Original Article

Evaluation of change in pterygium induced keratometric astigmatism in patients following pterygium excision with autologous graft surgery

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Abstract

Introduction: Pterygium is a common surface disorder of the eye that may cause change in visual acuity of patients by inducing astigmatic refractive error. Surgical excision with grafting is considered the most effective recommended treatment for pterygium. The objective of this study was to evaluate the outcomes of pterygium excision with autologous graft surgery on keratometric astigmatism and visual acuity.
Materials and methods: In this study total 64 eyes of 64 patients were enrolled having the diagnosis of pterygium. Prior to the pterygium excision surgery all the enrolled patients were studied for grading of pterygium, clinical symptoms, keratometric values and best corrected visual acuity (BCVA). Postoperatively, BCVA and keratometric readings were recorded at one week, one month, two months and four months intervals.
Results: Mean age of study participants was 34.16 ± 8.24 years in the age group of 18-60 years. 42 (65.62%) eyes had grade II pterygium, while 16 (25.0 %) and 6 (9.38%) eyes were having grade III and grade IV pterygium, respectively. Preoperative median and quartiles (25% -75%) horizontal and vertical keratometric values were 43.00 (42.50-44.00) D and 44.25 (43.75-44.50) D, respectively and both reduced significantly to 42.50 (42.50-42.94) D and 42.50 (42.50- 43.00) D, respectively after four months postoperatively. Median keratometric astigmatism before surgery was 1.37 (1.25-1.93) D which reduced significantly to 0.50 (0.32-0.75) D after four months of pterygium excision. Similarly, BCVA improved significantly [0.20(0.16-0.25) vs 0.53 (0.50-0.80)] when assessed postoperatively after four months.
Conclusion: Excision of pterygium with autologous graft reduced pterygium-induced keratometric astigmatism and improved BCVA significantly.

Key words: Pterygium, Astigmatism, Keratometry, BCVA, Cornea

Introduction

Pterygium is a triangular wing shaped superficial ocular surface disorder characterized by fibroelastic degeneration of the conjunctiva and subconjunctival tissue, wherein overgrowth of bulbar conjunctiva encroaches on the cornea and may disturb topography of cornea (Popat et al, 2014). Prevalence of pterygium in India ranges from 8.4% - 42% depending on the

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geography of the region, age and gender of the individual as it is more commonly seen in a younger population having more outdoor activities (Nangia et al, 2013; Maharjan et al, 2014; Vasantha, 2019).

Several previous studies have stated that the pterygium induced changes of corneal curvature are significant astigmatism and visual disturbances (Khan et al, 2014; Shelke et al, 2014). Studies indicate that in the majority of pterygium patients, localized flattening of the corneal curvature usually occurs at horizontal meridian, which results in with- the- rule astigmatism (Radadia, 2014; Vadodaria et al, 2019). However, other studies suggested that in some cases against-the-rule or oblique astigmatism can also be induced by the pterygium (Chourasia et al, 2014; Popat et al, 2014). Alteration in the curvature of cornea in pterygium is mainly supposed to occur due to pooling of tear film over the edge of the fibrovascular growth as well as tractional force applied on the cornea due to pterygium, leading to pulling of the cornea (Altan-Yaycioglu et al, 2013; Meitei et al, 2016; Mohite et al, 2017). Furthermore, patients with pterygium may also present with blurring of vision, foreign body and burning sensation in the eyes, redness in eyes, lacrimation, glare sensitivity, monocular diplopia and cosmetic splotch (Mohammad-Salih & Sharif, 2008; Makkar et al, 2015). Astigmatism developed due to pterygium as well as invasion of the visual axis and restriction of medial rectus muscle due to pterygium, might affect the visual acuity significantly and cause blurring of vision (Maheshwari 2003; Mohite et al, 2017). Grading of pterygium also affects the amount of corneal astigmatism. It has been shown in many previous studies that the higher grades of pterygium correspondingly increase the amount of corneal astigmatism (Bhargava et al, 2015; Deepankar & Jain, 2016).

Although early grades of pterygium can be managed by conservative treatment however, the surgical excision is considered the only effective approach for the treatment of pterygium (Makkar et al, 2015; Zheleva & Voynov, 2018). Various indications for surgical excision of pterygium include diplopia due to restriction of ocular motility, impingement of overgrowth onto the visual axis, prior to laser eye surgery and cosmetic reasons (Chourasia et al, 2014; Shelke et al, 2014).

