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ORIGINAL RESEARCH

Long-Term Surgical Outcome of Pterygium Excision and Conjunctival Limbal Autograft: Minimum 11 years Follow-up Study in a Country with High Ultraviolet Exposure

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Objective: To assess the long-term surgical outcome and complications in patients who underwent pterygium excision with conjunctival limbal autograft at least 11 years after surgery in a country with high ultraviolet light exposure.

Material and Methods: This was a long-term, cross-sectional, observational follow-up study of 15 patients with primary or recurrent pterygium who underwent surgery at King Abdullah University Hospital, Jordan, between June 2005 and June 2012. Data regarding the patients' satisfaction with the results, use of protective sunglasses, and daily sunlight exposure over the long-term period after surgery were collected. Recruited patients were then examined for pterygium recurrence and graft bed cosmesis. Primary outcome was the recurrence rate of pterygium. Secondary outcomes included graft bed appearance (cosmesis), patient-reported satisfaction, and long-term postoperative complications.

Results: The mean (SD) age of the patients at the follow-up was 50 (8.8) years (range: 34–66 years), and the mean (SD) follow-up duration was 13.1 (1.5) years (range: 11–16 years). There was one case of recurrence (6.7%) and one case of symblepharon at the harvested graft site. Eleven out of the 15 patients reported being completely satisfied with the outcome of the surgery (mean score of 9.7 out of 10, SD: 1.0, range: 7–10). Seven patients reported daily sunlight exposure of more than three hours, and most of them were not regular users of protective sunglasses.

Conclusion: The long-term follow-up, pterygium excision with conjunctival limbal autograft was found to be safe and effective in a country with high ultraviolet exposure.

Keywords: pterygium, conjunctival limbal autograft, recurrence, ultraviolet

Introduction

Pterygium is a limbal stem cell-related disorder characterized by a hyperplastic, centripetally directed growth of altered limbal epithelial cells accompanied by Bowman's layer dissolution, epithelial-mesenchymal transition, and an activated fibroblastic stroma with inflammation, neovascularization, and matrix remodeling, mediated through the concerted actions of cytokines, growth factors, and matrix metalloproteinases, in addition to exhibiting characteristics similar to tumors including a tendency to infiltrate healthy tissue and a high likelihood of recurrence after resection.[1] Clinically, it presents as a fleshy, wedge-shaped fibrovascular lesion that grows over the limbus from the conjunctiva onto the cornea, with a global prevalence estimated at 12%.[2]

Chronic ultraviolet (UV) light exposure has been reported as a significant risk factor in the pathogenesis of pterygium which is evident by the increased geographical prevalence in hot, dry climates and peri-equatorial regions.[3] However, high terrain reflectance such as from snow, sand, or water can substantially amplify ocular UV irradiation even at higher latitudes,[4] contributing to high pterygium prevalence in non-equatorial regions such as Greenland and Denmark.[5]

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Patients with pterygium may have no complaints, or they may have symptoms that include ocular irritation, cosmetic dissatisfaction, and blurred vision due to induced astigmatism, interference with tear film stability, or obstruction of the visual axis in advanced cases.

Medical treatment with lubricants and anti-inflammatory eye drops in addition to protection from excess UV exposure can be attempted initially in some patients with mild symptoms; however, surgery remains the standard treatment in complicated cases or when a conservative approach proves unsatisfactory.

Different surgical techniques have been implemented for pterygium excision, with recurrence remaining a major concern. Simple excision with the bare sclera technique has a recurrence rate reaching 89% while excision with the application of topical mitomycin C (MMC) (0.02%) has reported recurrence rates between 2% and 39%.[6–8] Excision with amniotic membrane transplant (AMT) has a recurrence rate between 14.5% and 27.3%.[9] Excision with conjunctival autograft has a recurrence rate ranging from 5.3% to 20%,[9–12] whereas pterygium excision with conjunctival limbal graft (CLA) has a recurrence rate of 0% to 14.3%.[13,14] In a more recent review, the mean global recurrence rates for conjunctival autograft, conjunctival limbal graft, and amniotic membrane transplant were 7.61%, 5.50%, and 9.0%, respectively.[15] The variation in recurrence rates reported among each technique and between different techniques may be attributed to differences in the effectiveness of the used technique, the surgeon's experience, as well as racial, gender, and age-related factors.

