Case Report

Multilayered amniotic membrane transplantation for tectonic stabilization and symptomatic relief in pediatric post-traumatic corneal thinning: a case report

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ABSTRACT

Background: Amniotic membrane transplantation (AMT) is a recognized technique in ocular surface reconstruction. Its application in pediatric patients remains less extensively documented across a range of ocular-surface indications. There is a literature gap regarding its use for rehabilitating symptomatic, post-traumatic corneal thinning with surface irregularity, where the goal shifts from visual recovery to achieving a painless, stable ocular surface amenable to prosthetic fitting. We detail the surgical strategy aimed at achieving rapid surface stabilization and highlight the considerations unique to managing such complex corneal pathology in a pediatric population.

Case Presentation: An 11-year-old girl presented with left ocular pain, epiphora, and profound intolerance of a previously fitted ocular prosthesis. Her history was significant for a penetrating corneal injury six years prior that was treated with primary repair. The affected eye subsequently had no light perception and developed progressive corneal opacification, with marked corneal thinning noted at the current presentation. Examination revealed a leukomatous cornea with a linear area of significant stromal thinning and marked surface irregularity, explaining the prosthetic intolerance. After failed medical management, surgical intervention with a two-layer cryopreserved amniotic membrane overlay was performed. Two layers of membrane were secured with absorbable sutures and tailored to the irregular corneal contour. The membrane remained well attached, underwent gradual resorption over the subsequent weeks, and was followed by a smoother, clinically stable corneal surface. This allowed for successful and comfortable refitting of the ocular prosthesis. At the three-month follow-up, the patient was asymptomatic, and the ocular surface remained clinically stable.

Conclusions: In this pediatric patient, a two-layer sutured amniotic membrane overlay was associated with resolution of ocular discomfort, clinical improvement in surface regularity, and successful prosthetic rehabilitation. The clinical objective was patient comfort and prosthetic tolerance rather than improvement in visual acuity. This case suggests that a two-layer sutured amniotic membrane overlay may be considered for selected pediatric patients with symptomatic post-traumatic corneal thinning and surface irregularity; however, its effectiveness and long-term structural outcomes require further evaluation.

KEYWORDS

amniotic membrane, transplantations, corneas, corneal injury, corneal trauma, corneal scar, pediatrics, unilateral blindness, ocular prosthesis, ocular surgery, ophthalmological surgical procedure

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INTRODUCTION

The amniotic membrane (AM), the innermost layer of the placental sac [1], possesses a unique combination of structural and biological properties that have established its role as a valuable biomaterial in regenerative medicine. Composed of a monolayer of epithelial cells, a thick basement membrane, and an avascular stromal matrix, the AM provides a natural scaffold that promotes wound healing, modulates inflammation, and reduces scarring. Its mechanisms of action are multifactorial, encompassing facilitation of epithelial migration, reinforcement of epithelial adhesion, suppression of apoptosis, and provision of a rich reservoir of growth factors [2–5]. These attributes underpin its use as a biomaterial in ocular-surface reconstruction, including the management of corneal thinning and perforation [1, 2, 6]. Furthermore, AM is reported to exert anti-inflammatory effects, serve as a protective barrier, and reduce pain in human tissues [2].

In ophthalmic surgery, AM transplantation (AMT) has become a widely used technique for ocular surface reconstruction since its initial reported use in the 1940s for ocular burns [1, 2]. In 1995, Kim and Tseng [7] reported that transplantation of preserved human AM promoted ocular-surface reconstruction and restoration of the corneal epithelial phenotype in rabbits with severe corneal damage and limbal stem cell deficiency. Preserved AM is now a therapeutic option for a spectrum of challenging conditions, including persistent epithelial defects, neurotrophic keratopathy, bullous keratopathy, symblepharon, cicatricial keratoconjunctivitis, corneal perforation, and corneal burns [8].

While the principles of AMT are well-established in adult populations [1], its application in pediatric ophthalmology remains less extensively documented [3, 4]. Reported pediatric applications have predominantly involved Stevens-Johnson syndrome, with other indications including difficult-to-treat corneal epithelial defects and ulcers, conjunctival reconstruction, postoperative scarring, and reconstruction after ocular surface lesion excision [3, 4]. Although recent reports, including a case series by Elkadim et al. [9], have described the use of AM-assisted repair in pediatric traumatic corneal injury, data specifically addressing symptomatic corneal thinning and surface irregularity aimed at facilitating prosthetic tolerance remain limited.

This case report describes the application of a two-layer, sutured AM overlay in a pediatric patient with a history of trauma, presenting with corneal opacity, significant thinning, and intolerable ocular discomfort precluding prosthesis use. We detail the surgical strategy aimed at achieving rapid surface stabilization and highlight the considerations unique to managing such complex corneal pathology in a pediatric population.

