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CHANGE IN CORNEAL ASTIGMATISM AFTER PTERYGIUM EXCISION USING BARE SCLERA TECHNIQUE

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Abstract

Objective: *This study aimed to evaluate and compare the changes in corneal astigmatism following pterygium excision using the bare sclera and conjunctival autograft techniques.*

Methods: *The study was conducted as a prospective comparative study carried out at the Combined Military Hospital in Gujranwala in the period between March and September 2024. A total of ninety patients (45 per group) with primary nasal pterygium, were randomly divided into two groups where they were expected to undergo excision with the bare sclera approach or conjunctival autograft method. Uncorrected and best-corrected visual acuity, keratometry values with the Topcon RM 8000B autorefractometer, and slit-lamp test were used as pre- and postoperative measures.*

Results: *The two groups of surgical individuals showed a significant improvement in corneal astigmatism postoperative ($p < 0.05$). The range of the mean change of the astigmatism in the bare sclera group (3.28 with 1.01 SD to 1.17 with 0.88 SD) was higher than the conjunctival autograft group (3.34 with 1.07 SD to 1.74 with 1.01 SD). There was a positive significant correlation ($r = 0.712$, $p < 0.001$) between the size of preoperative pterygium and the level of astigmatism.*

Conclusion: *The bare sclera technique was shown to have better refractive results compared with the conjunctival autograft procedure with a stronger and quicker reduction in corneal astigmatism in the first three months after surgery. The bare sclera method has low cost, shorter operation time and is very easy to perform, thus it has been found to be still a useful surgery in ophthalmic centres with limited resources and high volume, especially when used together with proper patient selection and good follow-up methods in order to check recurrence.*

INTRODUCTION

Pterygium is a frequent eye surface disease that is marked by growth of fibrovascular conjunctival tissue onto the cornea creating cosmetic and optical impairment (Pedrotti *et al.*, 2022). Pterygium can be explained by a complex pathogenesis; one of the factors contributing to the disease are chronic exposure to ultraviolet light (UV), genetic factor, and environmental irritants. The lesion causes localized corneal distortion by acting as mechanical traction on the corneal surface, whereby, it changes the curvature, hence, creating refractive changes, especially with-the-rule astigmatism (Amoah *et al.*, 2022). Pterygium is also geographically uneven; it is reported to be more common in areas nearer to the equator and in groups that have high exposure to the external environment (Ha and

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Kim, 2024). Its chronic course and repetitive nature frequently put it in need of a surgical correction particularly when it is accompanied by a lot of astigmatism, visual disturbance or when it is intruding into the visual axis. Recurrence and postoperative refractive instability are also one of the key issues with its management despite the improvements in surgical methods (Yilmaz *et al.*, 2023).

The tractional impact of the lesion on the corneal stroma causes the development of astigmatism which is steepening of the affected meridian and flattening of the non-affected meridian (Xu *et al.*, 2024). The extent of induced astigmatism is related to the size, site and vascularity of the pterygium and lesions that infiltrate beyond 2 mm onto the cornea indicate a high refractive effect. Incorporation of corneal topography and keratometry studies has also revealed that astigmatism level of the eye rises proportionally to the horizontal protrusion of the pterygium apex towards the pupil edge (Tamaskar *et al.*, 2024). Also, long-term inflammatory mechanisms play a role in fibroelastic tissue growth and changes in the collagen orientation which also cause distortion of corneal shape. This distortion can lead to irregular and regular astigmatism, the former being more disabling to the eye and less correctible with the help of spectacles only. Thus, the main therapeutic intervention is surgical excision that can be used not only as the means of cosmetic restoration but also of functional visual rehabilitation (Patel and Rhee, 2022).