When evaluating the rate of recurrence using different techniques, it is essential to have an adequate follow-up period. Many authors consider a one-year follow-up sufficient, as most recurrences occur during this time.[16] However, if cases are monitored for a longer period, other environmental factors, such as living in hot and dry climates with high exposure to ultraviolet light, can affect recurrence rates.

Here, we report the long-term surgical outcomes and complications in a series of 15 patients who underwent pterygium excision with conjunctival limbal autograft and followed up after a minimum of 11 years (an average of 13 years) in a country with high UV exposure (Jordan).

Materials and Methods

Study Design

This was a long-term follow-up, cross-sectional, observational study of patients with primary or recurrent pterygium who underwent pterygium excision with conjunctival limbal autograft at King Abdullah University Hospital, Jordan, between June 2005 and June 2012. Inclusion criteria in the study include a period of at least 11 years after surgery, no significant ocular disease affecting the ocular surface or systemic diseases interfering with wound healing, no exposure to trauma, and no other ocular surface procedures. The primary outcome was defined as clinical recurrence, characterized by fibrovascular regrowth onto the cornea. Secondary outcomes included postoperative graft bed appearance graded on a 4-point scale, patient satisfaction assessed via a numeric score, and the presence of any long-term complications.

The study was conducted in accordance with the Declaration of Helsinki and received ethical approval from the institutional review board at the Jordan University of Science and Technology (IRB approval No. 28/140/2021). All participants signed an informed consent form to participate in the study.

Patients and Data Collection

The patients' medical records were reviewed, and data on demographic and clinical characteristics, including the indication for surgery, type of pterygium (primary vs recurrent), preoperative visual acuity (Snellen chart), location and laterality of the pterygium, intraoperative and early postoperative complications, and duration of the postoperative follow-up period, were collected.

The eligible patients were then contacted by telephone and asked to undergo ophthalmic examination and participate in the study in November 2022. Of the 23 eligible patients who underwent the surgery, six were uncontactable and two were deceased. The 15 remaining patients underwent an ophthalmic examination that included visual acuity measurement, intraocular pressure measurement, anterior segment, and funduscopic examination with a slit lamp. Recurrence of the pterygium, graft bed cosmesis, and late postoperative complications (symblepharon, conjunctival contracture, granuloma, Dellen, motility restriction, and pseudo-pterygium at donor bed indicating limbal stem cell deficiency) were also assessed.

Additionally, data regarding the patients' overall satisfaction with surgical results (on a scale of 1–10), long-term postoperative exposure to daily sunlight as well as regular use of lubricant eye drops and sunglasses were collected. All long-term ophthalmic examinations were performed by the same examiner (HMJ).

Statistical Analysis

Continuous variables are presented as mean ± standard deviation (range), and categorical variables as counts. A Student's *t*-test was used to compare mean age between patients included in the long-term follow-up and those not included, with $p < 0.05$ considered significant.

