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Evaluation of changes in Corneal Curvature and Tear Film Stability Fol-lowing Pterygium Surgery and Their Impact on Visual Acuity and Refractive Outcome

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ABSTRACT

Aim: To evaluate the changes in corneal curvature and tear film stability following pterygium surgery and assess their impact on visual acuity and refractive outcomes.

Methods: A prospective study was conducted on 44 patients undergoing primary pterygium excision. Preoperative and postoperative corneal curvature was measured using keratometry at day 1, 1 week, 1 month, and 2 months post-surgery. Tear film stability was assessed using the tear breakup time (TBUT) test and Schirmer's test at the same intervals. Changes in refractive error and visual acuity.

Results : In our study , we evaluated the changes in corneal curvature and tear film stability following pterygium surgery and assessed their impact on visual acuity and refractive outcomes. It showed significant difference in BCVA between cases in preoperative period and control groups indicating that the cases had worse visual acuity preoperatively than controls. Similarly, the majority of the cases had with the rule astigmatism preoperatively with higher K1 values compared to the control group suggesting the role of pterygium in altering the corneal curvature. However, K2 values showed no significant difference between the 2 groups in the preoperative period. Our study also showed statistically significant difference in schirmers test and TBUT between cases and controls in the preoperative period, which is suggestive of poor tear film stability.

The with the rule astigmatism redcuced significantly after pterygium excision, as K1 values decreased postoperatively compared to preoperative values. Tear film stability reached a level similar to the unaffected eye within 60 days after surgical excision of pterygium with conjunctival autograft. All these factors had a cumulative effect on BCVA which has led to an improvement in BCVA postoperatively compared to preperative values

Conclusion: Our study showed that pterygium causes significant corneal astigmatic changes, majority of which was with the rule . It also caused instability in tear film which was proven by schirmers and TBUT tests. Both these factors have contributed in significant reduction of BCVA, which was proven by improvement in BCVA postoperatively along with improvement in tear film stability and with the rule astigmatism

Keywords: Pterygium Surgery, Corneal Curvature, Tear Film Stability

INTRODUCTION

Pterygium is a fibrovascular overgrowth of conjunctival tissue extending onto the cornea, commonly associated with ultraviolet (UV) light exposure, chronic irritation, and genetic predisposition [1]. The condition is prevalent in regions with high sun exposure and is thought to be linked to oxidative stress and chronic inflammation of the ocular surface [2]. Studies suggest that pterygium induces refractive changes by distorting the corneal curvature, leading to significant visual impairment, particularly in advanced cases [3].

Histopathologically, pterygium is characterized by elastotic degeneration of the subepithelial connective tissue, angiogenesis, and an inflammatory cell infiltrate [4]. It alters the ocular surface by disrupting the tear film, causing instability and symptoms of dry eye disease [5]. The tear film changes are attributed to mechanical disruption of the corneal surface, loss of goblet cells, and altered mucin secretion, which contribute to increased tear evaporation [6].

Pterygium also leads to corneal astigmatism due to the tractional forces it exerts on the cornea, causing irregularity and asymmetry in corneal curvature [7]. This distortion results in visual disturbances, including blurred vision and glare sensitivity [8]. Additionally, the severity of corneal topographic changes is proportional to the size and extent of the pterygium encroaching on the corneal surface [9].

Types of Pterygia

1. Progressive pterygium is thick, fleshy with pronounced vascularity, growing and can extend close to the visual axis. Cap (opaque infiltrative spot) and Stocker's line (a brownish iron line on the cornea in front of the apex) can be seen.
2. Atrophic (stationary) is thin and attenuated with poor vascularity. Cap is absent.

Primary double pterygium (both nasal and temporal limbus involvement), Pseudo pterygium (adhesion of a fold of conjunctiva to the peripheral cornea, which is usually unilateral, stationary and at any meridian), Recurrent pterygium (more width, more scarring of tissue, seen after primary treatment of pterygium) and Malignant pterygium (rare, a type of recurrent pterygium with restriction of ocular movements on the opposite side) are the other types[10].

The clinical appearance of the pterygium depends on its state of growth. Mature pterygium is raised, triangular, with its based on the para-limbal conjunctiva and its apex towards the centre of the cornea. Anatomically, pterygium has the following parts: Fuchs patches, Stocker's line, hood, head, body, base, superior edge, and inferior edge. For evaluating the severity of pterygium, the following parameters must be observed: -

1) Length of encroachment onto the cornea is the most important indicator of severity. More is the encroachment, and more will be the visual disturbances like induced astigmatism, corneal irregularities, light scatter, or pupil obscuration. According to this parameter, pterygium can be classified into four stages: -

   Stage 0- Pinguecula, posterior to the limbus.
   Stage 1- pterygium is restricted to the limbus.
   Stage 2- pterygium only marginally invades the cornea.
   Stage 3- pterygium is between the limbus and pupillary margin.
   Stage 4- pterygium is central to the pupillary margin.

