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Post Traumatic Lamellar Corneal Laceration Repair Using Shaped SMILE Lenticule

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Introduction

Corneal lacerations are a common cause of monocular vision loss worldwide. Inadequate tissue apposition during primary repair can lead to persistent epithelial ingrowth, irregular astigmatism, infection risk, and poor visual outcome. Multiple studies have established anterior lamellar corneal patch grafts as effective for enhancing wound strength and integrity in select corneal laceration repairs.[1] More recently, small incision lenticule extraction (SMILE) has been introduced as a flapless method of harvesting anterior stromal lenticules for correcting refractive error.[2] We present the use of a SMILE donor lenticule for the structural repair of a traumatic corneal laceration with epithelial ingrowth refractory to conservative management.

Case Report

A 24-year-old male was referred for evaluation of recurrent right eye pain, tearing, and blurry vision for the last 7 years. His symptoms originally started after sustaining an accidental corneal laceration from a knife while playing with his child. Though the injury was treated with antibiotic drops and appeared to resolve initially, his symptoms began recurring intermittently over the years.

On examination, uncorrected visual acuity was 20/80, improving to 20/40 with pinhole in the right eye and 20/20 in the left eye. Right eye had a 6 mm curved partial-thickness corneal laceration extending from the 3 to 9 o'clock hours position with epithelial ingrowth (Figure 1A). The laceration depth measured 388μm, and the width measured 652μm on anterior segment optical coherence tomography (AS-OCT) (Figure 1B). The remainder of his ocular exam was within normal limits, including an intact endothelium and quiet anterior chamber. A donor SMILE lenticule was carefully cut to match the length and width of the laceration. The depth of the lenticule was adjusted by carefully dissecting the stromal layers manually until the desired thickness was achieved, corresponding to the depth of the laceration. The edges of the lenticule were refined to ensure a smooth and precise fit into the corneal defect that was present despite opposing the edges of the laceration (Figures 1C-D).

