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Bovine pericardium membrane (TutoPatch) for emergency repair of total corneal melting over an infected corneal graft

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ABSTRACT

Purpose: Corneal perforation due to severe melting is a very dangerous, sight-threatening condition requiring immediate management due to the high risk of endophthalmitis and critical hypotony. In the case of perforated corneal grafts, retransplantation is usually postponed to avoid the detrimental effects of inflammation on the new graft. We describe the first case of the use of a TutoPatch graft for emergency replacement of a lamellar graft perforation over acute infectious total melting.

Observations: A 42-year-old male patient presented to the Emergency Department with pain in the left eye, which was red photophobic. He had been treated with bilateral deep anterior lamellar keratoplasty (DALK) for advanced keratoconus 5 years previously and had been experiencing recurrent corneal ulcers in the left eye within the last 8 months. Clinical examination documented corneal perforation over acute infectious melting involving the total graft surface in the left eye. The infected graft was removed along with the perforated infected residual Descemet membrane, and a double-layer TutoPatch covering was sutured to the host's margin with 10.0 nylon. The covering was left in place for three weeks, allowing the patient to undergo retransplant three weeks later without complications.

Conclusions and importance: TutoPatch covering can be safely used as an easy-to-preserve emergency material for a temporary bridge to retransplantation in large acute infectious corneal melting.

1. Introduction

Corneal perforation is a sight-threatening condition requiring prompt management due to the high risk of endophthalmitis and critical hypotony, potentially resulting in retinal and choroidal detachment and progression to phthisis bulbi. Signs and symptoms typically include a sudden drop in visual acuity (VA), acute pain and eye redness.[1] Patients usually report a relevant ophthalmic history, allowing for a hypothesis on the causes of perforation. Possible causes usually include ocular trauma, complications of ocular surgery, stromal and Descemet's membrane erosion over an infectious or neurotrophic corneal ulcer, melting induced by topical or systemic medications and systemic autoimmune diseases.[2,3] A positive spontaneous or pressure Seidel test, iris prolapse and a flat anterior chamber are diagnostic signs of corneal perforation. Once the presence of a perforation is ascertained, additional complementary exams, such as anterior segment optical coherence tomography and corneal scraping for microbiological diagnosis and drug sensitivity testing, may help direct clinical management of the condition.[4,5] The size and location of the perforation as well as the extent of stromal involvement are important factors in the choice of management. While small corneal perforations may be eligible for conservative treatment with a bandage contact lens or corneal gluing, large perforations require immediate repair of the wound.[1] The unstable and altered ocular morphology and the highly inflammatory status of large perforations confer a poor prognosis for corneal transplantation performed in an emergency setting. This has led to the application of

Abbreviations: DALK, deep anterior lamellar keratoplasty.

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alternative methods for primary sealing of the perforation. Patching techniques proposed for the management of large corneal perforations in the acute phase include the use of tectonic deep anterior lamellar keratoplasty, preserved corneal tissue, autologous tissues (conjunctival apposition, lamellar corneo-scleral rotational graft, scleral autoplasty, autologous fascia lata) and biological material (amniotic membrane grafts, NeuroPatch).[6] TutoPatch (irradiated bovine pericardium; RTI Surgical, Alachua, Florida) is an inert bovine pericardium patch that has been used for repair of scleral and corneal wounds of noninfectious origin.[7,8] We describe the first case of a double-layered TutoPatch graft used for emergency replacement of an infectious perforated lamellar graft.

2. Case report

A 42-year-old male patient presented with a photophobic painful left eye to the Emergency Department of the Policlinico Universitario Agostino Gemelli at 9 p.m. He had undergone deep anterior lamellar keratoplasty (DALK) in 2017 for advanced keratoconus. The primary indication for corneal transplantation was 20/100 Snellen visual acuity (VA) in the treated eye, which could not be improved by rigid contact lens wear due to elevated corneal curvature. VA after surgery reached 20/50, and a well-preserved graft was documented until 2022. In January 2022, the patient started complaining about recurrent episodes of painful red eye. Clinical examination detected multiple recurrent corneal erosions in the context of ocular rosacea, which were treated with fluorometholone 1 drop 3 times per day and short repeated treatments with ciprofloxacin and chloramphenicol eyedrops. Upon his arrival at the emergency department, the patient exhibited an 8.0 mm corneal abscess covering almost the entire surface of the corneal graft. The anterior chamber was flat, and positive spontaneous Seidel was present. Leakage was noted at the graft margins, indicating Descemet's perforation in the context of a previous DALK surgery. Corneal biopsy and antibiogram were performed, demonstrating a Pseudomonas aeruginosa infection resistant to cefepime and ceftazidime. The patient was brought to the surgical room 3 h after presentation (see Fig. 1).