2) The base width of the pterygium is usually measured with callipers as the chord length of the corneal limbus involved. Based on the size of ptrygium from the limbus pterygium may be:-

   Grade 1: 0-2 mm
   Grade 2: 2-4 mm
   Grade 3: > 4 mm

3) The translucency of the pterygium tissue is based on the visibility of the underlying episcleral vessels.

   Grade I: Atrophic pterygium – episcleral vessels clearly visible.
   Grade II: Intermediate pterygium – episcleral vessels partially visible.
   Grade III: Fleshy or opaque pterygium – episcleral vessels not visible[10].

Pterygium is usually asymptomatic but when growth is significant, a patient may complain of discomfort, foreign body sensation, irritation, redness, inflammation, dryness, lacrimation, decreased visual acuity, and diplopia on lateral gaze, acquired irregular or with the rule of astigmatism. Significant loss of vision may occur when pterygium obscure the visual axis[10].

The treatment of pterygium has evolved over the years. The recurrence rate after pterygium surgery is relatively high, ranging from 2% to 40%. Following are the current treatment modalities available for the management of pterygium:- bare sclera with intraoperative mitomycin-c, bare sclera with beta irradiation, sliding or rotational conjunctival autograft, conjunctival autograft, limbal conjunctival autograft (LCAG), amniotic membrane transplant, anterior segment indocyanine green angiography with conjunctival autograft transplantation, air-assisted pterygium surgery, suture less small incision pterygium surgery with fibrin tissue glue, use of antimetabolites like thiotepa, 5-fluorouracil (5-FU), mitomycin-c (MMC), deep anterior lamellar keratoplasty, medical management with Avastin[10].

But surgical excision remains the primary treatment for symptomatic pterygium. While it restores corneal symmetry and improves visual function, postoperative changes in corneal curvature and tear film stability require further investigation to optimize surgical techniques and outcomes [11]. Several studies have documented improvements in astigmatism, tear breakup time, and overall ocular surface stability following surgery [12]. However, some patients experience persistent dry eye symptoms postoperatively, highlighting the need for tailored postoperative management strategies [13].

This study aims to evaluate the impact of pterygium excision on corneal curvature and tear film stability, as well as its effects on visual acuity and refractive outcomes.

MATERIALS AND METHODS

The study was conducted in 88 eyes of 44 patients aged 30-65 years with all grades ofprimary pterygium in one eye as cases and other normal eye as controls with nopterygium, admitted for primary pterygium excision surgery with conjunctivalsutureless glue-free autograft using surgical site autologous serum at Department of Ophthalmology, Karnataka Medical College and Research Institute, Hubli

Aprospective,comparative interventional study was done during August 2024 to November 2024 including 44 patients diagnosed with any grade of primary pterygium who underwent primary pterygium excision surgery with conjunctival sutureless glue-free autograft using surgical site autologous serum after complete preoperative assessment. Contralateral normal eye is considered as control.

Institutional ethical committee clearance was obtained and study was carried out as per the declaration of Helsinki.Written consent was taken from all the patients for undergoing pterygium surgery.

Inclusion Criteria

1. Patients (>18 years of age) with primary nasal pterygium in one or both the eyes who is willing to undergo surgical excision and willing to participate in the study.

Exclusion Criteria

1. Patients with recurrent pterygium
2. Patients with prior ocular surgery,use of topical ocular medications
3. Patients with systemic diseases affecting tear film stability (e.g., Sjögren's syndrome, diabetes mellitus)
4. patients with other corneal disease or scar.
5. Patients with cicatricial corneal disease,ocular allergies

Consecutive 44 patients who attended our OPD with primary pterygium were considered for the study. Contralateral normal eye is considered as control. The risks,benefits and treatment alternatives were discussed with all patients and written consent was taken for the pterygium surgery.The following patient variables were noted before and after pterygium excision:age,sex,grade of pterygium, preoperative and postoperative corneal curvature was measured using keratometry at 1 week, 1 month, and 2 months post-surgery. Tear film stability was assessed using the tear breakup time (TBUT) test and Schirmer's test at the same intervals. Changes in refractive error, visual acuity, and dry eye symptoms were also recorded.

These pre-operative and post-operative parameters were compared and it was also compared with normal individuals who does not have pterygium and the analysis was done.