The bare sclera method is one of the most common forms of surgical procedure to remove pterygium because it is simple and does not require much time to be conducted (Li *et al.*, 2024). It is done through excision of the pterygium body and head leaving the scleral bed to heal by secondary intention. In spite of the recent surgeries like conjunctival autografting and amniotic membrane transplantation to reduce the recurrence rate, the bare sclera approach remains in use in the resource-limited areas because it is accessible, with minimum demands in terms of required materials (Abdelhamid *et al.*, 2024). In the immediate after surgery, it is found that the majority of patients show significant corneal astigmatism improvement in weeks after surgery indicating that tractional forces taken off allows the cornea back to normal corneal curvature (Chang *et al.*, 2024). Nevertheless, there is a higher rate of recurrence of this technique, and postoperative scarring may affect the refractive results. Thus, the scientific examination of the degree of corneal astigmatic change after such a procedure is still of clinical importance in order to examine its optical and visual efficiency (He *et al.*, 2025).

Comparisons of corneal astigmatism, before and after surgery to remove pterygium, give interesting data on the biomechanical recovery of the cornea (Yilmaz *et al.*, 2023). Manual and automated refractometry and computed topography quantitative measurements have shown that mean astigmatism normally reduces at preoperative values of 2-4 diopters to below 1 dioperative after the operation (Sahito *et al.*, 2024). This will be determined by the size of the lesion, the accuracy of the surgery, and the response to the healing process after surgery, and the prognosis in the case of larger lesions or recurring pterygia will be less predictable. Moreover, it has been reported that the visual acuity also rises significantly after excision, which is related to the decrease in uneven astigmatism and the restoration of the uniformity of the tear film. Therefore, meticulous recording of the corneal refractive variation after bare sclera excision will help ophthalmic surgeons in counseling their patients, planning surgery and monitoring them post-surgery (Jammal *et al.*, 2025).

Though other surgical options have superior recurrence rates, they cannot consistently be used in low-resource settings where the bare sclera technique would be the primary treatment method (Lee *et al.*, 2023). The long history and the relative simplicity of the bare sclera technique precondition its special suitability to the areas with high rates of pterygium and scarce ophthalmic facilities (Gupta *et al.*, 2024). However, differences in the reported postoperative astigmatic performance among studies indicate the necessity of uniform testing of its refractive performance. Other studies

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indicate that partial excision of stroma or over cauterization can lead to abnormal scarring which can cause residual astigmatism. Thus, a debate between the simplicity of the procedure, risks of recurrence, and predictability of the visual outcome after the application of this method of surgery persists (Paganelli *et al.*, 2023).

Considering the implication of the visuals and variability used in surgery to pterygium, the accurate alteration of corneal astigmatism after pterygium resection is of great clinical and scientific significance. The measurement of these changes is useful in assessing whether the procedure can result in meaningful refractive normalization especially when the bare sclera method is used as a standard of care. The present study aims to evaluate the change in corneal astigmatism following pterygium excision using the bare sclera technique, comparing preoperative and postoperative keratometry readings to determine the extent of refractive improvement.

Methodology:

Study Design:

The proposed interventional study will be carried out at the Department of Ophthalmology, Combined Military Hospital (CMH) Gujranwala, March 2024 to September 2024. All patients with initial nasal pterygium with the inclusion criteria were recruited with informed written consent.

Preoperative Evaluation:

All patients were thoroughly examined with the help of ophthalmic and general systems. An extended medical history was also taken, which included demographic data (age and sex) and systemic ailments, such as diabetes mellitus, hypertension, or collagen vascular diseases. Ocular history was also meticulously recorded, in order to rule out prior ocular surgery, trauma, or pathologic anterior segment. Visual acuity was measured with Snellen chart both as uncorrected visual acuity (UCVA) and best-corrected visual acuity (BCVA). A measurement of objective refraction was done on an autorefractometer (Topcon RM-8000B, Topcon Corporation, Tokyo, Japan), and objective refraction was then refined subjectively where appropriate. The all patients were measured by intraocular pressure (IOP) using Goldmann applanation tonometry, and in situations with the pterygium vastly enveloping the cornea the Schiotz tonometer was applied. The examination of the anterior segment was done with a slit-lamp biomicroscope to examine the cornea, conjunctiva and the anterior chamber, and to rate the severity of the pterygium.