Various surgical excision techniques can be used to reduce pterygium - induced corneal astigmatism and to improve the visual acuity of patients (Altan-Yaycioglu et al, 2013; Chourasia et al, 2014; Garg et al, 2019). Several studies done in the past concluded that effect of surgical excisions techniques on pterygium - induced corneal astigmatism can be measured by various methods including refraction, keratometry and corneal topography (Popat et al, 2014; Devika et al, 2015; Manhas et al, 2018). However, some studies proposed that keratometry is not a very useful tool to evaluate the corneal surface changes in pterygium because flattening of peripheral cornea is more than central cornea; hence the keratometry which measures only the central cornea can give rise to imprecise results. (Maheshwari, 2007; Radadia, 2014; Parajuli & Bajracharya, 2019)

Excision of pterygium with autologous conjunctival graft is considered the gold standard and most preferable choice of treatment for the management of pterygium (Gahlot et al, 2015; Parajuli & Bajracharya 2019). Results of these studies indicate that surgical excision of pterygium with conventional conjunctival autograft technique is associated with significant decrease in corneal astigmatism postoperatively; however, a study done by Cano-Parra et al, 2002 reported that after excision of pterygium no significant difference was found between pre and post-operative astigmatism values. Another study done by Makkar et al, 2015 showed that astigmatism increased following pterygium excision with conventional conjunctival graft procedure.

Most of the previous studies have reported that corneal astigmatism after pterygium excision reduced significantly all grades of pterygium (Chourasia et al, 2014; Deepankar & Jain, 2015; Garg et al, 2019). However, in terms of visual acuity previous studies show contradictory results in different grades of pterygium following surgical excision (Malik et al, 2012; Bhargava et al, 2015; Gahlot et al, 2015).

Considering these facts our study was conducted to evaluate the outcomes of pterygium surgery with autologous conjunctival grafting on visual acuity, corneal astigmatism and changes in corneal meridia by analyzing the pre and post-operative keratometric values and BCVA.

Materials and methods

This hospital based interventional prospective study was accomplished at the tertiary care teaching hospital of Western Uttar Pradesh in the department of ophthalmology. Using a simple random sampling method we enrolled a total of 64 patients (64 eyes) attending the Ophthalmology OPD with the diagnosis of pterygium fulfilling the inclusion criteria.

Sample size for this study was calculated using the formula $(Z_\alpha + Z_\beta)^2 pq/d^2$, with the following assumptions: prevalence of pterygium was assumed to be 40% (p=0.4), desired precision of 12% of true value (d=0.12), a confidence interval of 95% (Z_α = 1.96) and a power of 50% (Z_β =0.00). The total number of participants thus required for this study was 64.

Depending on the extent of pterygium over the cornea pterygium was divided into Grade I: crossing limbus, Grade II: halfway between limbus and pupil, Grade III: approaching the pupil edge and Grade IV: central pupillary portion.

Only those patients who were willing to give written informed consent for surgical excision of pterygium were recruited for study. Patients having no astigmatic error or less than 1 dioptre error with pterygium, patients unfit for pterygium excision due to other ocular or systemic conditions and were not fit for keratometry because of severe corneal pathologies were not included in the study. A well structured case record form was used to collect the required information from each patient. Source of data was the OPD record of the individual patient. Ethical clearance to conduct study was obtained from the Institutional Ethical Committee.

Methodology: Pre-operative best corrected visual acuity (BCVA) of the affected eye of all the enrolled patients was recorded as decimal values by using modified Early Treatment Diabetic Retinopathy Study (ETDRS) chart (6/6 equals 1.0 and 6/60 equals 0.1). Slit lamp examination was carried out to record the type and grade of pterygium. Subsequently, the keratometric readings of horizontal (K1) and vertical (K2) meridia for the same eyes were recorded in all patients using Bausch and Lomb keratometer.

Under aseptic precautions using local anesthesia all the pterygium excision surgeries with autologous conjunctival grafting were performed. About 3-4 mm conjunctival incision was made above the pterygium head and dissection of subconjunctival tissue was done to separate the tissue. Pterygium head was avulsed by blunt dissection and traction technique. To clear the tissue about 1-2 mm corneal epithelium was scrapped using a Bard Parker blade. Body of pterygium was excised using scissors and the bare scleral area was covered using thin conjunctival free flap taken from the superior-temporal region of the same eye. Eye dressing was done after subconjunctival injection of gentamicin and dexamethasone.

Post operative regimen: Next day dressing was removed and an eye drop of antibiotic with steroid combination and oral antibiotics along with anti-inflammatory drugs were prescribed

for one week duration. Topical drops were gradually tapered over a period of one month.

Post-operatively during the follow up visits BCVA and keratometric readings of the operated eye were documented after one week, one month, two months and four months durations.