Surgical Technique and Postoperative Care

All surgeries were performed by a single surgeon (HMJ) and were performed on nasal pterygia. The surgery started with marking the edges of the pterygium body with a gentian violet marking pen, followed by injection of balanced salt solution (BSS) under the body of the pterygium to aid its separation from the underlying tissue. The body was then excised at the superior, inferior, and nasal edges using conjunctival scissors, followed by dissection and excision of residual fibrous tissue and Tenon capsule under the body of the pterygium, with caution to avoid medial rectus muscle insertion. Further excision of episcleral scar tissue was carried out, and minimal cautery was applied to secure hemostasis. The head of the pterygium was then avulsed from the underlying cornea by grasping the body of the pterygium with conjunctival forceps and applying traction toward the apex while simultaneously using a surgical wick cell spear to separate the head from the Bowman's layer. The exposed corneal surface was then smoothed by a sharp blade, taking care to not over-scrape the surface. The bare scleral bed was then measured by a caliper, and the superior bulbar conjunctiva was marked according to these exact measurements. Harvesting the limbal conjunctival autograft started with the injection of BSS between the conjunctiva and Tenon's capsule to create a space for dissecting the conjunctiva using conjunctival scissors. The graft still attached to the limbus was then flipped onto the corneal surface, and partial thickness dissection was continued using a sharp blade into a clear cornea for 0.5 mm to harvest limbal epithelium. The limbal edge of the graft was then cut with scissors while applying gentle traction to the flipped graft toward the corneal center with a wick cell spear, thus ensuring the limbal epithelium was included in the graft. The free graft was then flipped back again and rotated to cover the bare sclera with proper placement of the limbal edge opposed to the corneal limbus. The graft was sutured to the underlying sclera with interrupted 8/0 polyglactin sutures. Postoperatively, all patients received a standardized regimen consisting of a fixed combination of tobramycin 0.3% and dexamethasone 0.1% eye ointment four times daily for 2 weeks, and then tapered gradually over the next 2–4 weeks based on clinical response and the degree of postoperative inflammation and patient discomfort. Additionally, artificial tears (sodium hyaluronate 0.1%) were prescribed 4–6 times daily for at least 8 weeks. Post-surgery, follow-up appointments were set at one day, one week, one month, and three months. Any remaining polyglactin sutures were removed at 1 month, or earlier if they were irritating.

In the early postoperative period, pterygium recurrence was defined as any fibrovascular growth crossing the limbus onto the cornea. During this study, we used the classification proposed by Prabhasawat[17] to describe the final appearance of the graft bed, which also designates grade 4 as pterygium recurrence (Table 1).

Table 1 Graft Bed Appearance Grading

Grade 1	The Appearance of the Operated Site was not Different from the Normal Appearance.
Grade 2	Some fine episcleral vessels in the excised area extending up to but not beyond the limbus and without any fibrous tissue.
Grade 3	Additional fibrous tissues in the excised area that did not invade the cornea
Grade 4	Fibrovascular tissue invading the cornea

Results

The study included 15 eyes of 15 patients who underwent pterygium excision with a conjunctival limbal autograft. All patients were Jordanians of Arab ethnicity. The mean (SD) age of the patients at the time of surgery was 37.5 (8.3) years (range: 21–52 years), and 10 of the patients were male.

The pterygium was unilateral in 8 patients and primary in 11 patients. The most common indication for surgery was irritation. All pterygia were nasal. The demographic and clinical characteristics of the participants are shown in Table 2.

Table 2 Patient Demographic and Clinical Characteristics

Characteristic	Value or Number of Patients
Age, years (At time of surgery)	
Mean (SD)	37.5 (8.3)
Range	21-52
Sex	
Male	10
Female	5
Laterality	
Unilateral	8
Bilateral	7
Pterygium type	
Primary	11
Recurrent	4
Indications for surgery	
Irritation	8
Reduced visual acuity	7
Duration of early follow-up (months)	
Mean (SD)	3.4 (3.9)
Range	0.5–16
Long-term daily sunlight exposure	
< 3hours	8
> 3 hours	7
Long-term regular use of sunglasses	
Yes	3
No	12
Long-term regular use of lubricants	
Yes	2
No	13

Abbreviation: SD, standard deviation.

Early Postoperative Follow-Up

The average (SD) duration of follow-up in the early postoperative period was 3.4 (3.9) months (range: 0.5–16 months). None of the patients experienced intraoperative complications; however, postoperatively, mild graft edema in 5 eyes and conjunctival hemorrhage in 2 eyes were observed and resolved spontaneously. In 2 eyes, a gap between the graft edge and the conjunctival bed developed, and epithelization occurred spontaneously. One eye developed a stitch granuloma, which resolved after stitch removal and continuation of topical steroid eye ointment. There was one case of recurrence at 3 months post-surgery for one patient. No other recurrences were reported during the early follow-up period.