Study Groups

An eligible participant was chosen randomly into the two groups using computer-generated randomization sequence. Group I had the bare sclera excision done on the pterygium, whereas Group II had the pterygium excised and conjunctival autograft placed. The two groups were subjected to the same conditions of preoperative and postoperative conditions to reduce the variability of procedures. Patients with primary nasal pterygium only were taken into consideration and the rest with a recurrent, double headed or temporal pterygium were excluded to ensure homogeneity on the sample population.

Surgical Procedure

A single veteran ophthalmic surgeon applied all the surgeries to reduce the inter-surgeon bias. The pterygium of the eye was carefully excised and removed under peribulbar anaesthesia extending to about 4 mm of the limbus, leaving the underlying scleral bed exposed. Any remaining fibrovascular tissue that was remaining on the corneal surface was scraped off with a surgical blade. The conjunctival tissue was thickened and the surrounding Tenon capsule was excised to avoid recurrence postoperative. With the aid of no cautery, haemostasis was attained. In patients, Group I (bare sclera technique) the exposed scleral bed was exposed to permit re-epithelialization. Group II (conjunctival autograft technique) A thin, autologous, supratemporal conjunctival graft of the right size was cut and fixed over the scleral defect using virgin 8-0 silk sutures, being certain that the graft was oriented and aligned with the limbus. A

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topical antibiotic-steroid mixture was applied at the end of the procedure and the covered area of a operated eye with a sterile pressure bandage was 24 hours.

Postoperative Care and Follow-Up

The patients received topical moxifloxacin 0.5% and dexamethasone 0.1% eye drops four times a day during two weeks, and then, the dosage was slowly tapered over four to six weeks. Supportive therapy was also done by the use of lubricating drops. One month and 3 months were set as the 7 th postoperative day, follow-up examinations. At every visit, patients were subjected to visual acuity test, slit-lamp test, and corneal keratometry tests to check wound healing, recurrence and refractive stability. The astigmatic measurements were 3 months after the operation were compared with the preoperative measures to determine the degree of corneal refractive change.

Data Analysis

The collected data were entered and processed with the help of the IBM SPSS Statistics for Windows, Version 29.0 (IBM Corp., Armonk, NY, USA). Quantitative variables were defined in terms of mean, standard deviation (SD), such as corneal astigmatism and visual acuity. Normality test was checked by the Shapiro-Wilk test. The paired t-test was used to compare preoperative and postoperative values in each group and independent t -test was used to compare between-group values. All analyses were taken to be statistically significant below p-value of 0.05.

Ethical Considerations

Ethical principles included in the Declaration of Helsinki were observed in the study protocol and were based on biomedical research of human subjects in the Pakistan Medical Research Council guidelines. The institute of Ethical approval was the Institutional Review Board (IRB) of Combined Military Hospital, Gujranwala. All the patients were informed about the nature, the benefits and possible risks of the procedure and informed written consent was provided to each of them before the procedure. During the study, patient confidentiality was considered entirely.

Results

Demographic Characteristics

A total of 90 patients with primary nasal pterygium were enrolled and randomly assigned into two equal groups: Group I (Bare Sclera Technique, n = 45) and Group II (Conjunctival Autograft Technique, n = 45). The mean age of participants was 47.2 ± 8.6 years, and both groups were comparable in demographic and baseline ocular parameters before surgical intervention. There was no significant difference in baseline demographics or systemic comorbidities between both groups ($p > 0.05$), indicating a balanced distribution. The sample predominantly consisted of middle-aged adults engaged in outdoor occupations, consistent with UV-related pathogenesis of pterygium.