Surgical Procedure

All patients underwent pterygium surgery by cut and paste method- a no suture,glue free conjunctival autograft technique.All surgeries were performed under peribulbar anaesthesia.Under all aseptic precautions,parts painted and draped.Eye speculum was placed.Pterygium head was separated from the cornea using forceps.Subconjunctival dissection was carried out upto the caruncle,superior and inferior fornix.Corneal epithelium at the site of pterygiumwas scraped off with no.15 Bard-Parker blade.Head of the pterygium was then excised.Conjunctival autograft was taken from the inferotemporal region.Fresh bleeding spots were made over the bare sclera for the graft to adhere and the graft was placed over the bare sclera.Pad and bandage were applied after confirming the stability of the graft.Postoperative care included topical antibiotic-steroid therapy for four weeks.

Evaluation Methods

- **Corneal Curvature Measurement**:
  Keratometry was performed preoperatively and at 1 week, 1 month, and 2 months postoperatively .
- **Tear Film Stability**:

TBUT and Schirmer's test were assessed preoperatively and at all postoperative intervals

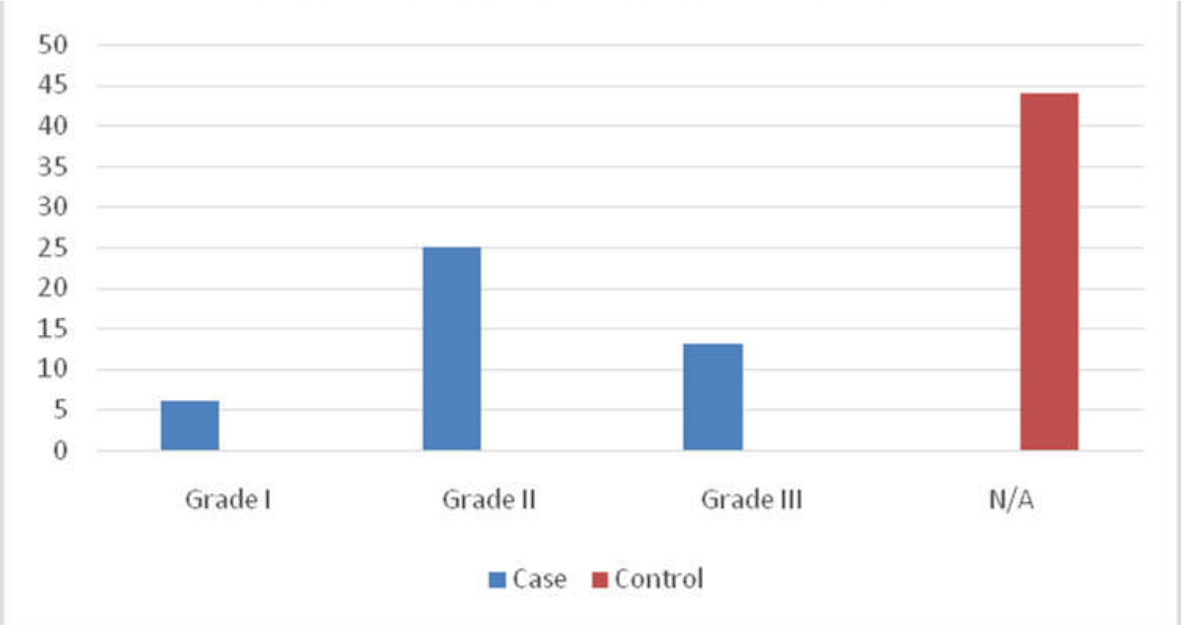
- **Visual Acuity and Refractive Error**:
  Uncorrected and best-corrected visual acuity (UCVA and BCVA) were recorded using Snellen's chart. Refractive changes were assessed via autorefractometry.

RESULTS

A total of 44 patients were included in the study who presented with primary nasal pterygium and underwent pterygium surgery, and were followed up on post operative day 1,7,30 and 60.

