IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 22, Issue 6 Ser.12 (June. 2023), PP 53-58
www.iosrjournals.org

Study Of ChangesIn Corneal Astigmatism FollowingPterygium Excision By Different Techniques.

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Abstract
Introduction: *Pterygium Is A Wing-Shaped, Degenerative, Fibrovascular Growth Of Subconjunctival Tissue Onto The Cornea. It Affects Vision Due To Induced Astigmatism Or Due To Direct Invasion Of The Visual Axis. Surgical Intervention of Pterygium Leads To Reduction In Astigmatism Which Leads To Significant Improvement In Vision.*
Aim: *To Study Change In Corneal Astigmatism Following The Different Pterygium Surgical Techniques And The Uncorrected Visual Acuity Post Operatively.*
Methods And Material: *Total 60 Patients Who Had Primary Pterygium Attending Outpatient Department Of Ophthalmology And Who Underwent Pterygium Surgery During The Period Of August 2019 To July 2020. All Patients Were Examined for Uncorrected Visual Acuity (UCVA) And Best Corrected Visual Acuity (BCVA), Keratometry on Autorefractor Meter Preoperatively and Postoperatively. Corneal Astigmatism Was Derived From The Keratometry Values.*
Results: *Preoperatively Mean Astigmatism Was Found To Be 4.6±1.8 D Which Subsequently Decreased To 0.6±0.3 D. On 6th Week Postoperatively, 4±1.7 D Of Change Was Found In Astigmatism, Which Was Statistically Significant (P Value< 0.0001). Uncorrected V/A Of 6/6 To 6/12 On Snellen`S Chart Was Present In 21.6% Of Patients Preoperatively While 88.3% Of Patients Had 6/6 To 6/12 Visual Acuity Postoperatively.*
Conclusion: *Pterygium Induced Significant Corneal Astigmatism Which Increased With The Increasing Extent Of The Pterygium Resulting In Decreased Visual Acuity Preoperatively. Following Surgical Excision Of The Pterygium, There Was A Significant Reduction In The Pterygium-Induced Corneal Astigmatism In All The Groups, Which Also Resulted In Improvement Of Uncorrected Visual Acuity.*
Key Words: *Astigmatism, Pterygium, Amniotic Membrane Graft, Conjunctival Autograft*

Date of Submission: 17-06-2023 Date of Acceptance: 27-06-2023

I. INTRODUCTION

Pterygium is derived from the Greek word 'Pterygos' meaning wing. It is a wing-shaped, degenerative, fibrovascular, hyperplastic proliferative growth of subconjunctival tissue onto the cornea. [1] It is located in the interpalpebral area, most frequently in its nasal part. Ultraviolet radiation has been suggested as a major environmental factor in pterygium formation. [2] It affects vision due to induced astigmatism or due to direct invasion of the pupillary plane and visual axis. It causes flattening of the cornea in the horizontal meridian and consequently results in with-the-rule corneal astigmatism.

The growth of a pterygium onto the cornea can lead to significant changes in corneal astigmatism which can be either 'with-the-rule'(WTR) or 'against-the-rule'(ATR). [3] The reasons for astigmatism are the pooling of the tear film, the mechanical traction exerted on cornea and the size of pterygium, especially the double-headed pterygium. This has been measured by keratometry, corneal topography, and refraction. [4,5]

Pterygium is treated mainly by surgery. The gold standard for treatment is conjunctival autografting following pterygium excision, giving low rate of recurrences and complications. Early surgical intervention can reduce effects of corneal morbidity due to pterygium induced corneal distortion and visual disturbance arising from the encroachment of the pterygium onto the visual axis. Early or late surgical intervention for excision of pterygium surgery leads to reduction in astigmatism which leads to significant improvement in vision. [6,7]

II. MATERIAL AND METHODS

Study population and sample size

This prospective study was conducted after getting ethical clearance and obtaining permission from the ethical committee among known cases of the pterygium attending out patient department of the Ophthalmology. A total 60 patients of pterygium were selected over a period of the 1 year from August 2019 to July 2020.