CASE PRESENTATION

An 11-year-old girl presented with several weeks of left eye pain, conjunctival injection, discomfort, and reflex tearing. Six years prior to presentation, she sustained penetrating ocular trauma to her left eye after being struck by a broomstick. Primary corneal laceration repair was performed at an outside institution. Over time, the patient developed progressive corneal opacification, and the affected eye had no light perception (NLP) by the current presentation.

Following the development of NLP vision, an ocular prosthesis was fitted for cosmetic purposes. The prosthesis had been generally tolerated until several weeks prior to presentation, when the patient began experiencing persistent ocular pain and irritation. These symptoms were refractory to topical antimicrobial and lubricant therapy, prompting referral for further evaluation.

On initial ophthalmic examination, best-corrected visual acuity in the right eye was 20/20 using a Snellen chart (Auto Chart Projector CP-670; NIDEK Co., Ltd., Gamagori, Japan). The left eye was assessed separately for light perception and had NLP. Intraocular pressure was measured using a portable rebound tonometer (iCare IC100; iCare Finland Oy, Vantaa, Finland), and the readings were within normal limits in both eyes; the left-eye measurement was interpreted cautiously because of the marked corneal opacity, thinning, and surface irregularity. Krimsky testing revealed 25 prism diopters of esotropia in the left eye, and ocular motility testing demonstrated a −1 limitation in abduction. Slit-lamp biomicroscopy (BQ 900; Haag-Streit AG, Koeniz, Switzerland) showed diffuse, irregular, leukomatous corneal opacity involving the visual axis in the left eye. A linear zone of clinically apparent stromal thinning with scalloped margins was noted within the opaque cornea, accompanied by prominent conjunctival injection (Figure 1A). Fluorescein staining showed no epithelial defect, and Seidel testing was negative. The anterior chamber could not be clearly visualized but appeared shallow. No serial pachymetric or anterior-segment optical coherence tomography measurements were available; therefore, progression of thinning and postoperative change in corneal thickness could not be quantified. The clinical appearance was consistent with post-traumatic corneal scarring, severe surface irregularity, and focal thinning, with no clinically evident infectious infiltrate.

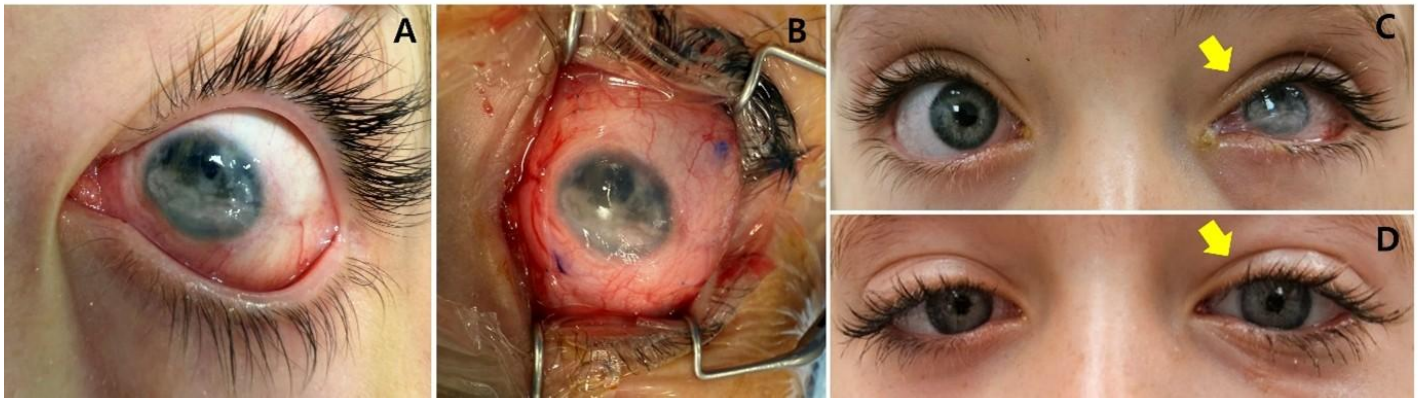

Figure 1. Clinical course from the initial visit through ocular prosthesis refitting after amniotic membrane (AM) surgery. (A) At the initial visit, diffuse whitish corneal opacity with a linear area of clinically apparent stromal thinning and conjunctival injection was observed. (B) Intraoperative photograph at the end of surgery demonstrating full-corneal coverage with two layers of cryopreserved AM. (C) Two weeks postoperatively, the AM remained well attached and was undergoing gradual resorption (yellow arrow). (D) At four weeks postoperatively, following clinical stabilization of the ocular surface, the ocular prosthesis was successfully refitted (yellow arrow).