Table 1. Pterygium Grade Distribution

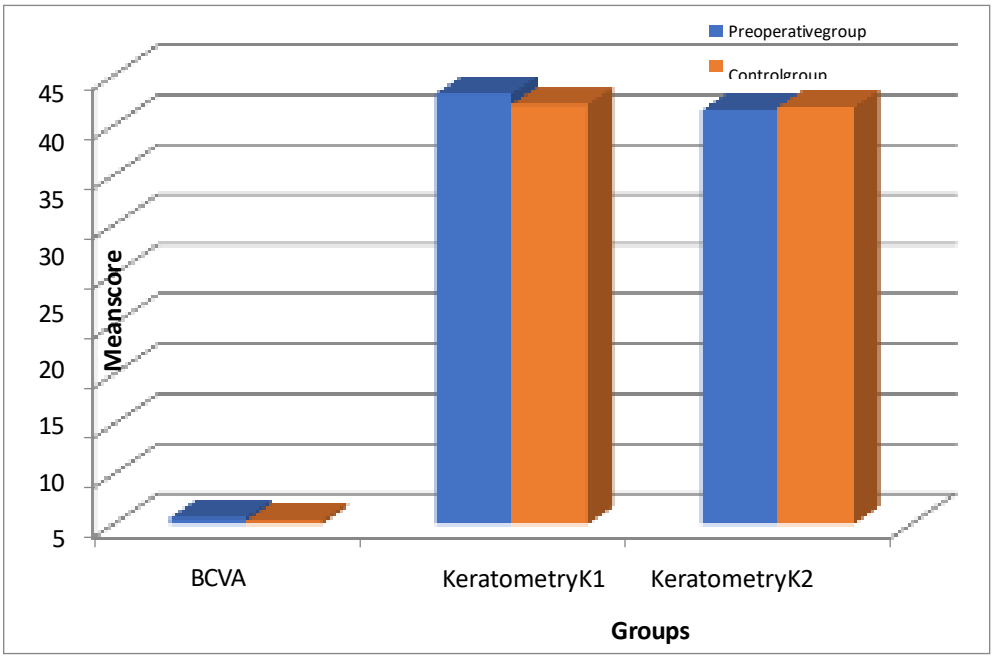
Pterygium Grade	Case	Control	Total
	Count (%)	Count (%)	Count (%)
Grade I	6 (13.64%)	0 (0.00%)	6 (6.82%)
Grade II	25 (56.82%)	0 (0.00%)	25 (28.41%)
Grade III	13 (29.55%)	0 (0.00%)	13 (14.77%)
N/A	0 (0.00%)	44 (100.00%)	44 (50.00%)
Total	44 (100.00%)	44 (100.00%)	88 (100.00%)



Graph 1- Pterygium Grade Distribution

Table 2:Comparison of the Case group (Preoperative) with the Control group for the following variables

Variables	Mean (Preoperative)	Mean (Control)	t-test	*P*-value	Significance
BCVA	0.65	0.35	3.45	0.001	**
Keratometry K1	43.2	42.1	2.10	0.040	*
Keratometry K2	41.5	41.8	-0.80	0.430	NS