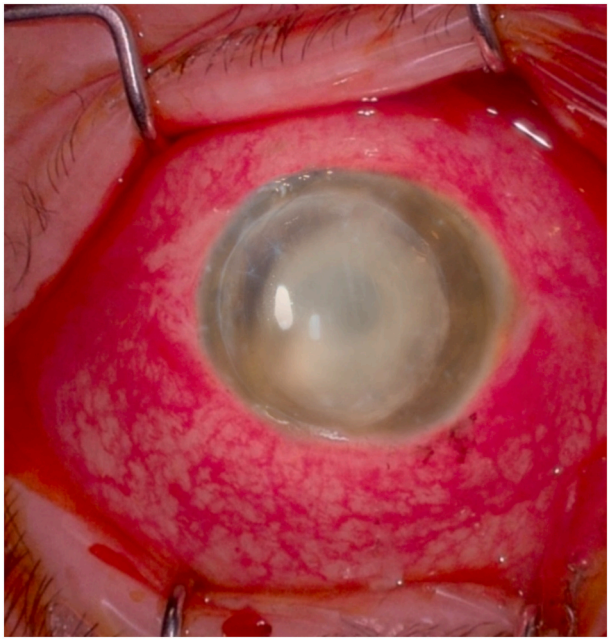

Fig. 1. Anterior segment photography of the preoperative condition shows the abscess covering almost the entire surface of the corneal graft with inferior leakage at the graft margin.

2.1. Surgical technique

The operation was performed under general anesthesia. Cohesive viscoelastic material was injected into the anterior chamber, and the infected lamellar graft (7.75 mm diameter) was completely removed along with the patient's residual Descemet membrane. Both the graft and the host's Descemet membrane were affected by the infectious process. Necrotic, possibly infected host tissue at the margin of the wound was symmetrically excised to avoid suture dehiscence and diffusion of the infection and to obtain regular borders. An inferior peripheral iridectomy was performed to avoid pupillary block. The TutoPatch tissue matrix (RTI Surgical) is a single dry layer of bovine pericardium, sized 20 mm × 30 mm, with a *smooth side* (membrane) and a *rough side* (stroma). For the double-layer patch preparation, two round 8.00 mm patches were trimmed with a Single Use Hannah 8.25 mm Punch (Moria Instruments, Nanterre, France) to fit the corneal defect. Hydration of the tissue with balanced salt solution (BSS) was then performed. A single hydrated patch of TutoPatch tissue matrix has a thickness of approximately 400 μm. The two round patches were sutured together and soaked in gentamicin sulfatic antibiotic solution for 5 minutes, keeping the stromal side in the middle. The circular 8.00 mm TutoPatch double-layer covering was then sutured using 10.0 nylon at the 4 cardinal points and sealed with 13 additional corneal separate sutures (Fig. 2). Once all the sutures were completed, the anterior chamber depth was restored using BBS and cefuroxime 0.1 mL intracameral injection. Anterior chamber depth was easily observed and evaluated from the peripheral host corneal tissue. Postoperative topical treatment included 1 drop of moxifloxacin 0.5% 4 times per day for 10 days, 1 drop of a combination of chloramphenicol 0.5% and betamethasone 0.2% 4 times per day for 10 days and 1 drop of dexamethasone 1.5 mg/mL 4 times per day. No systemic antibiotic therapy was instituted postoperatively.