Given the failure of conservative medical management to alleviate symptoms and the resulting intolerance of the cosmetic prosthesis, surgical intervention was indicated. The primary goals were to provide temporary surface support, improve the corneal surface contour, reduce ocular discomfort, and enable successful prosthetic refitting. A two-layer AM overlay was selected because AM can act as a temporary biologic dressing while supporting epithelial healing [1].

Because of the severity and broad extent of corneal surface irregularity, a two-layer AM overlay was selected. In the operating room, a cryopreserved 5 × 5 cm AM (AmnioGraft, Model AG-5050F; Biotissue, Miami, FL, USA) was carefully detached from the supporting plate before use. Under general anesthesia, two layers of AM were positioned stromal side-down over the corneal surface and tailored to match the irregular corneal contour. The trimmed membranes were secured to the conjunctiva approximately 3 mm posterior to the limbus using absorbable 8-0 Vicryl sutures (Ethicon Inc., Somerville, NJ, USA) to ensure full coverage of the cornea. Given the patient's sensory esotropia and pronounced nasal-side irregularity, additional sutures were placed nasally for enhanced fixation. Stable attachment of the AM was confirmed at the conclusion of surgery (Figure 1B).

The immediate postoperative regimen included a single intravenous dose of ceftriaxone (Rocephin® 1 g; Roche, Basel, Switzerland). Postoperatively, neomycin and polymyxin B sulfates and dexamethasone ophthalmic ointment (Maxitrol®; Novartis Pharmaceuticals Corporation, East Hanover, NJ, USA) was applied twice daily for two weeks, along with preservative-free artificial tears containing 0.5% CMC (Refresh Plus®; Allergan, Irvine, CA, USA), instilled four times daily for two weeks. The AM remained well attached and intact over the first postoperative week, providing continuous coverage. It subsequently underwent gradual resorption over the ensuing 2–3 weeks (Figure 1C). On slit-lamp examination, the underlying corneal surface appeared smoother and clinically stable, and the patient reported complete resolution of her preoperative pain and discomfort.

Once the ocular surface was deemed clinically stable and quiet, successful refitting of the patient's ocular prosthesis was performed at 4 weeks postoperatively (Figure 1D). At the three-month follow-up examination, the patient remained asymptomatic, the corneal contour appeared stable on slit-lamp examination, and the prosthesis was well tolerated. No postoperative infection, membrane displacement requiring intervention, wound leak, or other procedure-related adverse event was observed during the three-month follow-up.

This case report was registered with the institutional review board (IRB) under the Not Human Subjects Research self-determination process and was determined not to constitute human subjects research. Written informed consent for publication of clinical details and images was obtained from the patient's legal guardians prior to submission. All procedures performed adhered to the ethical principles outlined in the Declaration of Helsinki.

DISCUSSION

This case report details the use of a two-layer, sutured AM overlay for ocular-surface stabilization and symptomatic relief in a pediatric patient with post-traumatic corneal thinning and surface irregularity. The clinical scenario of a child with a blind, painful eye, post-traumatic corneal scarring, and prosthesis intolerance presents a distinct therapeutic challenge. While AMT is a well-established modality in adult ocular surface reconstruction [1], its use in pediatric populations has been relatively limited [3, 4]. This case describes its use for pediatric corneal rehabilitation, with the clinical goals of pain relief, surface regularization, and preservation of the ocular surface to enable prosthetic use.

Corneal thinning and related perforations have been managed using various techniques, including cyanoacrylate or fibrin glue, donor corneal patch grafts, tarsorrhaphy, conjunctival flaps, and AMT [6, 10–14]. Although our patient did not have a clinically evident corneal perforation, her persistent ocular discomfort and significant corneal contour irregularity made ocular prosthesis wear challenging. In this case, AM grafting was selected as an alternative to conjunctival flap surgery after topical therapy failed to relieve the patient's symptoms. More broadly, AMT has been evaluated as an ocular-surface reconstructive option, with comparative outcomes depending on the clinical indication and comparator; in pterygium surgery, conjunctival autografting was associated with lower risks of recurrence and unacceptable appearance than AMT [15]. Because those findings arose from a different ocular-surface condition, they do not establish the comparative efficacy or speed of symptomatic relief of AMT in pediatric post-traumatic corneal thinning.

The two-layer AM overlay was selected as an intermediate approach intended to provide temporary surface support and act as a biologic bandage while harnessing the membrane's anti-inflammatory and pro-healing properties [1, 7]. In this case, two layers of AM were positioned stromal side-down over the corneal surface and tailored to match the irregular corneal contour. The clinical course in this patient is consistent with reports that AMT may support corneal healing in other conditions, including persistent epithelial defects and infectious keratitis; however, those findings arose from different disease settings and cannot establish comparative efficacy in post-traumatic corneal thinning [16, 17].