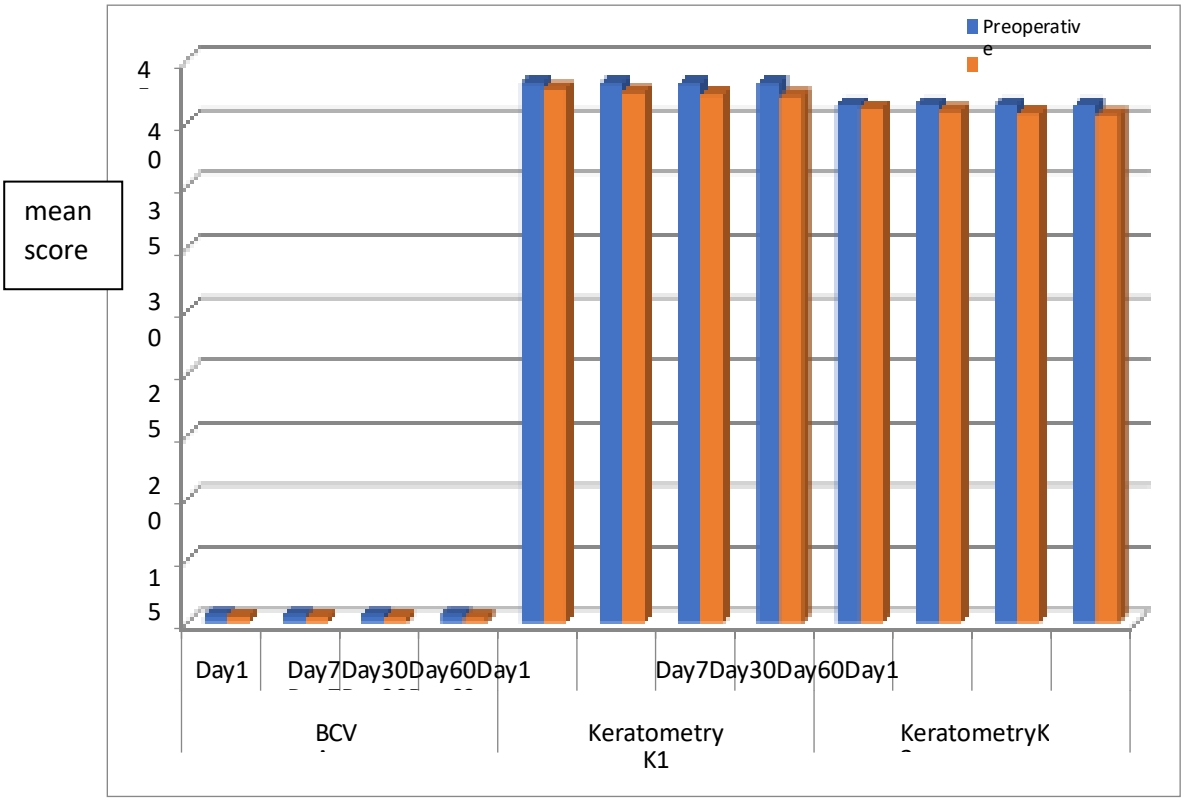


graph 2 :Comparison of the Case group (Preoperative) with the Control group

The above table-2 revealed asignificant difference in BCVAbetween thePreoperative and Control groups (p = 0.001), indicating that thePreoperative group had worse visual acuity. Similarly, Keratometry K1 values were significantly higher in the Preoperative group compared to the Control group (p = 0.040), suggesting alterations in corneal curvature. However, Keratometry K2 values showed no significant difference between the two groups (p = 0.430), indicating that this parameter remained relatively stable regardless of surgical status.

Table 3:To compare the postoperative measurements (Day 1, Day 7, Day 30, Day 60) with the preoperative measurements for the following variables:

Variables	Time Point	Mean (Preoperative)	Mean (Postoperative)	t-test	*P*-value	Significance
BCVA	Day 1	0.65	0.50	2.80	0.008	**
BCVA	Day 7	0.65	0.45	3.20	0.003	**
BCVA	Day 30	0.65	0.40	4.10	<0.001	***
BCVA	Day 60	0.65	0.38	4.50	<0.001	***
Keratometry K1	Day 1	43.2	42.8	1.50	0.140	NS
Keratometry K1	Day 7	43.2	42.5	2.00	0.050	*
Keratometry K1	Day 30	43.2	42.3	2.80	0.008	**
Keratometry K1	Day 60	43.2	42.2	3.10	0.004	**
Keratometry K2	Day 1	41.5	41.2	1.20	0.240	NS
Keratometry K2	Day 7	41.5	41.0	1.80	0.080	NS
Keratometry K2	Day 30	41.5	40.8	2.50	0.020	*
Keratometry K2	Day 60	41.5	40.7	2.90	0.006	**

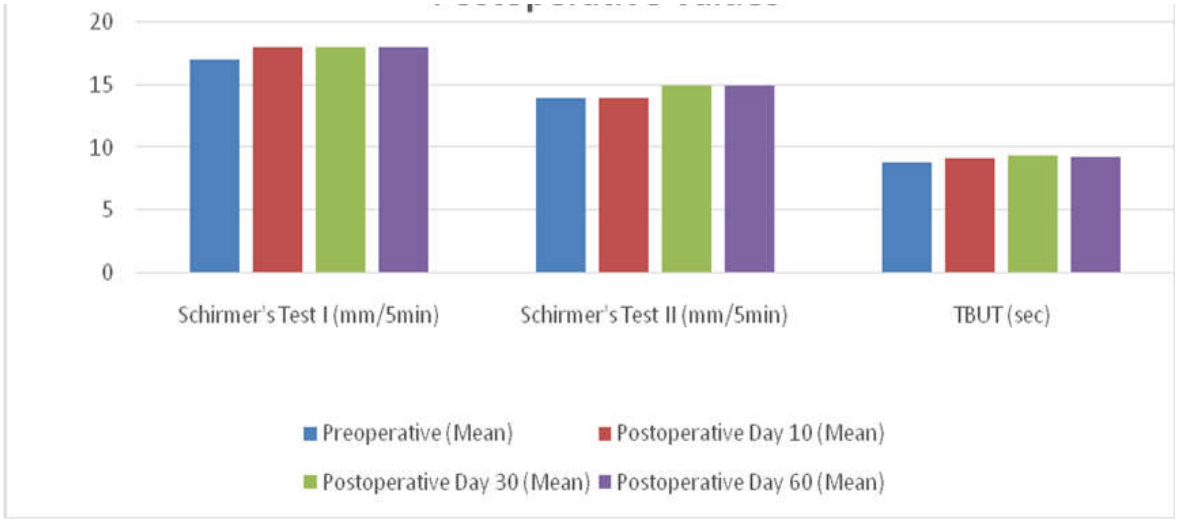


Graph 3: compare the postoperative measurements (Day 1, Day 7, Day 30, Day 60) with the preoperative measurements .

The above table-3 shows thata significant improvement in BCVA following surgery, with progressive enhancement over time. BCVA showed highly significant improvements from Day 1 ($p = 0.008$) to Day 60 ($p < 0.001$), confirming a steady recovery in visual acuity. Keratometry K1 exhibited a significant reduction by Day 7 ($p = 0.050$), with more pronounced changes by Day 60 ($p = 0.004$), suggesting a gradual flattening of the corneal curvature. Keratometry K2 showed no significant changes initially but became significant by Day 30 ($p = 0.020$) and Day 60 ($p = 0.006$), indicating delayed but notable corneal modifications. Overall, these findings suggest that surgical intervention leads to substantial visual acuity improvement and gradual corneal reshaping, particularly in the long term.