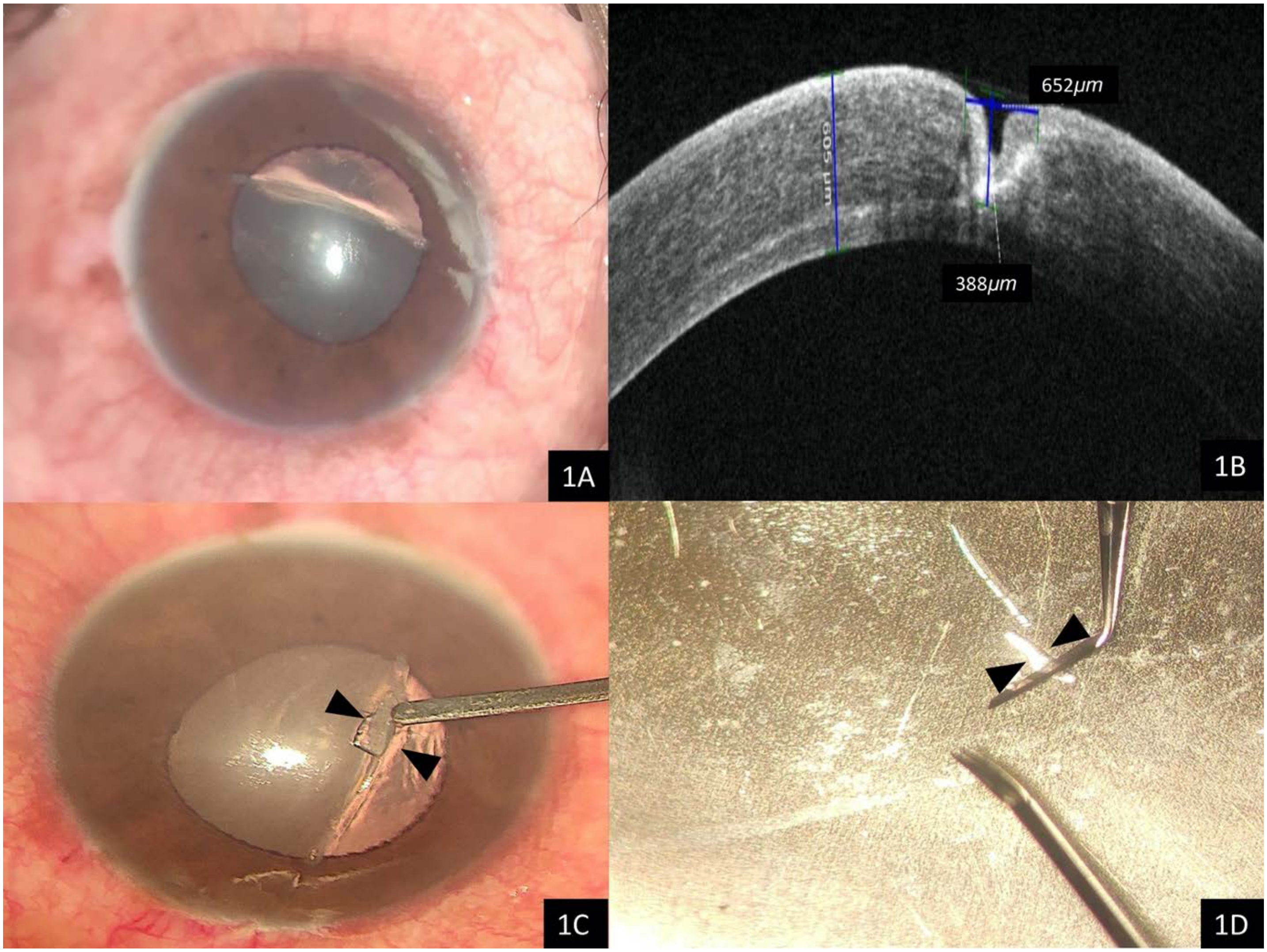

Figure 1. A. Intraoperative view (6x magnification) of the right eye demonstrates a 6mm curved partial-thickness corneal laceration extending from the 3 to 9 o-clock position with epithelial ingrowth. B. Preoperative anterior segment optical coherence tomography image reveals laceration depth of 388µm and width of 652µm. C. Donor stromal lenticule during preparation (black arrowheads). D. Manual layer-by-layer dissection to achieve shaped SMILE lenticule corresponding to the width and depth of the laceration (black arrowheads).

After debridement of the epithelial ingrowth, the laceration was fully exposed, revealing extensive underlying stromal scarring (Figure 2A). The donor stromal graft was secured into the laceration defect using fibrin glue (Figure 2B). Following the procedure, a bandage contact lens was applied, and a topical antibiotic-steroid combination eye drop was prescribed. At postoperative week 4, the edges of the laceration remained well-apposed with overlying intact epithelium (Figures 2C-D).

