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Geometric Technique in Pterygium Surgery: Simplifying Conjunctival Reconstruction without Compromising Efficacy: A Prospective Study of 40 Cases

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Abstract | **Original Research Article**

Background: Pterygium is a progressive fibrovascular growth that invades the cornea. Surgical excision is the only curative treatment, but no technique reliably eliminates recurrence. We report outcomes of a graft-free modified geometric technique. ***Methods:*** Prospective study of 40 consecutive patients with primary nasal pterygium (Vaniscotte grades II–III) operated at Avicenne Military Hospital, Marrakech, between April and December 2025. No conjunctival grafting was used. Follow-up at day 1, day 15, and months 1, 3, and 6. ***Results:*** Mean age 52 years (range 30–75). Male-to-female ratio 4:1 (80% male). Mean operative time 12 minutes (approximately 40% shorter than the time required for conjunctival autografting). At 3 months: 70% of patients had minimal irritation; 65% showed a smooth conjunctival surface. Recurrence rate: 12.5% (5/40); all recurrences occurred between months 3 and 6. ***Conclusion:*** Modified geometric surgery achieved an 87.5% success rate at 6 months, comparable to conjunctival autografting, with reduced operative time and preservation of conjunctival tissue.

Keywords: pterygium; geometric surgery; recurrence; conjunctival autograft; ocular surface.

INTRODUCTION

Pterygium is a triangular fibrovascular growth originating from the bulbar conjunctiva and encroaching onto the cornea, almost always in the nasal interpalpebral zone [1]. It is common in sun-exposed populations: prevalence ranges from about 1.2% in temperate climates to nearly 20% in parts of Southeast Asia [2].

Symptoms can be disabling. Patients typically report dryness and ocular irritation, irregular astigmatism, and in advanced cases reduced visual acuity from corneal invasion or frank diplopia [4]. Medical treatment is symptomatic only. Surgery is the sole curative option, but recurrence is the dominant complication. Available techniques span a wide range: bare scleral excision (recurrence 35–80%), conjunctival autografting (the current standard, recurrence 2–39%), limboconjunctival autografting, adjuvant mitomycin C, and the P.E.R.F.E.C.T. technique of Hirst (<1% recurrence) each carrying its own trade-offs [4,8,9].

Geometric pterygium surgery takes a different approach: it combines two anti-recurrence principles progression blockade and directional change without a conjunctival graft [10]. The modified version described here, applied to 40 patients between April and December 2025, incorporates refinements to the tissue cuts and suturing to improve outcomes.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective cohort study conducted in the Ophthalmology Department of Avicenne Military Hospital, Marrakech. Forty consecutive patients underwent modified geometric pterygium surgery between April and December 2025.

Inclusion and Exclusion Criteria

We included adult patients with primary nasal pterygium (Vaniscotte grades II or III). We excluded temporal pterygia, recurrent or bilateral cases, grade I or IV lesions, and patients with contraindications to topical anaesthesia.