Table 4-Comparative Analysis of Preoperative and Postoperative Values

Variable	Preoperative (Mean ± SD)	Postoperative Day 10 (Mean ± SD)	Postoperative Day 30 (Mean ± SD)	Postoperative Day 60 (Mean ± SD)	Pvalue
Schirmer's Test I (mm/5min)	17 ± 3	18 ± 3	18 ± 3	18 ± 3	<0.001
Schirmer's Test II (mm/5min)	14 ± 3	14 ± 3	15 ± 4	15 ± 3	0.001
TBUT (sec)	8.8 ± 1.1	9.2 ± 1.0	9.4 ± 0.9	9.3 ± 1.0	0.013



Graph 4- Comparative Analysis of Preoperative and Postoperative Values

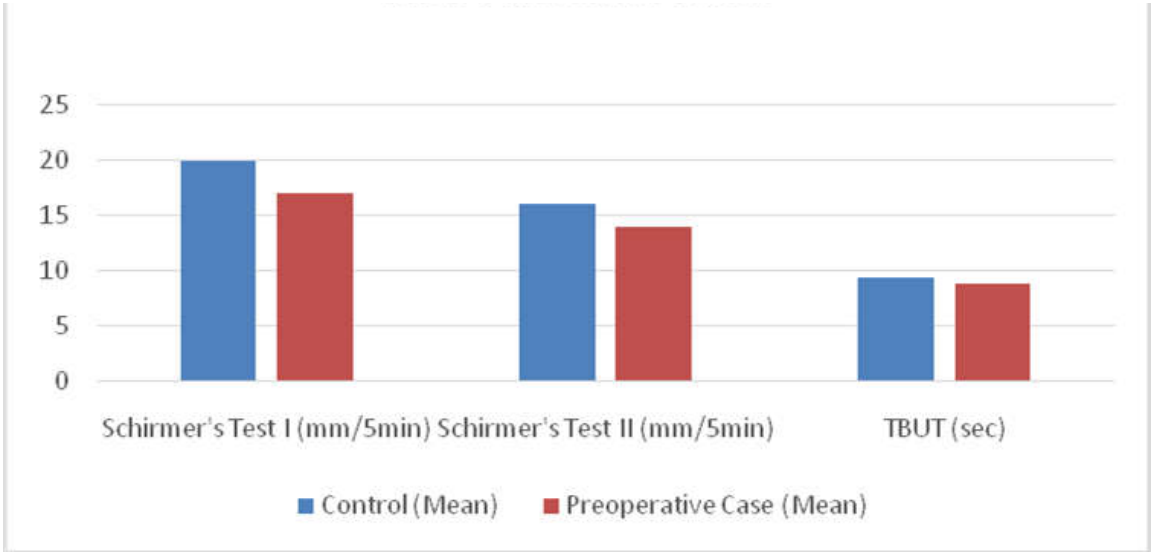
Schirmer's Test I values increased from a preoperative mean of 17 ± 3 mm/5min to 18± 3 mm/5min at postoperative day 10, 30, and 60. The p-value of <o.oo1 indicates astatistically significant increase in schirmer's test I values over time .

Schirmer's Test II values increased from a preoperative mean of 14 ± 3 mm/5min to14 ± 3 mm/5min at day 10, 15 ± 4 mm/5min at day 30, and 15 ± 3 mm/5min at day60. The p-value of <o.oo1 indicates a statistically significant increase in schirmer'stest II values over time .

TBUT increased from a preoperative mean of 8.8 ± 1.1 sec to 9.2 ± 1.0 sec at day 10,9.4 ± 0.9 sec at day 30, and 9.3 ± 1.0 sec at day 60. The p-value of <o.oo13 indicates a statistically significant increase in TBUT values over time.

Table 5-Control Group Analysis of Tear Film Function Tests

Variable	**Control (Mean ± SD)**	**Preoperative Case (Mean ± SD)**	**p-value**
Schirmer's Test I (mm/5min)	20 ± 3	17 ± 3	<0.001
Schirmer's Test II (mm/5min)	16 ± 2	14 ± 3	0.001
TBUT (sec)	9.4 ± 0.9	8.8 ± 1.1	0.013



Graph-5 Control Group Analysis of Tear Film Function Tests

Schirmer's Test I: The mean Schirmer's Test I value was 20 ± 3 mm/5min in thecontrol group and 17 ± 3 mm/5min in the preoperative case group. The p-value of<0.001 indicates a statistically significant difference between the two groups.