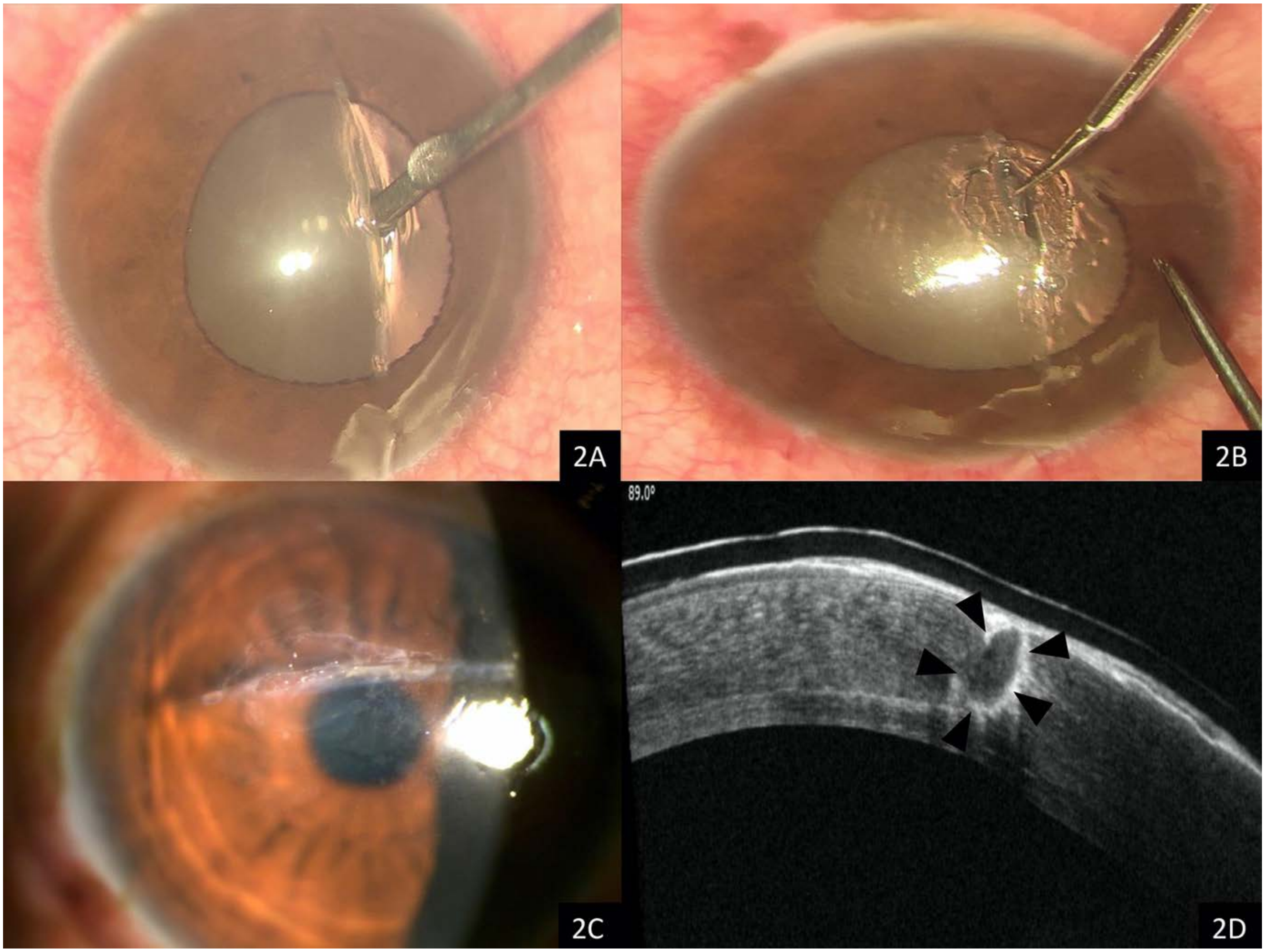

Figure 2. A. Intraoperative view of laceration after debridement of ingrown epithelium. B. Intraoperative view after securing the shaped donor lenticule into the laceration with fibrin glue. C. Slit-lamp photograph 4 weeks postoperatively shows a well-apposed laceration with overlying intact epithelium. D. Anterior segment optical coherence tomography image 4 weeks postoperatively demonstrates a well-apposed lenticule with host stroma and complete healing of the laceration site (black arrowheads indicate the margins of lenticule integration with host corneal stroma).

Eight weeks postoperatively, AS-OCT confirmed complete integration of the lenticule with host corneal stroma with well-epithelialized surface, and visual acuity improved to 20/30 (Figure 3).

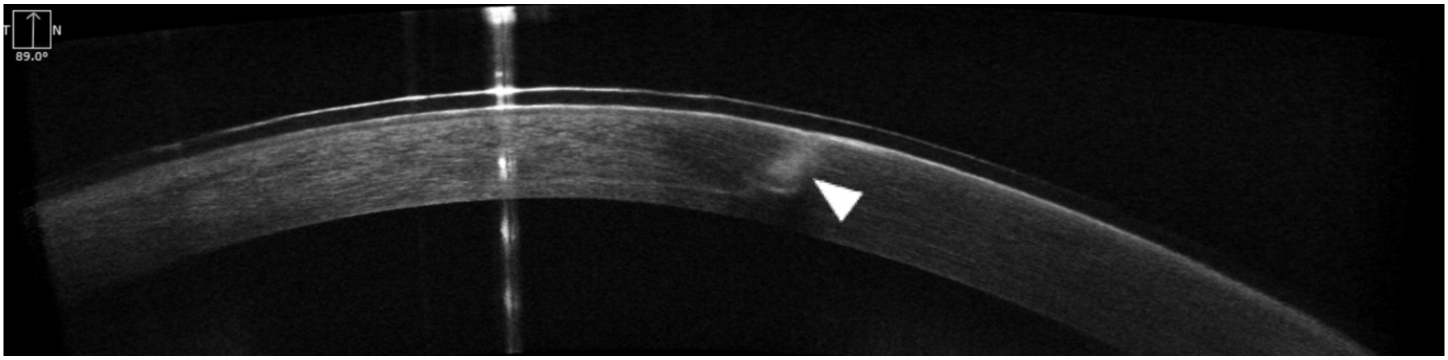

Figure 3. The 8-week anterior segment optical coherence tomography image shows complete stromal integration of the glued lenticule with host corneal tissue (white arrowhead), displaying almost uniform reflectivity and well-epithelialized anterior surface.