Statistical analysis

Statistical analysis was done using descriptive statistics. Values are expressed as actual numbers, percentage and median and quartiles (25% -75%). Wilcoxon signed rank test and Kruskal-Wallis test followed by Dunn's multiple comparisons test were used to analyze data before and after surgical excision of pterygium. P value <0.05 was considered as significant.

Results

In this study total 64 eyes of 64 patients with diagnosis of pterygium were included. Out of total 64 patients, 40 (62.50%) were male and 24 (37.50 %) were female. Mean ±SD age of all patients was 34.16±8.24 years. The overall age group of patients was 18-60 years where maximum numbers of patients were in the age group of 26-35 years. 22 (34.40%) patients belonged to urban areas while 42 (65.60%) were from rural areas**.** (Table 1)

58 (90.62%) patients were having pterygium in only one eye while the remaining 6 (9.38 %) were having in both eyes. Majority of patients [56 (87.50%)] were having pterygium on the nasal side of the limbus while 8 (12.50 %) patients had on the temporal side.

Table 1: Baseline and Demographic characteristics of patients

Characteristic	**Number (%)**
GENDER	
Male	40 (62.50)
Female	24 (37.50)
Total	**64**
Age Range	18-60 years
Age (Mean ±SD)	34.16±8.24
AGE DISTRIBUTION (years)	
18-25	6 (9.37)
26-35	34 (53.12)
36-45	18 (28.12)
46-55	4 (6.25)
56-60	2 (3.12)
Patients distribution	
Urban	22 (34.40)
Rural	42 (65.60)

Grade II pterygium [42 (65.62%)] patients were maximum in number followed by Grade III [16 (25.0%)] and Grade IV [6 (9.38%)]. 14 (21.88%) patients had non-progressive type while 50 (78.12%) had progressive type pterygium. (Table 2)

Table 2: Distribution of patients according to characteristics of pterygium

Variables	**Number (%)**
Position of pterygium	
Unilateral	58 (90.62)
Bilateral	6 (9.38)
Pterygium location	
Nasal	56 (87.50)
Temporal	8 (12.50)
Grade of pterygium	
I	0
II	42 (65.62)
III	16 (25.0)
IV	6 (9.38)
Type of pterygium	
Non-progressive	14 (21.88)
Progressive	50 (78.12)

Patients presented with various complaints including redness in eyes in 56 (87.50%), foreign body sensation in 42 (65.62%), cosmetic splotch in 38 (59.37%), Diminution of vision in 32 (50.0%), Itching of eyes in 26 (40.62%) and Hyperphoria in 24 (37.50%) patients. (Table 3)

Table 3: Distribution of patients according to symptoms

Clinical symptoms	Number (%)
Redness in eyes	56 (87.50)
Foreign body sensation	42 (65.62)
Cosmetic splotch	38 (59.37)
Diminution of vision	32 (50.0)
Itching of eyes	26 (40.62)
Hyperphoria	24 (37.50)

Table 4 shows keratometric reading before surgical excision and one week, one month, two month and four months post pterygium surgery. Median (25^{th}–75^{th} percentile) K1 (horizontal) and K2 (vertical) readings before surgical excision were 43.00 (42.50-44.00) D and 44.25 (43.75-44.50) D, respectively. Postoperatively, mean K1 subsequently changed to 43.25(42.25-43.75) 43.10±0.89 at one week, 42.50 (42.25-43.50) at one month, 43.00(42.00-43.25) at two months and 42.50 (42.50-42.94) at four months. Similarly, K2 reading after surgical excision decreased progressively in follow up period (44.00(43.25-44.25) at one week; 44.00(43.00-44.00) ($p<0.05$) at one month; 43.38 (43.00-44.00) ($p<0.001$) at two months and 42.50 (42.50-43.00) ($p<0.001$) at four months. The difference in horizontal keratometric (K1) before and after surgical procedure at 4 months was 1.00 (0.50-1.18) while difference in vertical keratometric (K2) before and after surgical procedure at 4 months was 1.50 (1.25-2.25) ($p<0.001$)

Pre and post- operative BCVA [median and quartiles (25% -75%)] in grade II pterygium cases were 0.20 (0.16-0.32) and 0.80 (0.52-1.00) decimals, respectively. In patients of grade III median pre and post-operative BCVA values were 0.20 (0.16-0.25) and 0.50 (0.34-0.52) while in grade IV pterygium values were 0.11 (0.10-0.13) and 0.32 (0.20-0.40), respectively. (Table 5)

Values of preoperative and postoperative keratometric astigmatism in cases who presented with different grades of pterygium are tabulated in Table 6. Pre and post operative keratometric astigmatism values at 4 month were 1.25(0.75-2.06) D and 0.50 (0.25-0.56) D, respectively in patients having grade II pterygium. However, in patients having grade III (16 cases) and grade IV (6 cases) the preoperative keratometric astigmatism values were 1.75 (1.56-1.75) and 2.75 (1.50-3.00) D, respectively while postoperative keratometric astigmatism values were 0.75 (0.50-0.75) and 0.87(0.00-1.75) D, respectively.