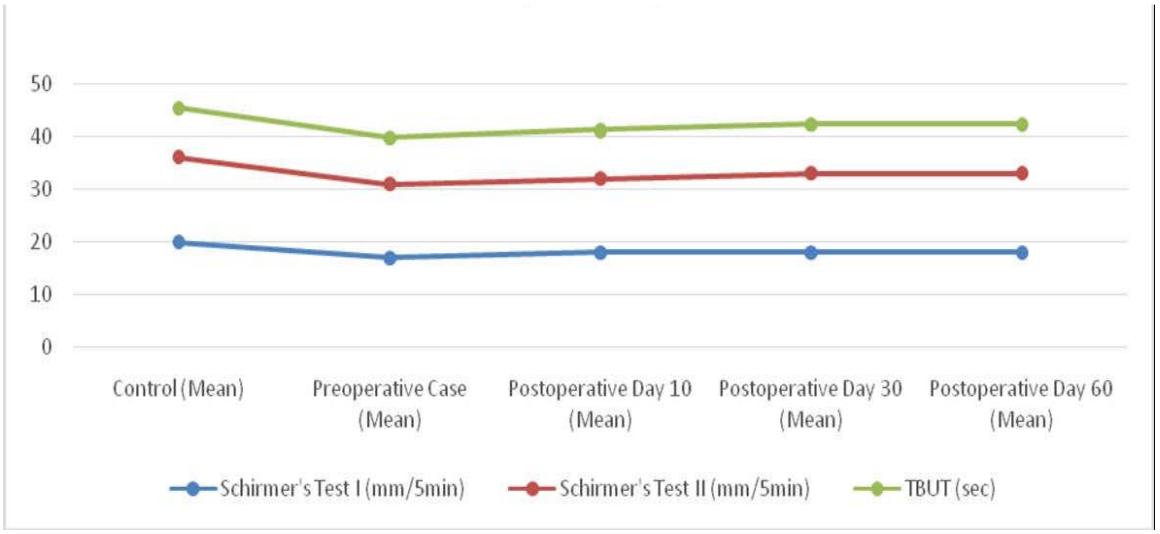
Schirmer's Test II: The mean Schirmer's Test II value was 16 ± 2 mm/5min in thecontrol group and 14 ± 3 mm/5min in the preoperative case group. The p-value of0.001 suggests a statistically significant difference between the two groups.

TBUT: The mean TBUT was 9.4 ± 0.9 seconds in the control group and 8.8 ± 1.1

seconds in the preoperative case group. The p-value of 0.013 indicates a statistically significant difference between the two groups.

Table 6-Comparison of Tear Film Function Tests Between Control and CaseGroups (Preoperative and Postoperative)

Variable	Control (Mean ± SD)	Preoperative Case (Mean ± SD)	Postoperative Day 10 (Mean ± SD)	Postoperative Day 30 (Mean ± SD)	Postoperative Day 60 (Mean ± SD)	pvalue (Control vs Preop)	pvalue (Control vs Postop Day 7)	pvalue (Control vs Postop Day 30)	pvalue (Control vs Postop Day 60)
Schirmer's Test I (mm/5 min)	20 ± 3	17 ± 3	18 ± 3	18 ± 3	18 ± 3	<0.001	0.026	0.042	0.053
Schirmer's Test II (mm/5 min)	16 ± 2	14 ± 3	14 ± 3	15 ± 4	15 ± 3	0.001	0.011	0.034	0.041
TBUT (sec)	9.4 ± 0.9	8.8 ± 1.1	9.2 ± 1.0	9.4 ± 0.9	9.3±1.0	0.013	0.564	0.841	0.693



Graph 6 : Comparison of Tear Film Function Tests Between Control and Case Groups (Preoperative and Postoperative)

The comparison of tear film function tests between the control group and the casegroup at different time points (preoperative and postoperative on Days 10, 30, and 60)reveals several significant findings.

Schirmer's Test I result indicated a significant reduction in tear production in thepreoperative case group compared to the control group ($p < 0.001$). Postoperativevalues improved, with significant differences at Days 10 and 30 ($p = 0.026$ and $p = 0.042$, respectively). By Day 60, the difference was no longer significant ($p = 0.053$),indicating recovery of tear production over time.

Schirmer's Test II also showed significantly lower values in the preoperative casegroup ($p = 0.001$). Postoperative improvements were noted, with significantdifferences compared to the control group at all postoperative time points ($p = 0.011$,$p = 0.034$, and $p = 0.041$ for Days 10, 30, and 60, respectively).