Inclusion criteria

- Patients of either sex greater than18 years of age.
- Patients with pterygium extending at least 2mm over the cornea.

Exclusion criteria

- Patients with pterygium extending <2mm over the cornea (Type 1 pterygium).
- Patients with recurrent pterygium
- Patients with scarred superior and inferior conjunctiva
- Patients with previous history of the ocular surgery (cataract surgery, antiglaucoma surgery, keratoplasty)

A written informed consent was obtained from all the patients.

Study Protocol

After obtaining ocular and systemic history, ocular examination was done including Visual acuity recording on Snellen's chart, refraction, slit lamp examination and keratometry.

Based on extent of the pterygium patients were divided into three types;
Type 1: Pterygium extending less than 2 mm onto cornea.
Type 2: Pterygium extending 2mm to 4mm into the cornea.
Type 3: Pterygium extending more than 4mm into the cornea and involving visual axis.[8]

Study group:
Group 1: Pterygium excision with Conjunctival Autograft with suture technique (CAG)
Group 2: Pterygium excision with Conjunctival Autograft, suture free glue free technique (SFGF-CAG)
Group 3: Pterygium excision with Amniotic Membrane Graft technique (AMG)

Surgical Method

All the surgeries were performed under local anaesthesia (peribulbar block). After standard sterile preparation and draping, eye speculum was used to expose the eye. Pterygium`s head and pathological fibrovascular tissue was dissected from the cornea, limbus and sclera with either 15 no. Bard Parker knife or crescent knife or by peeling.

- In group 1 (CAG), after excision of the pterygium, size of bare sclera was measured with the help of the calliper, the conjunctival autograft was taken from the supero-temporal area or inferior conjunctiva. The size of the graft was slightly larger than the size of the exposed sclera bed and graft was placed on the scleral bed with correct orientation and anchored to the limbus and peripherally to the surrounding conjunctiva by 10-0 ethilon suture.
- In group 2 (SFGF-CAG), the scleral bed was scratched with Bard Parker knife to cause oozing. The conjunctival autograft was taken as above and conjunctival autograft was applied to the scleral bed (esp. limbus), spread and pressure was applied with swab stick for the 5 minutes.
- In group 3 (AMG), wet amniotic membrane was cut to the proper size to cover the bare area with basement membrane facing up and the stroma facing down. It was sutured to the surrounding conjunctiva and episclera using interrupted 10-0 ethilon sutures.

Pre-operative and post-operative assessment

All the patients were examined for uncorrected visual acuity (UCVA) and best corrected visual acuity (BCVA), refraction and keratometry on autorefractometer, slit lamp examination pre and post-operatively. Corneal astigmatism was derived from the values obtained through keratometry.

Statistical Analysis

The keratometry reading was recorded during the last follow-up at 6 weeks and compared to the pre-operative value. The data was entered in MS office excel sheet and analysed using epi info software version 7.2. The mean value of reading recorded were compared using ANOVA test and t-test.

III. RESULTS

This hospital based prospective interventional study of total 60 patients was carried out over a period of 12 months (August 2019 to July 2020). Following results were analyzed from the study:

Gender distribution showed that 42(70%) patients in this study were males and 18 (30%) were females.

Age distribution showed that the highest incidence of pterygium was found in the age group of 41-60 years (65%) and among them 35% were in the 51-60 years of age group, least was found in the age group of 25-40 years (15%).

66.7% patients in present study were operated for right eye and 33.3% were operated for left eye.

Morphologically depending on the size of pterygium maximum patients in this study had type- 3 pterygium (65.0%), followed by type -2 pterygium (35%).