Preoperative median and quartiles (25% -75%) difference in keratometric astigmatism (K1-K2) was 1.37 (1.25-1.93) D whereas, postoperative keratometric astigmatism was 0.50 (0.32-0.75) D. Median and quartiles (25% -75%) BCVA in all subjects was 0.20 (0.16-0.25) (preoperatively) and 0.53 (0.50-0.80) decimal (post-operatively at 4 months). (Table 7)

Table 4: Outcomes of pterygium surgery on keratometric values (D) following pterygium excision with autograft

	Preoperative keratometric value (D)	Post operative keratometric value (D)			
		1 week	1 month	2 months	4 months
K1 (horizontal)	43.00 (42.50-44.00)	43.25(42.25-43.75)	42.50 (42.25-43.50) *	43.00(42.00-43.25)$^{\$}$	42.50 (42.50-42.94)$^{\$}$
K2 (vertical)	44.25 (43.75-44.50)	44.00(43.25-44.25)	44.00(43.00-44.00) *	43.38(43.00-44.00)$^{\$}$	42.50 (42.50-43.00)$^{\$}$

Values are represented as median and quartiles (25% -75%). D= dioptres; Kruskal-Wallis test followed by Dunn's multiple comparisons test. *$p<0.05$, $^{\$}p<0.001$ when compared with preoperative keratometric value.

Table 5: Preoperative and postoperative (4 months) visual acuity according to grading of pterygium

Pterygium grade	Number of patients	Preoperative BCVA (decimals)	Postoperative (4 months) BCVA (decimals)	p-value
II	42	0.20 (0.16-0.32)	0.80 (0.52-1.00)	<0.0001
III	16	0.20 (0.16-0.25)	0.50 (0.34-0.52)	<0.0001
IV	6	0.11 (0.10-0.13)	0.32 (0.20-0.40)	0.031

Values are represented as median and quartiles (25% -75%).; BCVA = Best Corrected Visual Acuity

Table 6: Preoperative and postoperative (4 months) astigmatism according to grading of pterygium

Pterygium Grade	Number of patients	Preoperative keratometric astigmatism (D)	Postoperative (4 months) keratometric astigmatism (D)	p-value
II	42	1.25(0.75-2.06)	0.50 (0.25-0.56)	<0.0001
III	16	1.75 (1.56-1.75)	0.75 (0.50-0.75)	<0.0001
IV	6	2.75 (1.50-3.00)	0.87(0.00-1.75)	0.0625

Values are represented as median and quartiles (25% -75%). D= dioptres

Table 7: Keratometric astigmatism (K1 – K2) and BCVA before and after pterygium excision

Parameter	Keratometric astigmatism (D)	Mean BCVA (decimal)
Before excision (Preoperative)	1.37 (1.25-1.93)	0.20 (0.16-0.25)
After 4 months of excision (Postoperative)	0.50 (0.32-0.75)	0.53 (0.50-0.80)
P value	p<0.0001	p<0.0001

Values are represented as median and quartiles (25% -75%) D= dioptres, BCVA = Best Corrected Visual Acuity;

Discussion

Invasion of cornea due to encroachment of connective tissue overgrowth in pterygium is often associated with change in the topography of cornea leading to visual disturbances as well as cosmetic splotch. The exact cause of change in topography of cornea due to pterygium is not clearly recognised however, different theories suggest that alteration in tear film and pulling of cornea due to pterygium tissue lead to distortion of cornea (Makkar et al, 2015; Meitei et al, 2016). As the pterygium encroaches towards the cornea, formation of tear meniscus takes place between apex of the cornea and pterygium tissue that cause apparent flattening of corneal meridian (Yousuf, 2005; Vadodaria et al, 2019). Thus, pterygium can induce astigmatism by involving the corneal meridia which in turn will lead to refractive changes. Alteration in refractive status of cornea due to pterygium can be calculated using keratometric values, corneal topographical analysis and refractive status (Popat et al, 2014; Devika et al, 2015; Garg et al, 2019).

In the present study total 64 eyes of 64 patients including 40 male and 24 females were involved, having the majority of male patients. Similarly predominance of male subjects was

present in previous studies (Shelke et al, 2014; Garg et al, 2019).