Discussion

Open globe injuries due to corneal lacerations have a significant global impact, with an estimated incidence of 1.5-2.0 million cases of corneal blindness annually worldwide.[3] Various treatment options exist for corneal stromal defects following such trauma, including tissue adhesives, amniotic membrane graft (AMG), multilayered patches, and corneal transplantation.[4] However, each approach has limitations in recurrence risk, technical complexity, cost, or risk of graft rejection. More recent evidence has explored the potential of SMILE lenticules as an alternative source of corneal graft tissue. Bhandari et al. demonstrated successful treatment of two corneal lacerations using SMILE lenticules, concluding that this approach was feasible, safe, effective, and economical for lamellar defects.[5]

Additional properties of SMILE lenticules support their utility for corneal repair. The native extracellular matrix composition provides a collagen-rich stromal scaffold that can recruit and differentiate host cells to enhance endogenous regeneration.[6] This organized ultrastructure is similar to normal corneal architecture, enabling precise substitution of affected layers. SMILE lenticules can be used for the treatment of corneal ulcer, perforation, tissue defect, hyperopia, presbyopia, and keratectasia and have proven to be relatively effective and safe.[7]

This case demonstrates the successful structural repair of a longstanding traumatic corneal laceration using a shaped donor SMILE lenticule graft. Due to the tissue loss and curvilinear shape of the laceration, no other option could have been feasible without potentially worsening the vision. Primary repair with sutures alone could have resulted in high irregular astigmatism postoperatively. Moreover, the laceration was acting as a nidus for infection, causing the patient to experience recurrent symptomatic episodes. The SMILE lenticule graft was preferred over AMG because it provided a more organized stromal architecture that closely resembled the native corneal tissue, leading to better corneal transparency and visual outcome. In contrast, AMG would have primarily served only as a basement membrane for epithelial growth and would not have contributed to the stromal structure.[8]

The shaped SMILE lenticule graft provided an innovative solution to address these challenges and achieve optimal visual and structural outcomes. Customization is a key advantage of using SMILE lenticules for corneal repair, as it allows for the restoration of the corneal contour and refractive surface. The glued tissue eventually was incorporated into the host cornea with a well-epithelialized surface, indicating that this treatment could be a permanent solution.

Though prior studies have demonstrated effective visual rehabilitation in eyes with corneal injury following the use of full-thickness or lamellar corneal donor tissue, our approach employs a flapless partial-thickness graft from a SMILE procedure, which confers several advantages including reduced graft rejection risk, precise stromal layer substitution, and increasing availability as lenticule extraction becomes widespread.[4,5,9] Building upon previous successful applications by Wu et al. and Bhandari et al., who demonstrated success with sutured lenticules and patch grafting respectively, our case presents a distinct advancement through customization of the SMILE lenticule to match specific laceration dimensions.[4,5] These encouraging results warrant further investigation of precisely shaped SMILE lenticules as a treatment option for complex corneal repairs following unsuccessful conservative care.

While SMILE lenticules offer significant therapeutic potential, their quality and biomechanical properties can vary based on preservation protocols. Current evidence supports standardized preservation methods using either hypothermic storage in Optisol-GS or cryopreservation. Limited regional accessibility, particularly in areas without established eye banking infrastructure, presents another significant challenge. This could be addressed through development of dedicated lenticule banking systems with standardized protocols for collection, processing, and distribution.[10] The current lack of international standardization policies hinders widespread implementation. The development of robust preservation methodology and banking infrastructure will be crucial for realizing the full clinical potential of this technique.

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Statement of Ethics

This case report adheres to patient confidentiality and ethical principles in accordance with the guidelines of the Declaration of Helsinki and relevant local regulations. Written informed consent was obtained from the patient for the publication of this case report.

Conflict of Interest Statement

The authors declare no conflicts of interest related to this topic.

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Authorship

We attest that all authors contributed significantly to the creation of this manuscript, each having fulfilled the criteria as established by the ICMJE.