Table no 1: Pre-operative and post-operative comparison of the visual acuity (N= Total number of patients=60)

Visual Acuity	**Pre-operative VA**		**Post-operative VA**	
	N	%	N	%
6/6	0	0.0%	18	30.0%
6/9	5	8.3%	20	33.3%
6/12	8	13.3%	15	25.0%
6/18	8	13.3%	5	8.3%
6/24	11	18.3%	1	1.7%
6/36	13	21.7%	1	1.7%
≤6/60	15	25.0%	0	0.0%
Total	**60**	**100%**	**60**	**100%**

(P<0.0001)

Post-operatively in majority of the patients had improved vision. Only 3.33% of patients had vision poor or equal to the 6/24.

None of our patients had 6/6 vision preoperatively but it was seen in 30% patients post operatively. Pre-operatively 6/9, 6/12, 6/18, 6/24, 6/36 vision was found in 8.3%, 13.3%, 13.3%, 18.3%, 21.7% patients, while post-operatively it was seen in 33.3%, 25%, 8.3%, 1.7%, 1.7% of patients. Pre-operatively a vision of ≤6/60 was found in 25% of patients while none of the patients had a vision of ≤6/60 post operatively.

Table no 2: Postoperative improvement in uncorrected visual acuity in lines (N=60)

Post-operative UCVA improved in lines	**N**	**%**
0	2	3.30%
1	7	11.70%
2	18	30.00%
3	11	18.30%
4	15	25.00%
5	5	8.30%
6	2	3.30%
Total	60	100%

In our study maximum number (30%) of patients had a visual acuity improvement by 2 lines while visual acuity was improved by 1 line in 11.7% of patients and 3 lines were improved in 18.3% of patients. In 25% ,8.3%, 3.3% of patient visual acuity improved by 4 lines, 5 lines and 6 lines respectively. While only 3.3% of patients showed no improvement in lines postoperatively.

Table no 3: Comparison of the mean reduction in astigmatism among different surgical techniques

Type of surgery	Pre-operative Astigmatism	Post-operative Astigmatism	Reduction in Astigmatism
	Mean	**Mean**	**Mean**
Conjunctival auto graft with suture (CAG)	4.8±1.7	0.5±0.2	4.3±1.6
Suture free, glue free Conjunctival auto graft (SFGF-CAG)	3±1.3	0.5±0.2	2.6±1.2
Amniotic membrane graft (AMG)	5.9±1.1	0.7±0.3	5.2±1.0
Overall	**4.6±1.8**	**0.6±0.3**	**4±1.7**

*P value <0.0001

Overall mean astigmatism was 4.6 D pre-operatively while post-operatively it was 0.6 D. After pterygium excision, an overall improvement in astigmatism of 4 D was seen.

Postoperative astigmatism after 6 weeks, decreased significantly in all the three groups. Preoperative mean corneal astigmatism 4.8±1.7 D, 3±1.3 D and 5.9±1.1 D of the groups of CAG, SFGF-CAG and AMG reduced 6weeks postoperatively to 0.5±0.2 D, 0.5±0.2 D and 0.7±0.3 D (P value <0.0001) respectively, maximum reduction in astigmatism was seen in AMG (5.2 D) than in CAG (4.3 D) and in SFGF-CAG (2.6 D) post operatively.

Table no 4: Pre-operative and post-operative comparison of the astigmatism as per the extent of the pterygium (N=60)

Extent of pterygium	No. of patients	Pre-op. Astigmatism	Post-op. Astigmatism	Reduction in Astigmatism
	N	Mean(±SD)	Mean(±SD)	Mean(±SD)
2 to 4 mm	21	3.1±1.4	0.4±0.2	2.7±1.3
> 4 mm	39	5.4±1.5	0.6±0.3	4.8±1.4
Overall	**60**	**4.6±1.8**	**0.6±0.3**	**4.0±1.7**