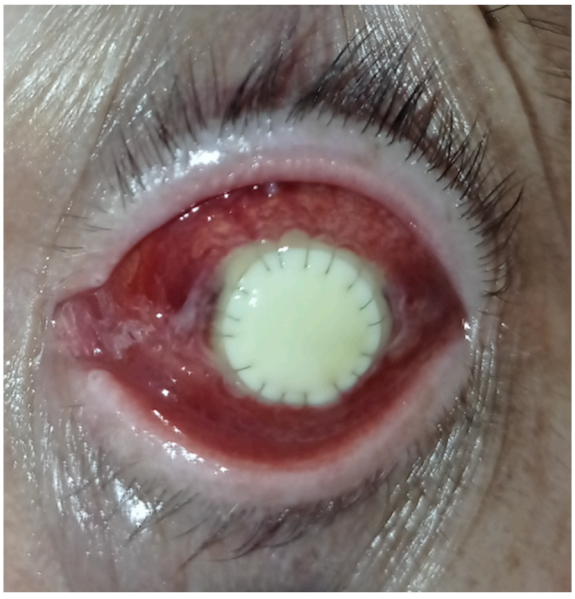

Fig. 2. Anterior segment photography showing the 48-h postoperative condition of the operated eye.

2.2. Postoperative course

The TutoPatch covering remained in place for three weeks (Fig. 3). No ocular complications were noted, and the Seidel sign remained negative until the date of the planned secondary penetrating keratoplasty. Fig. 4 shows the removal of the double-layered TutoPatch during delayed penetrating keratoplasty. The permanence of the TutoPatch did not damage the corneal-graft junction and did not result in limbal

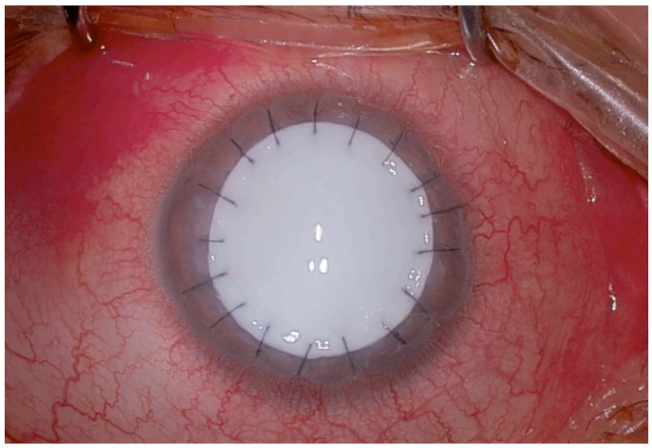

Fig. 3. TutoPatch covering in place 3 weeks post-operatively. The suture margins did not show any sign of dehiscence or inflammation, and the Seidel test was negative.

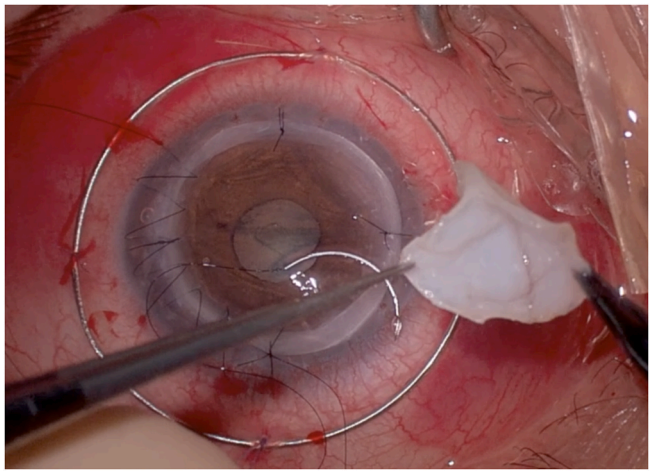

Fig. 4. Picture taken during the secondary retransplantation procedure. The removed TutoPatch cover is intentionally split by the surgeon to show the double layer of the patch. The filamentous sides of both layers faced each other and were kept out of contact with the aqueous humor.

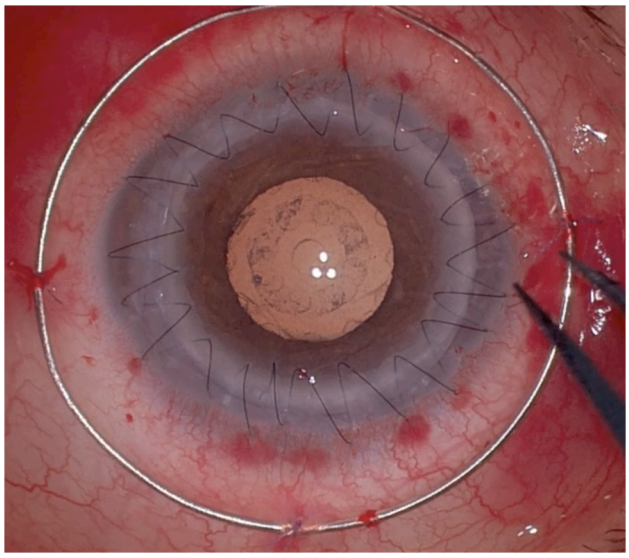

Fig. 5. Final result after secondary penetrating keratoplasty.