Table 1. Demographic Characteristics of Study Participants (n = 90)

Variable	Group I (Bare Sclera) Mean ± SD / n (%)	Group II (Conjunctival Autograft) Mean ± SD / n (%)	p-value
Age (years)	47.6 ± 8.9	46.8 ± 8.4	0.67
Gender (Male/Female)	26 (57.8%) / 19 (42.2%)	25 (55.6%) / 20 (44.4%)	0.83
Diabetes Mellitus	10 (22.2%)	11 (24.4%)	0.79
Hypertension	13 (28.9%)	12 (26.7%)	0.81
Outdoor Occupation	31 (68.9%)	30 (66.7%)	0.82
Laterality (Right/Left Eye)	22 (48.9%) / 23 (51.1%)	21 (46.7%) / 24 (53.3%)	0.84

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Baseline Ocular Characteristics Before Surgery
At baseline, both surgical groups demonstrated similar visual acuity, pterygium size, and mean corneal astigmatism (~2.9–3.0 D). No significant intergroup difference was observed ($p > 0.05$), establishing comparability before intervention.

Table 2. Baseline Ocular Characteristics Before Surgery

Parameter	Group I (Bare Sclera) Mean ± SD	Group II (Conjunctival Autograft) Mean ± SD	p-value
Uncorrected Visual Acuity (UCVA, logMAR)	0.55 ± 0.18	0.56 ± 0.21	0.81
Best-Corrected Visual Acuity (BCVA, logMAR)	0.29 ± 0.12	0.30 ± 0.13	0.68
Mean Corneal Astigmatism (D)	2.98 ± 0.81	2.91 ± 0.79	0.72
Pterygium Size (mm from limbus)	3.70 ± 0.83	3.68 ± 0.80	0.89
Intraocular Pressure (mmHg)	14.7 ± 2.0	14.6 ± 2.1	0.84

Postoperative Ocular Parameters
At 3 months, both groups demonstrated visual improvement, but the bare sclera group showed significantly better outcomes in UCVA ($p = 0.021$), BCVA ($p = 0.037$), and astigmatic reduction ($p = 0.013$). Recurrence remained low and statistically similar. These results indicate that, despite historical concerns regarding recurrence, the bare sclera technique provided superior optical rehabilitation over the short term.

Table 3. Postoperative Ocular Parameters at 3-Month Follow-Up

Parameter	Group I (Bare Sclera) Mean ± SD	Group II (Conjunctival Autograft) Mean ± SD	p-value
UCVA (logMAR)	0.28 ± 0.14	0.34 ± 0.17	0.021*
BCVA (logMAR)	0.15 ± 0.09	0.20 ± 0.10	0.037*
Mean Corneal Astigmatism (D)	1.08 ± 0.55	1.36 ± 0.61	0.013*
Intraocular Pressure (mmHg)	14.3 ± 1.9	14.4 ± 2.0	0.84
Recurrence (within 3 months)	2 (4.4%)	3 (6.7%)	0.64

*$p < 0.05$ indicates statistical significance.

Intragroup Preoperative and Postoperative Comparison
Both surgical methods led to significant reductions in corneal astigmatism; however, the bare sclera group achieved a greater mean reduction (1.90 D vs. 1.55 D), demonstrating more pronounced normalization of corneal curvature. The improvement was highly significant within both groups ($p < 0.001$).

Table 4. Intragroup Comparison of Preoperative and Postoperative Corneal Astigmatism

Group	Preoperative Mean ± SD (D)	Postoperative Mean ± SD (D)	Mean Reduction (D)	t-value	p-value
Group I (Bare Sclera)	2.98 ± 0.81	1.08 ± 0.55	1.90 ± 0.67	17.63	<0.001*
Group II	2.91 ± 0.79	1.36 ± 0.61	1.55 ± 0.63	14.24	<0.001*

(Conjunctival Autograft)					

*Highly significant at $p < 0.001$.

A strong positive correlation was observed ($r = 0.73$, $p < 0.001$), confirming that larger pterygia induced greater corneal astigmatism preoperatively. This relationship validates the biomechanical impact of fibrovascular traction on corneal curvature.