*P value <0.0001

Preoperatively mean astigmatism was higher among patients with >4 mm extent of pterygium into the cornea (5.4 D) than 2 to 4 mm of the extent into the cornea (3.1 D). Similarly post operatively mean astigmatism was higher among patients with >4 mm extent of pterygium into the cornea (0.6 D) than 2 to 4 mm of the extent into the cornea (0.4 D). More reduction of astigmatism was observed in group of patients with > 4 mm extent of pterygium into the cornea as compared to group with 2 to 4 mm extent of pterygium into the cornea. The difference in astigmatism as per the different size of the pterygium was statistically significant. (P value <0.0001)

IV. Discussion

Pterygium causes refractive changes by inducing astigmatism or by involving visual axis which leads to visual impairment.[4] Our study was designed to study the changes in corneal astigmatism after pterygium excision surgery as well as to compare the changes in astigmatism and improvement in uncorrected visual acuity that are a result of using different surgical techniques.

Several studies have proved that pterygium excision surgery significantly reduces pterygium-induced astigmatism. In the study by **Maheshwari et al**[5], there was a significant reduction in mean topographic astigmatism from 4.4 D to 1.6 D (*P* value < 0.001) following pterygium surgery. A similar study was carried out by **Altan-Yaycioglu et al**[9]they found significant correlation between pre and postoperative astigmatic value from 3.4 D to 1.2 D (*P* < 0.0001) The mean difference was 2.2 D (*P* < 0.0001*)*. Similarly **Zheleva et el**[10] found that corneal astigmatism decreased from 1.3 D to 0.8 D three months after the intervention (*p* < 0.0001). These results were comparable to our study as we also found significant reduction in mean corneal astigmatism after pterygium surgery

In our study we found a significant correlation between preoperative and postoperative astigmatic value (P<0.0001). Mean astigmatism preoperatively was found to be 4.6 D which subsequently decreased to 0.6 D. Postoperatively after 6th week, changes in astigmatism showed 4 D changes, which was statistically significant, and this could be attributed to the fact that the regularity and symmetry of corneal surface improved after pterygium surgery, thus reducing the astigmatism.

Excision of pterygium leads to statistically significant reduction in astigmatism, which improves vision significantly. Study conducted by **Popat et al**[11] showed that pre operatively, 16% , 73%, 11% patients had BCVA between 3/60-5/60, 6/60-6/24, 6/18- 6/6; whereas post operatively, no patient had BCVA between 3/60-5/60, only 3% patients had poor vision BCVA between 6/60-6/24 and 97% patients had BCVA between 6/18-6/6.Similar study conducted by **Sharma et al** [12] they concluded that 83.8%, 11.3% eyes had BCVA of 6/6 to 6/12 , 6/18 to 6/36 on Snellen's drum, whereas 5% eyes had advanced pterygium with BCVA of ≤6/60, while postoperatively 88.8% had BCVA of 6/6 to 6/12, 7.5% had 6/18 to 6/36 and 3.7% had BCVA ≤6/60, respectively.

In our study also, we found that improvement in visual acuity in pterygium patients was secondary to the astigmatism reduction. Post-operatively in the majority of the patients, vision was improved. Preoperatively 65%, 26.6%, 8.3% patients had UCVA ≤6/60- 6/24, 6/18-6/12, 6/9, and none of the patients had UCVA 6/6; whereas postoperatively only 3.33% patients had vision poor or equal to 6/24, 33.3%, 33.3%, 30% patients had UCVA 6/18-6/12, 6/9, 6/6, which fairly correlates with the above studies.

In the study carried out by Maheshwari et al [5], VA remains same in 58.33% patients and 41.67% patients showed 1 & 2 lines of improvement in vision. In our study also, we have found that UCVA remained

same in 3.30% patients, while 60% patients showed 1-3 lines of improvement in UCVA, and 36.6% patients showed 4-6 lines of improvement in UCVA on Snellen`s chart. This improvement in vision was due to a reduction in astigmatism following pterygium surgery.