Mean age of patients in this study was 34.16 ± 8.24 years and maximum number of patients i.e. 34 (53.12 %) were in the age group of 26-35 years. It means that pterygium is more common in younger age groups. Similar observations were reported by Sadhu et al, 2015; Deepankar & Jain, 2016; Mohite et al, 2017.

Considering the pterygium grades, in our study 42 patients (65.62%) had grade II while rest 16 patients (25.0%) and 6 patients (9.37%) had grade III and grade IV pterygium, respectively. Previous studies done by Chourasia et al, 2014, Shelke et al,2014; Mohite et al, 2017 also reported that the majority of patients had grade II and III pterygium in their study.

Surgery is the main treatment of pterygium to decrease astigmatism as well as to improve visual acuity of patients. Various types of surgical procedures done for the treatment of pterygium-induced astigmatism are simple pterygium excision with bare sclera, pterygium excision , using either conjunctival autograft or amniotic membrane graft. Many previous studies showed that corneal astigmatism due to pterygium significantly decreased following surgical excision (Radadia, 2014; Mohite et al, 2017; Garg et al, 2019).

Results of present study showed that median keratometric astigmatism in grade II and grade III pterygium patients before surgical excision was 1.25(0.75-2.06) D and 1.75 (1.56-1.75) D, respectively which reduced significantly ($p < 0.0001$) to 0.50 (0.25-0.56) D and 0.75 (0.50-0.75) D, respectively after 4 months period. However, in grade IV pterygium patients reduction in keratometric astigmatism was found non-significant after pterygium excision. These results indicate that quantum of astigmatism varied with the grades of pterygium i.e. with increase in grade, the value of astigmatism increases proportionately. These results were similar to the studies done by Maheshwari, 2007; Gahlot et al, 2016; Mohite et al, 2017; Manhas et al, 2018; Parajuli & Bajracharya, 2019. Moreover, after surgical excision reduction of astigmatism in grade II and grade III patients was more significant as compared to grade IV pterygium patients. This shows that chances of reversal of corneal curvatures after excision of pterygium are more with early grades of pterygium. These observations were similar to the studies performed by Yousuf, 2005; Saleem et al, 2011; Shelke et al, 2014; Garg et al, 2019.

BCVA in all grades of pterygium significantly improved following surgical excision at four months which are in correlation with previous studies (Mohite et al, 2017; Shastry et al, 2019). However, some studies reported improvement in BCVA only in 50-60% cases (Bhargava et al, 2015; Gahlot et al, 2015) or no improvement (Malik et al, 2012).

In our study the preoperative keratometric values in horizontal (K1) and vertical meridian (K2) were 43.00 (42.50-44.00) D and 44.25 (43.75-44.50) D, respectively indicating that the vertical meridian is comparatively steeper. Similar findings were observed by Vadodaria et al, 2019 in their study. Postoperatively at 4 months the pre and post-operative difference in mean K1 and K2 values were 1.00 (0.50-1.18) D and 1.50 (1.25-2.25) D respectively; the change of corneal curvature occurs more significantly in vertical meridian (K2). Median astigmatism before excision of pterygium was 1.37 (1.25-1.93) which reduced significantly ($p<0.001$) to 0.50 (0.32-0.75) D at 4 months after excision. This shows that excision of pterygium caused a significant flattening of vertical meridian along with reduction in values of keratometric astigmatism postoperatively. Similar observations have been reported in by Yousuf, 2005; Maheshwari, 2007; Sipai & Shukla, 2016. In contrast, another study found significant flattening in horizontal meridian

(Chourasia et al, 2014).

Thus, observations of this study prove that surgical excision of pterygium using autologous conjunctival graft is an effective technique to treat pterygium induced keratometric astigmatism and hence the improvement in the visual acuity.

However, there are some limitations in our study including tools used for measurement of corneal astigmatism. Corneal topography or computerized videokeratography are considered most effective tools to measure corneal surface changes and we have used keratometry for the same purpose. In addition, various other surgical techniques used to correct the corneal astigmatism produced by the pterygium were not included in present study. Also, the study duration, sample size and power used to calculate sample size was relatively less to observe the effect of pterygium excision on corneal surface changes and visual acuity.

Conclusion

The results of study shows that timely excision of pterygium with conjunctival autologous graft especially in early grades leads to a significant reduction in pterygium induced astigmatism with significant flattening of vertical corneal meridian and improvement in visual acuity. The follow up period was limited which indicates that the changes occurred in corneal astigmatism may or may not sustain for a longer duration.

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