Regarding the 8 patients who were not included in the study, the mean (SD) age was 58.8 (18.8) years (range: 32–82 years) (*t*-test, p-value=0.016), and there was no recurrence in 6 of the cases after a follow-up duration ranging from 6 weeks to 1 year. The medical records of the 2 deceased patients were not available for review.

Long-Term Follow-up

The mean (SD) age of the patients at follow-up was 50.0 (8.8) years (range: 34–66 years), and the mean (SD) follow-up duration was 13.1 (1.5) years (range: 11–16 years). Most patients reported being satisfied with the outcome of the surgery, with a mean score of 9.7 out of 10 (SD=1.0, range: 7–10). Approximately half of the patients reported more than three hours of exposure to sunlight per day, and the majority did not use regular lubricant eye drops or protective sunglasses.

On examination, dry eye disease or meibomian gland dysfunction was present in seven patients, but there were no significant complications except for one case of symblepharon at the harvested graft site, which did not interfere with ocular motility.

There was one case of recurrence in an eye that was originally operated on for recurrent pterygium, with fibrovascular tissue crossing onto the cornea (grade 4). This recurrence was documented at 3 months after surgery, and the patient did not return for further follow-up. Table 3 shows the graft bed appearance grading in all 15 eyes and the level of satisfaction among the 15 patients. Figure 1 shows the appearance of the grade 1 graft bed in one of the study eyes, and Figure 2 illustrates another study eye with grade 2.

Discussion

Recurrence after surgery remains a major issue in the management of pterygium. The choice of procedure should therefore address this issue, concerning safety, cost, difficulty and duration of surgery, postoperative pain, and cosmetic appearance. Conjunctival limbal autograft is a well-established and widely accepted technique for pterygium excision due to its favorable recurrence and safety profile.[14,18]

Table 3 Graft Bed Appearance and Patient Satisfaction

Characteristic	Number of Patients
Grading of graft bed	
Grade 1	8
Grade 2	6
Grade 3	0
Grade 4	1
Patient satisfaction level	
10	11
9	1
8	2
7	1

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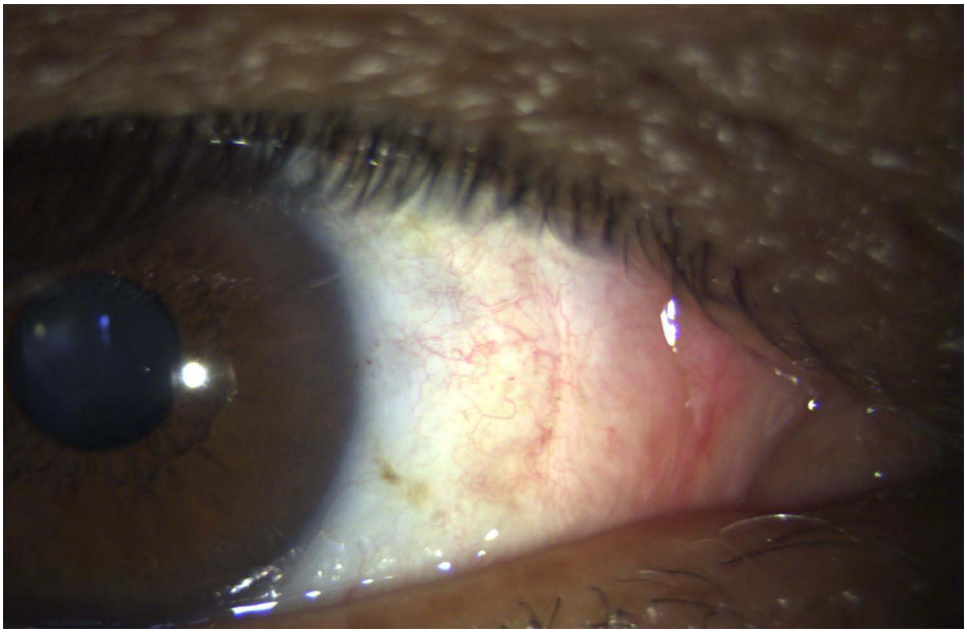

Figure 1 Color photo showing the appearance of grade 1 graft bed.