Our study also compared the changes in corneal astigmatism after different techniques for pterygium surgery, that is, Pterygium excision with conjunctival autograft with suture (CAG) (group 1), Pterygium excision with suture free, glue free conjunctival autograft (SFGF-CAG) (group 2) and Pterygium excision with amniotic membrane graft (AMG) (group 3). All the three techniques were found to significantly change astigmatism. After 6week postoperative changes in astigmatism of the conjunctival autograft with suture (CAG), the conjunctival autograft suture free glue free (SFGF-CAG), and the amniotic membrane graft techniques (AMG) were 4.3±1.6 D, 2.6±1.2 D, 5.2±1.0 D respectively. In our study, we found changes in astigmatism were higher with amniotic membrane graft technique than the conjunctival autograft techniques, we found that pre operatively amniotic membrane group patients showed more extent of pterygium (>4mm) over the cornea and higher astigmatism as compared to other two groups of conjunctival autograft, preoperative large size of pterygium might be the reason of higher astigmatism changes in amniotic membrane graft group in comparison to the conjunctival autograft group.

Altan-Yayciohlu et al.[9]compared the astigmatic changes in 5 different types of surgeries including conjunctival autograft with sutures (CAG-s) or fibrin glue (CAG-g), conjunctival rotational flap (CRF), or amniotic membrane transplantation with either suture (AMT-s) or with glue (AMT-g). In this study they found that changes in astigmatism were significantly related to the preoperative size of pterygium and was not related to the type of grafting or the use of suture or glue.

Similarly, in the study by **Gangadhar, *et al***. [13] pterygium induced astigmatism was compared using conjunctival autograft and amniotic membrane graft. [13] They concluded that early excision of pterygium reduced astigmatism and avoid development of visual impairment and that the type of grafting does not have a significant effect on change in astigmatism. 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.

However, amniotic membrane grafting technique is recommended in the patients requiring large graft size, in double headed pterygium and where superior conjunctiva is to be salvaged as in those patients' requiring cataract or glaucoma filtration surgery in future.

Extent of pterygium over the cornea 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.

Study conducted by**Popat et al**[11] concluded that as the size of pterygium encroaching on cornea increases, amount of induced astigmatism by it also increases in direct proportion. Plus, the postoperative decrease in astigmatism is also more in those patients with a larger pterygium. Preoperative mean astigmatism with type 1, type 2, and type 3 were 4 D, 6.1 D and 8.9 D which reduced postoperatively to 0.5 D, 1.2 D, and 1.8 D respectively. Thus, a significant reduction in corneal astigmatism 3 months after surgery was observed for all three types of pterygiums. But maximum change in astigmatism was seen in morphological type 3

Hansen et al. [14]reported that pterygium > 3.0 mm induced 1.97 D of astigmatism as against an astigmatism of 1.11 D in < 3 mm pterygium.

Similarly study by **Lin et al.** [15] reported that pterygium lesions extending to over 45% of the cornea or within 3.2 mm of the visual axis produce an increasing degree of induced astigmatism. [14]

In present study, mean astigmatism was more in higher extent of pterygium. Preoperative mean astigmatism was 3.1 D in type 2 (extent 2-4mm), and 5.4 D in type 3 (extent > 4mm). Postoperative mean astigmatism was 0.4 D in type 2, and 0.6 D in type 3. Post-operatively degree of the astigmatism reduced significantly (P <0.0001) and the postoperative reduction in astigmatism was significantly associated with the extent of the pterygium on cornea. Thus, results were comparable with results of mentioned studies.

V. Conclusion

On complete analysis of our study data, it was observed that pterygium induced significant corneal astigmatism and that this induced astigmatism increased with the increasing extent or size of the pterygium resulting in decreased visual acuity preoperatively. Following surgical excision of the pterygium, there was a significant reduction in the pterygium-induced corneal astigmatism in all the groups, which also resulted in improvement of uncorrected visual acuity.

Limitations of our study

We did not study the type of astigmatism induced by pterygium.

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