Anaesthetic Protocol

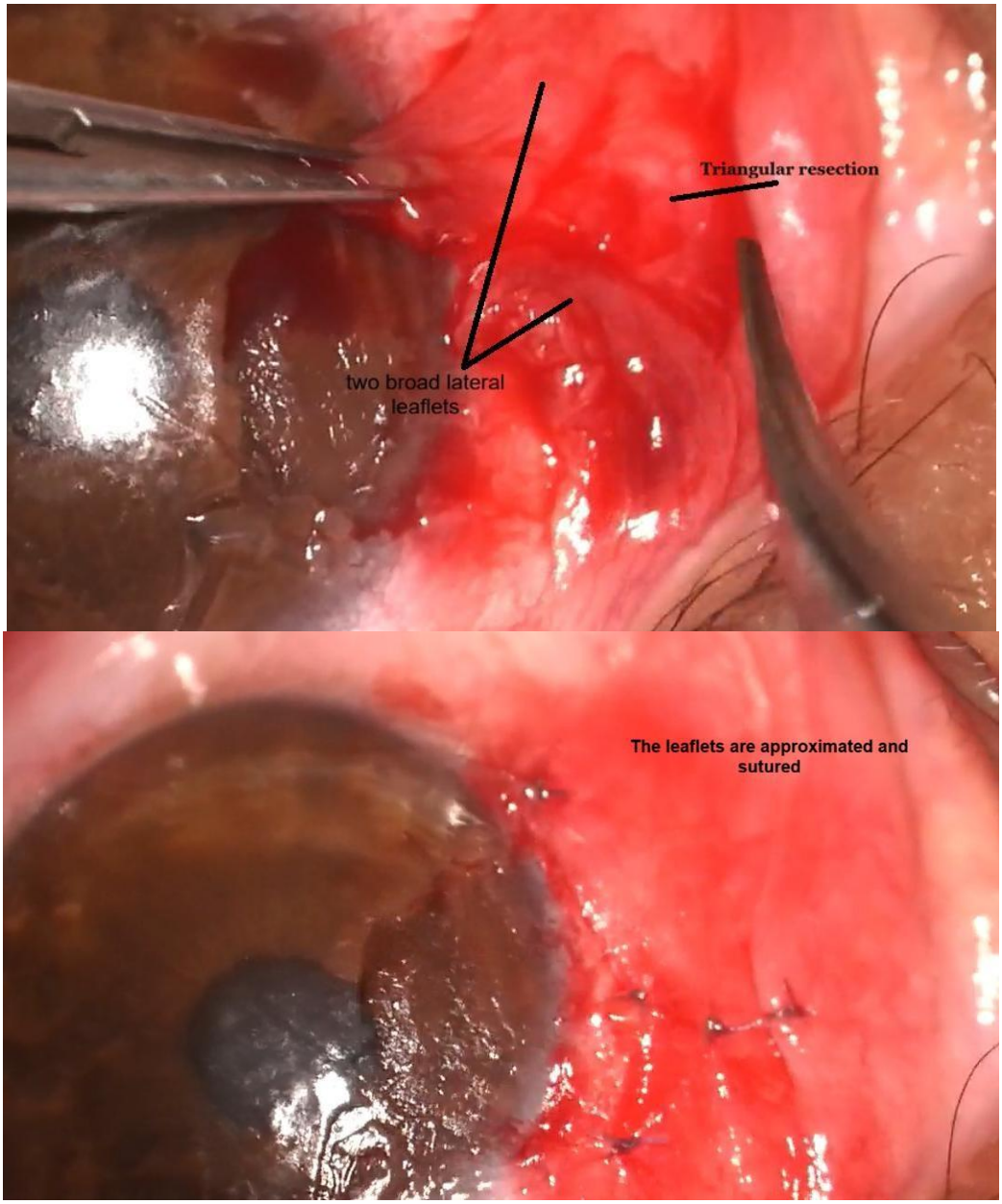
Topical anaesthesia was achieved with 2% lidocaine gel (Xylogel) applied 10 minutes before surgery, supplemented by intraoperative instillations of

0.4% oxybuprocaine. For thicker pterygia, a subconjunctival infiltration at the semilunar fold was added.

Surgical Technique

The modified geometric technique proceeds in five steps:

1. **Cleavage:** Gentle traction of the pterygium head toward the central cornea along the natural dissection plane.
2. **Horizontal section:** Longitudinal split of the head (1.5–2 mm) with curved scissors, creating superior and inferior leaflets.
3. **Triangular resection:** A triangular conjunctival segment is excised from the pterygium body with its base at the precaruncular margin, yielding two broad lateral leaflets.
4. **Relaxing incisions:** Arcuate incisions parallel to the limbus, without additional resection or suture.
5. **Suture:** The leaflets are approximated and sutured perpendicularly to the horizontal axis (Vicryl 8/0, 3–4 interrupted sutures), then fixed to the precaruncular conjunctiva. Healthy lateral conjunctiva migrates spontaneously over the bare scleral bed, forming the "blocking butterfly."



Postoperative Management and Follow-up

All patients received a tapering antibiotic–corticosteroid eye drop regimen over 8 weeks, combined with two preservative-free lubricants. Clinical assessments were performed at day 1, day 15, and months 1, 3, and 6. Outcomes evaluated were: irritative symptoms (minimal / moderate / severe), conjunctival surface appearance (smooth / slightly irregular / fleshy), and recurrence, defined as biomicroscopically confirmed fibrovascular reinvasion of the cornea.