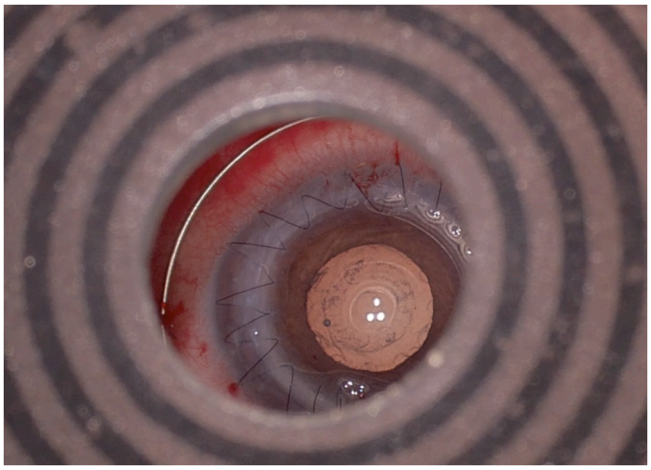

Fig. 6. Intraoperative keratoscopy showing minimal corneal astigmatism after penetrating keratoplasty.

inflammation or fibrosis. Notably, despite prolonged direct contact of the pericardium (smooth side) with aqueous humor, no toxic or inflammatory reaction in the anterior chamber was noted. Penetrating keratoplasty was successfully performed three weeks after the first referral with no complications. Visual acuity ten days post-operatively was 20/200 with −2.00 D residual astigmatism (Figs. 5 and 6). The complete secondary surgical procedure (differed penetrating keratoplasty) is available in Supplemental Video 1.

3. Discussion

Management of large acute corneal melting in the emergency setting can be a real challenge. Corneal transplantation in an acute setting bears a very high risk of rejection and graft infection (especially in infectious cases). Moreover, primary retransplantation is made difficult by the need for a biocompatible cornea, a request that must be made in advance to the providers. The ideal substitute is thus a material similar to the cornea in terms of biomechanical properties, allowing survival of the patch for a sufficient time to ensure safe wound closure until transplantation surgery. This strategy allows surgeons to wait for the inflammatory and infectious processes to resolve before performing corneal retransplantation. Therefore, the ideal material should also be inert to avoid its degradation due to inflammatory erosion or spread of the infection. From this perspective, TutoPatch is a very suitable material for large acute corneal melting management, especially in the setting of infected perforations. Its high compatibility with corneal material is shown by a case report from Kroll et al.[9] that reported eventual fusion of the tectonic paracentral patch with the residual cornea of the treated patient. The use of TutoPatch for the repair of noninfectious corneal perforations was also described in a case series by Alio et al.,[8] which included 2 patients with noninfectious perforation over lamellar grafts and described the combined use of solid platelet-rich plasma with a tectonic TutoPatch graft sutured to the conjunctiva followed by partial tarsorrhaphy. To the best of our knowledge, our case is the first in the literature to describe the use of TutoPatch in the emergency management of infectious perforation. This is also the first study in which TutoPatch was used as a temporary substitute for a corneal graft to allow safe bridging to corneal retransplantation in the context of a rapidly progressing erosive process involving the entire original corneal graft. Interestingly, in contrast with reports describing a proinflammatory action of TutoPatch when in contact with aqueous humor,[10] the prolonged contact in our case did not result in delayed toxic or inflammatory reactions. We chose to use a double layer of TutoPatch to allow better adherence between the cornea and the TutoPatch covering