The Tear Break-Up Time (TBUT) test revealed significantly lower values in thepreoperative case group compared to the control group ($p = 0.013$), indicating poorertear film stability before surgery. Postoperative TBUT values improved, showing nosignificant differences compared to the control group at any postoperative time point($p = 0.564$, $p = 0.841$, and $p = 0.693$ for Days 10, 30, and 60, respectively), suggestingrestored tear film stability after surgery.

This study compared tear film function tests between eyes with primary pterygium(case eyes) and eyes without pterygium (control eyes) in the same patients before and after pterygium excision with conjunctival sutureless glue-free autograft usingautologous serum. The mean age of the participants was 50.8 ± 7.6 years, with aslightly higher proportion of males (56.82%). The majority of the pterygium caseswere Grade II (56.82%) and located nasally (65.9%). The mean preoperativepterygium size was 3.12 ± 1.03 mm. Schirmer's Test I, Schirmer's Test II, and TBUTvalues were significantly lower in the preoperative case eyes compared to the controleyes. After pterygium excision, all three parameters improved significantly in the caseeyes, with Schirmer's Test I and II values approaching those of the control eyes bypostoperative day 60. These findings suggest that primary pterygium excision withconjunctival sutureless glue-free autograft using autologous serum can improve tearfilm function in affected eyes, potentially reaching levels similar to those inunaffected eyes within 60 days post-surgery.

DISCUSSION

Pterygium is a common disease of the ocular surface characterized by the invasion of fibrovascular tissue from the bulbar conjunctiva onto the cornea.The indications for pterygium surgery are (a) pterygium either invading of threatening the visual axis; (b) visual impairment due to astigmatism; (c) irritative symptoms and inflammation; (d) restricted movements and (e) cosmesis.

Pterygium can have various effects in the eye including changes in corneal curvature,tear film instability,changes in visual acuity,refractive errors and dry eye symptoms.

In a study conducted by Oldenburg JB, Garbus J, McDonnell JM, McDonnell PJ,it is reported that Pterygia induce irregular corneal astigmatism that sometimes necessitates surgical removal before the lesion has advanced close to the visual axis. This astigmatism may occur either due to traction generated by the pterygium mechanically pulling on and distorting the cornea, or by the pooling of tears in advance of the pterygium, or both[14].

Fen Ye et al in their study on evaluation of meibomian gland and tear film changes in patients with pterygium observed that meibomian glands' alterations in pterygium patients may have aggravated the tear stability and ocular surface damage, possibly because of the changes in the lipid layer of the tear film, which may have resulted from a greater extent of meibomian glands dropout and lid margin changes. This study revealed new evidence regarding the pathologic changes of meibomian gland (MG) in pterygium[15].

The effect of pterygium excision on pterygium induced astigmatism was studied by sejalMaheshwari.This study says that pterygium induced astigmatism can lead to visual complaints.The astigmatism appears to be due to an alteration in the tear film caused due to the lesion.This study verifies that as the size of the pterygium increases, the amount of induced astigmatism increases in direct proportions. Successful pterygium surgery reduces the pterygium-induced refractive astigmatism and improves visual acuity[16].

In a study conducted by Dr Ambika S Patil and Dr Sanjeev M Patil on Dry Eye in Pterygium and Post Pterygium Surgery,it was concluded that pterygium causes unstable tear film causing dry eye. Tear film abnormality improves after pterygium excision surgery with Auto conjunctival graft or with 0.02% Mitomycin-C for 2minutes. Both the methods were safe.Further TBUT was more reliable test than schirmer’s test in assessing the correlation between dry eye in pterygium and post pterygium excision surgery[17].

In our study , we evaluated the changes in corneal curvature and tear film stability following pterygium surgery and assessed their impact on visual acuity and refractive outcomes. It showed significant difference in BCVA between cases in preoperative period and control groups indicating that the cases had worse visual acuity preoperatively than controls. Similarly, the majority of the cases had with the rule astigmatism preoperatively with higher K1 values compared to the

control group suggesting the role of pterygium in altering the corneal curvature. However, K2 values showed no significant difference between the 2 groups in the preoperative period. Our study also showed statistically significant difference in schirmers test and TBUT between cases and controls in the preoperative period, which is suggestive of poor tear film stability.

The with the rule astigmatism reduced significantly after pterygium excision, as K1 values decreased postoperatively compared to preoperative values. Tear film stability reached a level similar to the unaffected eye within 60 days after surgical excision of pterygium with conjunctival autograft. All these factors had a cumulative effect on BCVA which has led to an improvement in BCVA postoperatively compared to preperative values.

CONCLUSION

Our study showed that pterygium causes significant corneal astigmatic changes, majority of which was with the rule . It also caused instability in tear film which was proven by schirmers and TBUT tests. Both these factors have contributed in significant reduction of BCVA, which was proven by improvement in BCVA postoperatively along with improvement in tear film stability and with the rule astigmatism.

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