

## Modified “Top-up sandwich” technique for the management of corneal perforations: A case report and a literature review

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### ARTICLE INFO

#### Keywords:

Descemet stripping automated endothelial keratoplasty  
Graft  
Perforation  
Management

### ABSTRACT

**Purpose:** We describe a modified technique for managing a peripheral, non-infected, corneal perforation using a “Sandwich” technique that combines posterior lamellar keratoplasty, an amniotic membrane patch and a Gundersen conjunctival flap.

**Observations:** A 75-year-old female patient presented with Sjogren’s syndrome-related corneal perforation. A mini-Descemet stripping automated endothelial keratoplasty (DSAEK) graft (5 mm) was introduced into the anterior chamber and was mobilized to plug the perforation. Then, two amniotic membrane patches were stacked over the perforation and glued. Finally, the whole area was covered with a Gundersen conjunctival flap, mobilized from the inferior conjunctiva and secured in place using interrupted 10-0 nylon sutures. A step-by-step guide is also described. At three months, the final visual acuity was 6/9. A literature review revealed ten cases in which a posterior lamellar graft was effectively employed to treat corneal perforations.

**Conclusions and Importance:** We described a modified approach for treating peripheral corneal perforation surgically. This “sandwich” approach is simple to replicate and can give quick healing with few visual repercussions. Our detailed guide may be utilized to obtain similar results and may be added to the array of treatment options for peripheral corneal perforation.

### 1. Introduction

Corneal perforations are considered a potential sight-threatening emergency. It might arise due to local infection, inflammation, or systemic autoimmune disorder. Management choices are influenced by the location and size of the perforation and the underlying etiology and visual potential.<sup>1</sup>

Depending on the perforation’s size, cyanoacrylate glue with a plastic drape plug can be used as an initial temporizing measure.<sup>2</sup> Long-term management can include an anterior lamellar or penetrating keratoplasty.<sup>3</sup> Recently, a novel method that includes only posterior lamellar keratoplasty graft was described using an amniotic membrane in a staged approach for impending corneal perforation. This resulted in structural support, reepithelization and ocular surface healing.<sup>4</sup> To the best of our knowledge, only 11 cases were reported, where a tectonic posterior lamellar keratoplasty graft was used in the management of

impending or actual perforation, [Table 1.](#)<sup>4–8</sup> Therefore this paper aims to add to the existing research by presenting our experience with posterior lamellar keratoplasty in the treatment of peripheral perforation cases. We have modified the original method by Graue-Hernandez et al. for impending perforation<sup>4</sup> and termed it the “top-up sandwich technique.” The corneal surface is reinforced with a partial Gundersen flap externally in addition to an external layer of amniotic membrane sandwiched between the perforation and a mini-posterior lamellar graft in the anterior chamber.

This study also includes step-by-step guidance to facilitate understanding of our methods, hoping other surgeons would adopt it when faced with similar situations.

### 2. Methods

A 75-year-old female with a history of hypertension and chronic

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<https://doi.org/10.1016/j.ajoc.2022.101765>

Received 9 August 2022; Received in revised form 14 November 2022; Accepted 28 November 2022

Available online 14 December 2022

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**Table 1**  
Previous cases of a tectonic posterior lamellar keratoplasty graft in managing impending or actual perforation.