Studies have described the therapeutic effects of AMT in ocular surface reconstruction, particularly in damaged corneas [1, 7, 16–19]. Lee et al. [17] described 11 patients who underwent AMT for persistent corneal epithelial defects associated with sterile ulceration that had lasted an average of 17.5 weeks. Ten of the 11 patients achieved corneal healing, with a mean healing time of 3.9 weeks. In a systematic review and meta-analysis of moderate-to-severe bacterial and fungal keratitis, Ting et al. [16] found that adjunctive AMT reduced the mean time to complete corneal healing by approximately 4.1 days compared with standard antimicrobial treatment alone, although the authors characterized the supporting evidence as low quality.

The recent retrospective case series by Elkadim et al. [9] described the use of an AM onlay strip incorporated into corneal suturing for acute traumatic corneal lacerations. Their series included eight eyes, notably comprising two pediatric patients aged 11 and 12 years, thereby establishing documented precedent for AM-assisted repair in pediatric traumatic corneal injury. Their primary objective was to achieve watertight wound closure while minimizing suture-related corneal astigmatism and optimizing postoperative visual outcomes [9]. In contrast, the present case differs substantially in both timing and therapeutic intent. Our patient presented years after the initial trauma with a chronically altered corneal surface and prosthetic intolerance rather than an acute laceration requiring emergent closure. Accordingly, the goal of intervention was not visual rehabilitation but symptomatic relief, temporary surface support, and restoration of surface contour sufficient to permit comfortable prosthetic use. This distinction suggests that AMT may have a potential rehabilitative role in selected remote post-traumatic corneal sequelae, in addition to its use as an adjunct in acute traumatic repair.

Various methodological refinements of AMT have also been introduced, including sutureless AMT using a bandage contact lens, the plug-and-patch technique, and the sandwich technique for microperforations [20–22]. These developments further underscore the expanding applicability and versatility of AMT in managing complex corneal surface disease.

This case represents an uncommon application of AM surgery in a pediatric patient and highlights several technical considerations. First, we employed a two-layer sutured overlay rather than a single-layer or sutureless approach. Given the extent of surface irregularity and the linear area of thinning, two layers were selected to provide broad temporary coverage and improve surface contouring. Because corneal thickness and biomechanics were not measured, the degree of structural reinforcement attributable to the two layers could not be quantified. Second, we utilized 8-0 polyglactin 910 (Vicryl) absorbable sutures for fixation rather than the non-absorbable nylon sutures commonly described [2]. Evidence from pediatric cataract surgery, although not specific to AM surgery, indicates that absorbable sutures may avoid a subsequent suture-removal procedure [23]. In this patient, the absorbable sutures maintained membrane fixation during the early postoperative period without requiring subsequent suture removal. Third, the membrane was tailored to fit the irregular corneal contour to promote uniform attachment and reduce edge lift. This report addresses a relatively underreported pediatric application of AM surgery. Previous studies of pediatric AMT have included Stevens–Johnson syndrome and a range of other ocular-surface indications [3], as well as ocular-surface reconstruction after lesion excision [4]. In the broader

AMT literature, the procedure has also been described for the acute ocular manifestations of Stevens–Johnson syndrome and toxic epidermal necrolysis [24].

This case highlights the potential utility of a two-layer sutured AM overlay for managing symptomatic corneal thinning and surface irregularity in pediatric patients. In the present case, the procedure was followed by clinically improved surface regularity, resolution of discomfort, and successful prosthetic rehabilitation. The therapeutic objective was ocular comfort and improved prosthetic tolerance rather than visual rehabilitation. However, corneal thickness and biomechanical stability were not quantitatively evaluated, and quality of life was not formally measured. The findings are also inherently limited by the single-case design and the absence of long-term follow-up data. Further studies involving larger pediatric cohorts are needed to better characterize long-term outcomes, refine patient selection criteria, and establish the optimal surgical indications for AMT in similar clinical settings.

CONCLUSIONS

In this pediatric patient with no visual potential, a two-layer sutured AM overlay was associated with resolution of ocular discomfort, clinical improvement in surface regularity, and successful prosthetic rehabilitation. The clinical objective was patient comfort and prosthetic tolerance rather than improvement in visual acuity. This single case suggests that a two-layer sutured AM overlay may be considered for selected pediatric patients with symptomatic post-traumatic corneal thinning and surface irregularity; however, its effectiveness, long-term structural outcome, and effect on quality of life require further evaluation.

ETHICAL DECLARATIONS

Ethical approval: This case report was registered with the IRB under the Not Human Subjects Research self-determination process and was determined not to constitute human subjects research. Written informed consent for publication of clinical details and images was obtained from the patient's legal guardians prior to submission. All procedures performed adhered to the ethical principles outlined in the Declaration of Helsinki.

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