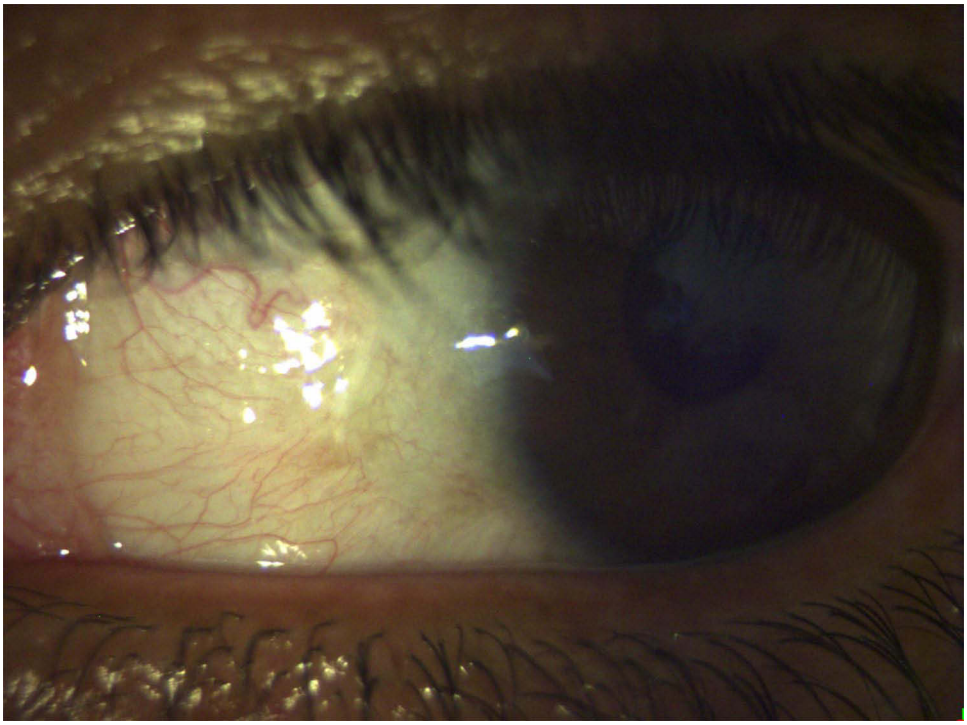

Figure 2 Color photo showing the appearance of grade 2 graft bed.

In our cohort, only one patient (6.7%) experienced recurrence after a mean follow-up of 13.1 years, underscoring the long-term efficacy of CLA in high UV exposure settings. This aligns with other long-term studies with high UV exposure settings, such as that by Atima et al in Nigeria, who reported 2 recurrences among 59 patients (3.4%) after 5 years of follow-up.[19] In the high-UV climate of Saudi Arabia, recurrence rates have been more variable; Al Fayez reported a 1% recurrence rate (1 case) among 105 patients undergoing CLA for recurrent pterygia with a 62-month follow-up,[20] while

Alshahrani et al observed recurrence rates of 15–16% with a mean follow-up of 2.5 years.[21] Notably, 37% of recurrences in the latter study occurred after the first postoperative year. More recently, in an Australian cohort, Lee et al reported on a modified limbal–conjunctival autograft in 176 eyes using a "beheading" technique of the pterygium head and inclusion of approximately 50% of Vogt's palisades.[22] Their study demonstrated a median pterygium-free follow-up interval of nearly 2 years, with a recurrence rate of 1.7% and no graft-related complications. Although differences in sample size, patient demographics, excision and grafting technique modifications, and follow-up duration limit direct comparison, both Lee et al.'s findings and ours demonstrate the durability and safety of limbal–conjunctival. With a mean follow-up of 13.1 years, the longest reported to date, our findings further demonstrate the long-term efficacy of CLA in maintaining low recurrence rates under sustained high-ultraviolet exposure.