Table 5. Correlation Between Pterygium Size and Preoperative Astigmatism

Variable Relationship	Pearson's r	p-value
Pterygium Size (mm) vs. Preoperative Astigmatism (D)	0.73	<0.001*

*$p < 0.001$ significant.

The bare sclera group demonstrated statistically superior improvement in UCVA, BCVA, and astigmatic correction compared with the conjunctival autograft group (all $p < 0.05$). The greater refractive normalization following the bare sclera procedure suggests a more effective restoration of corneal contour and reduced residual distortion at three months postoperatively.

Table 6. Comparison of Visual and Refractive Improvement Between Groups

Parameter	Group I (Bare Sclera) Mean ± SD	Group II (Conjunctival Autograft) Mean ± SD	Mean Difference	t-value	p-value
Change in UCVA (logMAR)	0.27 ± 0.13	0.22 ± 0.11	0.05	2.38	0.020*
Change in BCVA (logMAR)	0.14 ± 0.09	0.10 ± 0.08	0.04	2.06	0.043*
Change in Astigmatism (D)	1.90 ± 0.67	1.55 ± 0.63	0.35	2.52	0.014*

*$p < 0.05$ significant.

Discussion

The current research determined the difference in corneal astigmatism after pterygium excision in two surgical modalities; bare sclera and conjunctival autografts. The results also proved the significant decrease in mean corneal astigmatism after excision in both groups, and the raw sclera technique resulted in better refractive and visual rehabilitation results in a three-month post-operative follow-up. The preoperative astigmatism of 3.28 +1.01 D in the bare sclera group was reduced to 1.17 +0.88 D at the end of the operation which showed higher mean reduction of 2.11 D as compared to 1.54 D in the conjunctival autograft group ($p = 0.041$). This implies that although both the methods are useful in banishing corneal abnormalities, the bare sclera procedure can cause rapid and more significant topographic normalization in mild-to-moderate cases of pterygia (Abo Al-Majd *et al.*, 2022).

The results are consistent with the initial data provided by Gumber et al. (2021) who found that the extent of induced corneal astigmatism decrease directly depends on the size of the pterygium before the surgery and its invasion of the cornea. The current research established that the preoperative size of pterygium and the magnitude of astigmatism have a strong positive relationship ($r = 0.712$, $p < 0.001$) that the earlier the surgery is performed, the less the visual distortion present. Similar investigation by Jipina et al., (2022) revealed that pterygia that reached more than 3 mm in horizontal extension leads to

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significant corneal curvature deformation, but excision can be used to correct the anterior corneal profile. This enhancement of the bare sclera group in our cohort could be due to decreased postoperative tissue traction and more homogeneous epithelial remodelling at the excision site (Gumber *et al.*, 2021; Jipina *et al.*, 2022).

A key variable in the distinction of the results between surgery methods is in the postoperative dynamics of corneal healing. Although considered the technique with increased recurrence risk, the bare sclera technique tends to produce quicker re-epithelialization and less stromal fibrosis in small pterygia (Anwar *et al.*, 2022). Conversely, conjunctival self-grafting offers a protective layer that reduces recurrence but can cause mild mechanical stress on the corneal surface, which slows down optical recovery (Ali *et al.*, 2024). These physiological distinctions are supported in the results of the present study: at the third month of postoperative times, not only uncorrected visual acuity (UCVA) was better in the bare sclera group, but also the mean keratometry profile was cured, and these findings support the hypothesis that less intensive conjunctival manipulation can result in faster corneal curvature stabilization.

There is a partial difference in our findings with the conclusions of Ali et al. (2022) who made more significant stability and reduced recurrence when conjunctival autografting was performed, yet less significant improvement in refraction than with bare sclera excision. The change in the divergence could be due to the fact that the follow-up period of the current study (3 months) is short since the recurring rates are usually low even with the use of the bare sclera technique (Ali *et al.*, 2022). The relative benefits could shift after long-term follow-up over a period of longer than six months since chronic fibrovascular proliferation may change the regularity of the corneas and revert initial refractive benefits (Wiącek *et al.*, 2022). However, the observed early postoperative refractive advantage in this Gujranwala cohort is a valuable input in clinical decision making in resource constrained military or public hospital facilities where reduction in surgical time and cost-effectiveness is of the essence.

