival autograft (group 2) and amniotic membrane graft (group 3). All the three techniques were found to significantly change astigmatism [Table 4]. The 3-months postoperative changes in astigmatism of the bare sclera, the conjunctival autograft, and the amniotic membrane graft techniques were 1.85 ± 0.88 D, 2.55 ± 1.26 D and 2.67 ± 1.44 D, respectively. We noticed significant difference in the astigmatic changes of the bare sclera technique and the conjunctival autograft technique ($P = 0.035$) and also between the bare sclera technique and the amniotic membrane graft technique ($P = 0.024$). However, the difference was not significant between conjunctival autograft technique and amniotic membrane graft technique ($P = 0.751$) [Table No 5].

As compared to the bare sclera technique, changes in astigmatism were significantly more with amniotic membrane graft and conjunctival autograft technique mainly due to better healing and less granulation tissue formation.[11,13–14]

Altan-yaycioglu *et al*. have used different surgical techniques: conjunctival autograft with sutures (CAG-s) or fibrin glue (CAG-g), conjunctival rational flap (CRF), or amniotic membrane transplantation with either suture (AMT-s) or with glue (AMT-g) on the postoperative astigmatism.[15] They found that changes in astigmatism were significantly related to the preoperative size of the pterygium and were not related to the type of grafting or the use of suture or glue. Similarly, in a study conducted by Gangadhar, *et al*. pterygium-induced astigmatism was compared by using conjunctival autograft and amniotic membrane graft.[16] They concluded that early excision of pterygium reduces the pterygium-induced astigmatism and that the type of grafting does not have a significant effect on change in astigmatism. Though the above two studies did not include the bare sclera technique in their study, their comparison results between conjunctival autograft and amniotic membrane graft groups were similar to our results

of no significant difference between conjunctival autograft and amniotic membrane graft in terms of change in corneal astigmatism.

Popat *et al*. compared the astigmatism changes by using bare sclera technique and conjunctival autograft technique.[11] They found that decrease in astigmatism after pterygium surgery was more in conjunctival autograft technique (6.21 D to 1.0 D) as compared to bare sclera technique (6.17 to 2.85 D). They concluded that the type of pterygium surgery also plays a role in modifying the pterygium-induced astigmatism.

We could not find any significant difference in postoperative astigmatism between the amniotic membrane graft and the conjunctival autograft techniques. However, we recommend amniotic membrane grafting as the preferred technique because it can be used in cases with very large conjunctival defects after pterygium excision and where bulbar conjunctiva is required for future glaucoma filtration surgery. However, extensive use of amniotic membrane technique in pterygium surgery is limited by its high cost.

Although a larger sample size would have helped in a better analysis, our study has a small sample size (71). Moreover, the follow-up period of our study was 3 months. Larger follow up period would have helped in better evaluation of long-term complications.

Conclusion

Pterygium is associated with significant astigmatism in most cases. Our study verifies that with increase in the amount of induced astigmatism also increases with increase in the size of pterygium. Pterygium-induced astigmatism can be significantly reduced by surgical excision. This results in improvement of visual acuity as well. There was significant reduction in corneal astigmatism depending upon the different types of pterygium surgeries namely bare sclera, amniotic membrane graft, and conjunctival autograft techniques. However, we suggest that amniotic membrane graft and conjunctival autograft are better surgical techniques than bare sclera as far as reducing astigmatism is concerned.

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Conflicts of interest

There are no conflicts of interest.

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