Author	Year	Region	Number of cases	Description	Type of procedure	Follow up	Outcomes	Final VA
Graue-Hernandez <sup>4</sup>	2012	Mexico	1	Corneal thinning secondary to dry eye.	A tectonic DSAEK and amniotic membrane graft.	8 months	Ocular surface healed quickly, and re-epithelialization occurred over 2 weeks and lasted for follow-up.	NA
Nahum <sup>5</sup>	2016	Israel and Italy	3	Case 1,2: Endothelial decompensation and sterile corneal perforation. Case 3- an impending corneal perforation.	DSAEK	Case 1: 3 months Case 2: 1 year Case 3: 1 year	All grafts remained clear throughout the follow-up. Case 1 underwent DALK on DSAEK with improved visual acuity.	Case 1-20/30 Case 2-20/60 Case 3-20/400
Okada <sup>8</sup>	2016	Japan	1	A corneal perforation of undetermined etiology.	Partial-thickness corneal button A DSAEK graft.	5 months	Seven weeks postoperatively, the corneal defect was closed and lasted for follow-up.	6/6
Jesse <sup>6</sup>	2017	Switzerland	1	A perforated corneal ulcer due to neurotrophic keratopathy caused by previous recurrent herpetic keratitis.	A DSAEK graft.	6 months	Re-bubbling was performed the day after and four 10-0 Nylon sutures were placed for 2 weeks those = The long-term follow-up showed stable and transparent cornea.	CF due to severe AMD.
Tourkmani <sup>7</sup>	2020	United Kingdom	4	Case 1- perforation due to exposure keratopathy Case 2,3- perforation due to herpetic keratitis Case 4- corneal hydrops secondary to PMD.	Cases 1-3: DSEK Case 4: hemi-DSEK	Case 1: 2 months Case 2:NA Case 3:NA Case 4:NA	Case 4- patient underwent 2 re-floating attempts before anchoring suture placement due to repeated graft detachment.	Case 1-NA, without visual potential. Case 2-NA Case 3-NA Case 4-NA

DSEK; Descemet stripping endothelial keratoplasty, DSAEK; Descemet stripping automated endothelial keratoplasty, BCVA; best-corrected visual acuity, VA; visual acuity, CF; counting fingers, PMD; pellucid marginal degeneration, NA; not available, DALK; deep anterior lamellar keratoplasty.

obstructive pulmonary disease was referred to our tertiary center for a tectonic keratoplasty. She had no relevant ocular history other than bilateral cataract surgery more than a year earlier with no complications and a quiescent follow-up. The history of the present illness started four weeks prior with spontaneous ulceration. There was no evidence of corneal infiltrates. Microbial culture, sensitivity, and viral swabs were all done and returned negative. Blood work was done to rule out underlying autoimmune etiology, and the results were within normal range. The etiology was presumed to be related to underlying Sjogren disease. The patient received pulse steroid treatment over three days with subsequent oral steroids, which were weaned over six weeks.

Given the positive response and lack of active inflammation, ongoing immunosuppressive medications were not deemed necessary. Upon presentation, the patient had a 3 × 2 mm right side peripheral inferior corneal perforation. An active leak was partially sealed through the perforation wound by iris tissue, cyanoacrylic glue, and a plastic drape plug. With repeated gluing, a complete seal was created. Topical treatment included prophylactic antibiotics, prednisolone 0.5%, and lubrication. All topical treatment was preservative free. Oral Doxycycline was added. Due to the perforation's size, the irregular depth of the anterior chamber, and the eye's visual potential, surgical management was considered the definitive solution. Even more than a year after the procedure, the patient is still being followed up on by our department.

### 2.1. Surgical technique

The donor cornea was mounted an artificial anterior chamber (Single-use artificial chamber, Moria) and the epithelium was removed. The approximate thickness of the DSAEK was between 150 and 160 μm, measured with a hand-held pachymetry. The amniotic membrane transplant diameter was 3 mm punched using a standard dermatology punch.

A single-pass lamellar dissection was performed using a 2.75 mm metal keratome. The residual stromal bed was then punched using a 5 mm dermatology punch, and the tissue was marked and dyed with vision blue (DORC, Zuidland, The Netherlands). An anterior chamber (AC) maintainer was introduced following sterilization and draping. The anterior synechiae were broken by gentle sweeps using an iris reposer. With a complete seal of the perforation still maintained by the glue, the graft was introduced manually through a 3 mm incision. Once in the eye, the main port was sutured with 3x 10/0 Nylon sutures, the AC maintainer was removed, and the DSAEK (Descemet Stripping Endothelial Keratoplasty) corneal graft was floated by air injection at the iris plan. A 30G needle ab interno achieved graft mobilization to avoid destabilization of the glue. Once in place, the glue was removed, and more air was injected to ascertain a complete seal. The epithelium was next debrided around the perforation and two amniotic membrane discs were placed using tissue glue (Tisseel, Baxter Advanced Surgery, Deerfield, IL, US). For added stability, a Gunderson conjunctival partial flap was then mobilized from the adjacent inferior conjunctiva and pulled to cover the whole ulcerated area and secured in place by combining tissue glue and 10/0 Nylon sutures. The Gunderson flap has not receded. A bandage contact lens (BCL) was placed (Movie 1-Supplemental digital content).