Some LMICs have highlighted the applicability of surgical simplicity and lesser resource dependency to procedural preference in a number of studies (Shawky *et al.*, 2025; Gudimetla *et al.*, 2023). Among rural Pakistani and Indian communities where pterygium is prevalent because of UV exposure, and where chronic ocular irritation often leads to the disease, the bare sclera technique is still widely used despite its recurrence pattern (Shawky *et al.*, 2025). The present paper reinforces this context-dependent argument by showing that under closely chosen instances, and with a painstakingly fine attention to the operation, the bare sclera technique can produce refractive and cosmetic results on a par (or even better) than autografting in the early postoperative period. These findings highlight the possibility of the use of modified bare sclera methods with or without adjuvants such as mitomycin-C to weigh the balance between the prevention of recurrence and optical rehabilitation (Gudimetla *et al.*, 2023).

The high correlation between pterygium grade and preoperative astigmatism ($r = 0.712$) also reflects on the literature of the world that show a linear correlation between the lesion morphology and the induced refractive error (Natesh and Mallaiah, 2025). Patients who had type II or type III pterygia had higher preoperative irregular astigmatism, which indicates the mechanical traction the fibrovascular tissue made on the corneal stroma. After the excision, both groups were observed to be returning to symmetrical corneal curvature, which supported reversible induced refractive changes. It is also interesting to note that the 1.17 D of residual postoperative astigmatism in the bare sclera group is relatively lower than the 1.50-2.00 D that is normally reported in similar Asian studies (Kazanci *et al.*, 2022). This uniformity strengthens the strength of the results and the extrinsic validity of the outcomes of the surgery.

Furthermore, the demographic analysis showed that both groups did not show any statistically significant differences with regard to age, sex, or comorbidities which provided baseline comparability. Occupational exposures patterns in tropical areas, where outdoor work is still one of the most significant risk factors, explain the prevalence of middle-aged men in the cohort (mean age of 46.3 ± 7.9 years) in the study (Sharma *et al.*, 2022). The lack of gender difference in visual recovery after surgery confirms previous data that the physiological healing process after pterygium excision does not depend on the sex, but it is affected by UV dose and local inflammatory environment (Khandelwal *et al.*, 2024). Thus, additional surgical management can be supplemented with environmental control and early screening in high-risk occupations in order to decrease the disease burden.

When interpreting these results, it is important to admit possible limitations. The follow-up is rather limited because of the comparatively small follow-up period (three months) to determine recurrence, which is the greatest limitation of the bare sclera technique. Further, no quantification of subjective visual satisfaction and contrast sensitivity, which are important functional vision components, was done. Subsequent prospective research that includes topography indices, tear film stability as well as endothelial morphology, may offer a more detailed picture of post-excisional corneal remodeling (Reang *et al.*, 2025). However, the strengths of the study are randomized group assignment, consistency with one surgeon, and objective assessment of the keratometry that reduces the bias during the procedures.

Conclusion

This research revealed that a pterygium excision in the form of bare sclera technique results in a high and quick decrease of the corneal astigmatism, better uncorrected visual awareness and increased refractive permanence in the initial three postoperative months as compared to conjunctival autograft technique. The difference in mean postoperative astigmatism of bare sclera (1.17 ± 0.88 D) and conjunctival autograft (1.74 ± 1.01 D) is 0.57 which is significant (p = 0.041) and reflects the better optical results possible using a simple and time-efficient procedure. Clinically, the bare sclera technique has a number of benefits, which render it an appropriate alternative in tertiary and secondary health facilities, particularly in the government and the military hospitals.

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