(due to the similar thickness) and to provide more stiffness to the patching material. Moreover, the use of a double layer allowed us to avoid direct contact of the filamentous side of the pericardium with the aqueous humor of the anterior chamber by keeping the filamentous sides in between the smooth sides (it was used as a "graft" if compared with the human amniotic membrane). In our opinion, this potentially reduced the postoperative inflammatory reaction. In addition, the preserved peripheral host corneal tissue allowed monitoring of the anterior chamber status and the formation of hyphema and/or hypopyon for the duration of TutoPatch permanence as a corneal substitute. In contrast, accurate details of the anterior chamber, such as the presence of cells and/or flare, were not detectable. Finally, vitreous and retinal statuses were checked using ultrasound exams, as the TutoPatch material did not affect the ultrasound signal. In this technique, we thus recommend periodic ultrasound examination of the posterior segment of the eye to exclude intervening complications, such as endophthalmitis and choroidal or retinal detachment. Other patching methods that are quickly available in the emergency setting have been proposed in the literature as temporary substitutes for corneal grafts and are summarized in Table 1. Turner et al.[11] presented a case series of 9 eyes treated with scleral autoplasty for medium-sized corneal perforations. Even though the material showed good biocompatibility, 3 cases resulted in patch melting before graft surgery. Furthermore, this technique implies harvesting of autologous ocular tissue, thus exposing the patient to further complications and altering ocular anatomy. Krisyk et al.[12] described their results in a large cohort of patients treated with an amniotic membrane patch for acute medium-sized perforation. In this series, 33% of patients needed patch replacement, and 21% of patients developed persistent postoperative ocular hypertension. A recent case series described the therapeutic success of the combined use of platelet-rich plasma and amniotic membrane grafts in a cohort of 10 patients. However, once again, only medium-sized corneal defects were treated. Glycerol-preserved corneal tissue has been proven to have a comparable safety and efficacy profile to fresh corneal tissue.[13] Thus, this could represent a possible solution to the problem of immediate availability of biocompatible material for centers provided with preserved corneal tissue supplies. However, the use of this technique still does not avoid the risk of graft contamination from the original infection or the risk of early rejection due to the procedure being performed in inflammatory conditions. An additional option is represented by sterile irradiated cross-linked corneas (VisionGraft). Among the advantages of this material are its ease of storage (remaining stable at room temperature for up to two years), low immunogenicity and durability and transparency comparable to those of fresh corneas.[14] Finally, Tenon's capsule tectonic grafting is used in low-resource settings for small-to medium-size corneal perforation repair in the absence of active suppuration with good functional and anatomical results.[15] In conclusion, we report satisfactory functional and anatomical success using TutoPatch in the described critical setting. Although validation in a larger sample size is highly recommended, we believe that these results suggest this technique as a possible valid solution for the emergency management of large corneal perforations. Even though our experience was completely positive, attention should be given to the possible onset of complications, such as endophthalmitis and ocular inflammation, the early signs of which may go unnoticed due to opacity of the patch. Moreover, the potential risk of wound dehiscence demands caution in choosing lengthy follow-up intervals. We therefore suggest periodic follow-up and encourage the scientific community to report their experiences to increase the knowledge about the safety and efficacy of the procedure.

Table 1
Biocompatible temporary patching materials alternative to corneal grafts used in case of corneal perforation in the emergency setting.

Patching material	Use	Advantages	Disadvantages
Scleral autoplasty	Medium size perforations	• Good biocompatibility •Low immunogenicity •No need for storage •Low costs	•High rate of melting before graft surgery •Harvesting exposes to complications and alters anatomical integrity
Tenon's capsule tectonic grafting	Small to moderate perforations without active suppuration	•Good biocompatibility •Low immunogenicity •No need for storage •Low costs	•High rate of melting before graft surgery •Risk of graft displacement and pseudoectasia
Amniotic membrane patch ±Platelet Rich Plasma	Medium size perforations without active suppuration	•High availability •Wide surgical experience •Good biocompatibility	•High rate of melting before graft surgery •Postoperative ocular hypertension
Glycerol-preserved corneal tissue	Large to medium size perforations	•Relative durability and transparency •Good availability •Easy storage	•Susceptibility to inflammatory and infective processes •Risk of early rejection in inflammatory settings
Irradiated crosslinked corneas	Large to medium size perforations	•Durability and transparency •Easy storage •Low immunogenicity	•High costs

Ethics approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent to participate

Informed consent was obtained from the patient.

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Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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None.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.ajoc.2023.101885.

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