Supplementary video related to this article can be found at <https://doi.org/10.1016/j.ajoc.2022.101765>.

### 3. Result

During follow-up, the BCL was removed and the anterior chamber was formed with no leak. Anterior segment photos and anterior segment OCT are presented in Figs. 1 and 2. Visual acuity was 6/50 at week one following surgery and final visual acuity at four months was 6/9. The patient denoted comfort as soon as week one.



**Fig. 1A.** Anterior segment photography at day 1 post-operatively. Anterior segment photography presents a sealed perforation by the “Sandwich” technique which combines posterior lamellar keratoplasty, an amniotic membrane patch, and a Gundersen conjunctival flap.



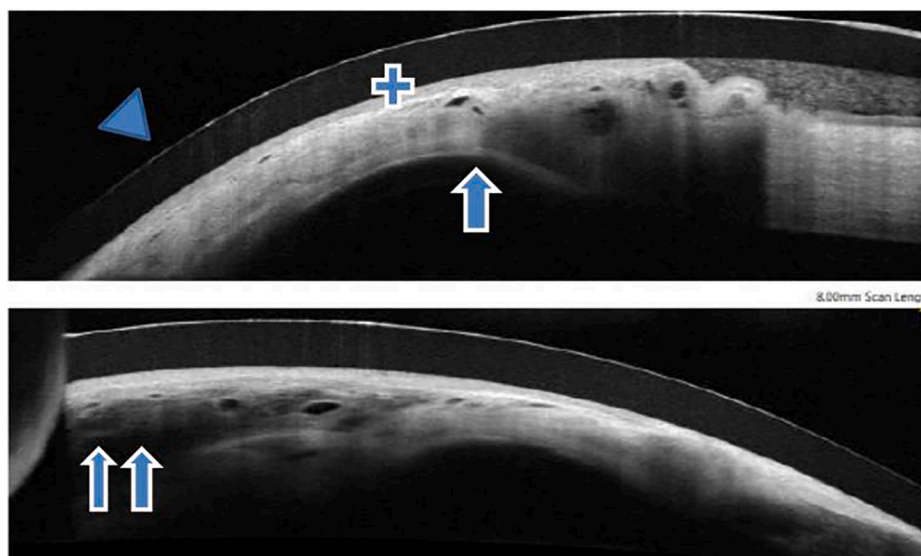
**Fig. 1B.** Anterior segment photography at 6 weeks post-operatively. Anterior segment photography presents a sealed wound with a satisfactory result.

#### 4. Discussion

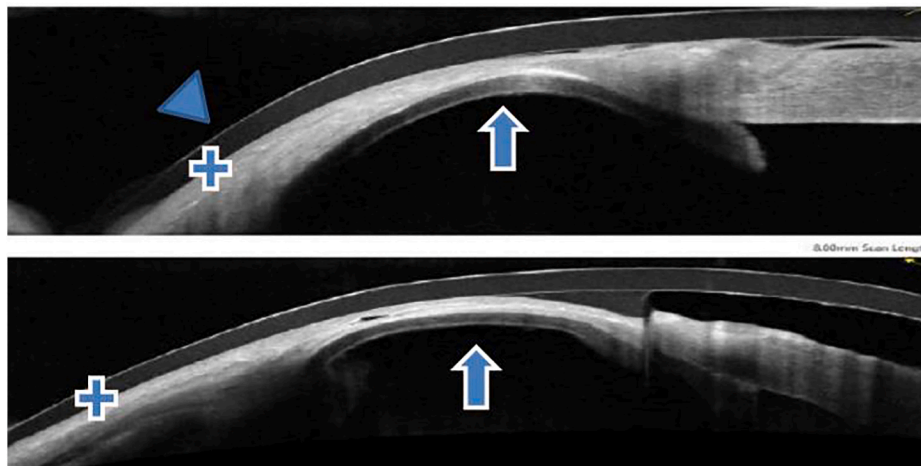
In this study, we demonstrate the effectiveness of a posterior lamellar graft in the treatment of corneal perforation. According to the literature, most grafts were larger than 8 mm, however similar to our case, Tourkmani et al. also employed a smaller graft (Hemi-DSAEK) to seal off the inferior perforation in a young patient with pellucid marginal degeneration.<sup>7</sup> We propose that the DSAEK graft be added to the arsenal of treatments for corneal perforation. We chose a tectonic DSAEK due to considerations of perforation’s location, visual potential, age, co-morbidities, and anesthetic risk. The surgeon could consider suture pull-through to pass needles to intended site of placement and drag the lenticule directly to that location. Similar to Hernandez et al., who strengthen the superior cornea with the amniotic membrane,<sup>4</sup> we stabilize the perforation with double amniotic membranes and an additional Gundersen partial flap. This benefits from adding an extra layer of protection, promoting cornea healing underneath, and improving the patient’s comfort.