RESULTS

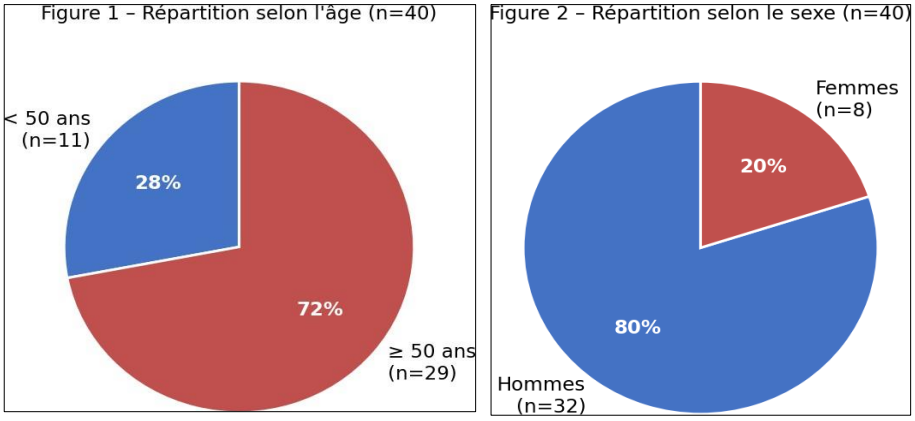
Patient Characteristics

The series comprised 40 patients with a mean age of 52 years (range 30–75). Patients over 50 accounted for 72.5% of the cohort (n = 29). There was a marked male predominance: 32 men (80%) and 8 women (20%), giving a sex ratio of 4:1. The male patients were active-duty military personnel with more than 15 years of cumulative desert exposure; the female patients were homemakers. Regarding disease severity, 75% had grade III pterygium and 25% had grade II.

Table 1: Baseline characteristics of the study population (n = 40)

Characteristic	n	%
Male sex	32	80%
Female sex	8	20%
Age < 50 years	11	27.5%
Age ≥ 50 years	29	72.5%
Grade II pterygium	10	25%
Grade III pterygium	30	75%

The age and sex distributions are illustrated in Figures 1 and 2.



Figures 1–2. Age distribution (left) and sex distribution (right).

Operative Data

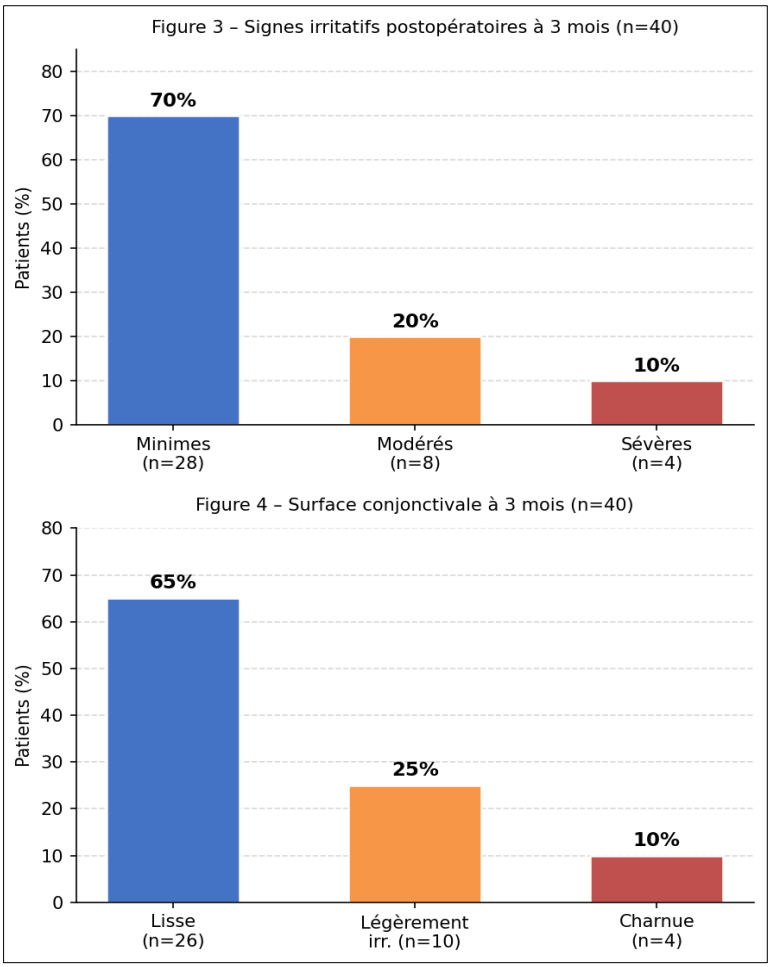
Mean operative time was 12 minutes (range 10–14 minutes), approximately 40% shorter than the time typically required for conjunctival autografting. Topical anaesthesia was adequate in all cases. Mean postoperative follow-up was 5 months (range 1–6 months); all patients completed scheduled reviews.

Postoperative Outcomes at 3 Months

Early postoperative recovery (first month) was uneventful in 78% of patients. At 3 months, 70% of patients (n = 28) had only minimal irritation, 20% (n = 8) had moderate symptoms, and 10% (n = 4) had severe symptoms (Figure 3). Conjunctival surface assessment showed a smooth surface in 65% (n = 26), slightly irregular in 25% (n = 10), and fleshy with neovascularisation in 10% (n = 4) (Figure 4).