Cosmetic outcomes in our series were similarly favorable. At final follow-up, 73% of patients achieved a Grade 1 graft bed appearance. This is consistent with previous reports, including Kam et al, who found that the use of CLA for recurrent pterygium resulted in better cosmetic outcomes compared to other surgical techniques,[23] and, Küçükerdönmez who reported only a 10% rate of poor cosmetic outcomes (grade 3) after CLA, compared to 21.1% with amniotic membrane transplantation despite both techniques showing similar recurrence rates.[24]

Patient satisfaction was also high in our cohort, with 73% of patients rating their surgical result as 10/10, and the remainder giving a score no lower than 7. This aligns with existing literature demonstrating consistently high satisfaction rates with CLA, largely due to its combined impact on visual improvement and cosmetic restoration.[25] Our data support the use of CLA as a reliable method achieving long-term low recurrence, excellent cosmesis, and high levels of satisfaction in high-UV settings.

Few studies have evaluated the long-term results (10 years or more) of CLA for pterygium. Following a randomized trial comparing MMC 0.02% and CLA after primary pterygium excision,[26] Young followed patients who underwent CLA for primary pterygium at 10 years and found 2 cases of recurrence out of 29 patients (6.9%); one recurrence had already been documented at 3 months after surgery, and 72% of cases had grade A bed appearance.[27] At a 15-year follow-up of 17 cases who underwent CLA for recurrent pterygium, Kam reported one case of recurrence out of 17 cases (5.9%), but the time of recurrence was not clear.[23] We found a near-similar rate of recurrence in the current study (6.7%), which recruited cases of both primary and recurrent pterygia. Although most recurrences reported in the above studies were within one year after surgery, it is worth noting that one case recurred at 10 years.[27]

Masters reported a recurrence of 2.14% (five cases) in 234 patients with a mean follow-up of 46.4 months.[13] Although most recurrences reported were within one year after surgery, two out of five recurrences occurred after more than four years, further emphasizing the importance of extended follow-up in accurately assessing recurrence risk.

Several factors may influence recurrence rates and limit direct comparisons between studies, including patient demographics (age, race, geography), surgical indications (primary vs recurrent), follow-up duration, definition of recurrence, and surgeon experience.[12,21]

The etiology of pterygium is closely linked to high exposure to sunlight and UV radiation. However, the direct impact of such exposure on pterygium recurrence after surgery is not yet clearly established. In a study conducted on Korean adults, serum 25-hydroxy vitamin D levels were used as an indicator for sun exposure and were positively associated with pterygium recurrence.[28] Similarly, in another study, sun exposure over a lifetime was associated with recurrence after CLA surgery, which was evidenced by a higher recurrence rate among patients who immigrated from Latin America to Spain, compared to those born in Spain.[29] It is possible that lifetime cumulative sun exposure triggers the onset of pterygium through certain pathological mechanisms and continues to influence recurrence even after surgical intervention. Further evidence for the impact of sunlight and UV radiation on the recurrence of pterygium may be seen in the higher recurrence rate seen following surgery performed in the summer, compared to those in the winter.[30]

This study has inherent limitations related to its retrospective design and small sample size, as well as some degree of loss to long-term follow-up. Several clinical and behavioral variables were based on patient self-report, introducing potential recall bias, and the retrospective nature precluded control over incomplete documentation in patient records.

In conclusion, in this study of 15 patients who underwent pterygium excision with conjunctival limbal autograft, there was one case of recurrence after long-term follow-up. Although the findings support the fact that recurrence is likely to occur early after surgery, the procedure was found to be safe and efficient in preventing long-term recurrence in a country with high sunlight and UV exposure.

Data Sharing Statement

All data generated or analyzed during this study are included in this article.

Ethics Approval and Informed Consent

The study was conducted in accordance with the Declaration of Helsinki and received ethical approval from the institutional review board at the Jordan University of Science and Technology (IRB approval No. 28/140/2021). All participants signed an informed consent form to participate in the study and consent to publish the data.

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Disclosure

The authors report no conflicts of interest in this work.

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