In contrast to full tectonic (penetrating keratoplasty) or partial (deep anterior lamellar keratoplasty), tectonic DSAEK procedure will not induce significant corneal astigmatism. Furthermore, it is characterized by a rapid healing time, reduces the need for general anesthetic, has no graft sutures-related complications, and is associated with less immunological rejection.<sup>9</sup> In our case, we introduced the tissue through a 3 mm incision by pulling it with endoglide forceps. Other authors suggested that the graft might be inserted through the perforation wound, removing the necessity for the main corneal incision utilized in traditional DSAEK.<sup>5</sup> In our experience, this is the sole option if the perforation is more significant than 4 mm in diameter. The size chosen for the corneal graft was sufficient to completely seal the perforation without extending to affect the visual axis or excessively cover normally functioning endothelial cells while leaving as much recipient endothelium as possible untouched. We recommend choosing a graft size at least 1.5 mm wider than the perforation’s largest diameter. In addition, maintaining a temporary perforation seal throughout surgery is paramount during the graft introduction and mobilization. Using cyanoacrylate gluing can facilitate easier manipulation while the glue can be removed after graft introduction, mobilization and floating with air injection into the AC. Alternatively, with more extensive perforations, the graft tissue could be placed over the perforation and pushed into the anterior chamber directly.

Our literature review of the other report 11 cases is summarized in



**Fig. 2A.** Anterior Segment OCT (Optical Coherence Tomography) photos 1 week post-operatively.



**Fig. 2B.** Anterior Segment OCT (Optical Coherence Tomography) photos at 6 weeks post-operatively. Arrow head: contact lens Single arrow: DSAEK button Double arrow: amniotic membrane transplantation Plus sign: conjunctiva.

**Table 1.** Three of these cases had perforation owing to herpetic keratitis, three had undetermined etiology, two had endothelial decompensation, one had exposure keratitis, one had dry eye disease and one had corneal hydrops attributable to Pellucid marginal degeneration. The surgeries included a DSAEK tectonic graft, an amniotic membrane graft, and a hemi-DSAEK.<sup>7</sup> Overall, using a DSAEK as a tectonic graft was successful in achieving a stable cornea surface with rapid healing (mean follow-up of  $6.8 \pm 3.71$  months; mean final visual acuity of 6/15, Only two cases (2/11, 18%) needed a secondary procedure for rebuilding and sutures anchoring of the grafts. Moreover, it is important to use smear and tissue culture to rule out infection in suspected cases and, if necessary, antibiotic management. The use of antivirals in herpetic keratitis, the management of neurotrophic keratopathy in case it is the cause, and immunosuppressive treatment in autoimmune diseases. Furthermore, it is important to emphasize the importance of a correct diagnosis and management of the underlying disease for the long-term survival and outcome of the tectonic graft.

In conclusion, we present a modified technique for managing a peripheral, non-infected, corneal perforation using a “Sandwich” technique that combines posterior lamellar keratoplasty, an amniotic membrane patch and a Gunderson conjunctival partial flap. This “sandwich” approach is straightforward to replicate and can give quick healing with few visual repercussions. Our detailed guide may be utilized to obtain similar results and may be added to the array of treatment options for peripheral corneal perforation.

#### Patient consent

Consent to publish this case report has been obtained from the patient in writing. This report does not contain any personal identifying information.

#### Disclosures authorship

All authors attest that they meet the current ICMJE criteria for

Authorship.

#### Funding

No financial support was received for this submission.

#### Declaration of competing interest

The authors have no conflicts of interest.

#### Acknowledgements

None.

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