Table 2: Irritative symptoms and conjunctival surface appearance at 3 months (n = 40)

Parameter	Category	n	%
rritative symptoms	Minimal	28	70%
	Moderate	8	20%
	Severe	4	10%
Conjunctival surface	Smooth	26	65%
	Slightly irregular	10	25%
	Fleshy / neovascular	4	10%



Figures 3–4. Irritative symptoms (left) and conjunctival surface appearance (right) at 3 months.

Recurrence Rate

Five of 40 patients (12.5%) developed recurrence, all confirmed biomicroscopically as fibrovascular reinvasion of the cornea. Every recurrence occurred between months 3 and 6, and all five affected active-duty military personnel with ongoing high UV exposure (Figure 5).

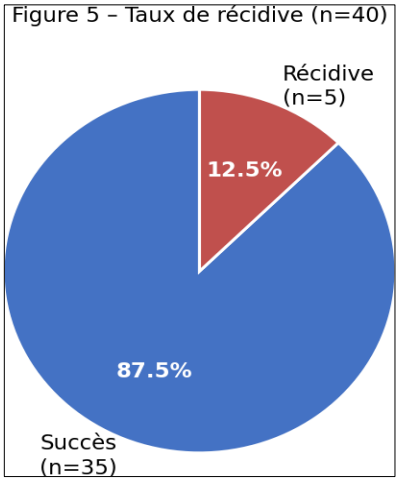


Figure 5: Timeline of recurrence cases

Analysis of recurrence mechanisms identified four contributing factors: suture dehiscence with leaflet retraction; poor wound edge apposition (step-off suturing); leaflets too thin to form an adequate barrier; and premature discontinuation of postoperative anti-inflammatory treatment.

Discussion

Pterygium is a clinically relevant problem in sun-exposed regions. The 4:1 male predominance we observed is consistent with most published series [12,13] and reflects both the predominantly male composition of the military population and the occupational UV exposure inherent in prolonged desert service.

Pathogenesis is multifactorial. UVB radiation is the dominant environmental risk factor [3]. Coroneo's model explains the preferential nasal location through limbal UV concentration from peripheral light rays, which can reach more than 20 times the intensity of direct incident radiation [2,3]. Dust, heat, wind, and dryness compound this through chronic ocular surface irritation [4].

At the histopathological level, pterygium shows subepithelial elastotic degeneration, fibroblastic and vascular proliferation, and progressive invasion of the corneal stroma with destruction of Bowman's layer [1,5]. More recent work has implicated matrix metalloproteinases particularly MMP-9 in lesion development and progression [6], along with UV-induced p53 mutations [7].

The mean age of 52 years mirrors data from Méry *et al.,*(56 years) [13] and fits the expected pattern of cumulative UV exposure over a career in the military. Taylor *et al.,* showed that UV radiation induces protein denaturation in Bowman's layer, triggering limbal neovascular proliferation [15]; Coroneo's optical amplification model adds that this effect is intensified at the nasal limbus [3].

Bare scleral excision has been widely abandoned given its recurrence rate of 35–80% [8,16]. Conjunctival autografting remains the current standard, achieving 90% success in experienced centres [14]. The P.E.R.F.E.C.T. technique of Hirst yields a 99.99% success rate, but requires 90–120 minutes of surgery and carries a heavier recovery burden [9].

Modified geometric surgery combines both anti-recurrence principles progression blockade and directional change in a single graft-free procedure [10]. The mean operative time of 12 minutes, representing roughly a 40% reduction compared with autografting, is clinically meaningful, particularly in resource-limited settings. Avoiding a graft also preserves conjunctival tissue for any future procedures the patient may need.

A 12.5% recurrence rate at a maximum follow-up of 6 months falls within the range reported for conjunctival autografting (2–39%) [14,19] and is in line with the original geometric technique (13%) [10]. The fact that all recurrences occurred in active-duty soldiers points to ongoing environmental exposure as a major driver, irrespective of surgical technique. Chen *et al.,* and manning *et al.,* have both reported that age above 50 is a protective factor against recurrence [19,20], which is consistent with the profile of our cohort.

The main limitations of this study are its single-centre, single-surgeon design, the absence of a randomised control group, and the specific occupational exposure pattern of the military population. Larger comparative studies including an autograft arm remain necessary.

Conclusion

Modified geometric pterygium surgery is a graft-free technique that combines progression blockade and directional change within a single, relatively brief procedure.

In this series of 40 patients, it achieved an 87.5% success rate at 6 months, comparable to conjunctival autografting, while cutting operative time by 40% and sparing conjunctival tissue. The technique has a short learning curve and a favourable postoperative profile. These results support evaluation in a larger prospective randomised trial.

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