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ORIGINAL PAPER

Stromal Patch with fibrin glue as a novel surgical technique to seal peripheral Descemet's membrane perforations in deep anterior lamellar keratoplasty

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Abstract

Purpose The purpose of this article was to introduce a novel surgical technique for the management of peripheral Descemet's membrane perforation during deep anterior lamellar keratoplasty (DALK).

Methods First, a thin stromal patch was prepared either from the anterior stromal lamella cut during DALK or from the anterior stroma of a Descemet's stripping automated endothelial keratoplasty button. The stromal patch was secured in a stromal pocket dissected deep in the trephination edge along the perforation site. Fibrin glue was applied to the stromal patch. Finally, the graft was sutured to the recipient bed.

Results We used this technique in 3 cases with peripheral DM perforations during DALK. The first case was a persistent postoperative double anterior chamber who developed Urrets-Zavalia syndrome after air injection in an attempt to seal the perforation. In the second case, this technique was applied to seal an intraoperative DM perforation, without which the procedure would have been converted to penetrating keratoplasty. The third case had a persistent postoperative double chamber despite multiple air injections and fibrin glue application. The technique was effective in the management of all DM perforations with a resolution of double anterior chamber.

Conclusion This technique is safe and effective as an intraoperative method or a postoperative measure to seal peripheral DM perforations. We recommend this technique for repairing peripherally located DM perforations during DALK not amenable to simple measures like air injection or fibrin glue application.

Keywords Deep anterior lamellar keratoplasty · Double anterior chamber · Fibrin glue · Stromal patch

Introduction

Intraoperative perforations of the Descemet's membrane (DM) are a relatively common complication during deep anterior lamellar keratoplasty (DALK) with a reported average rate of 11.7% [1]. Apart from intraoperative challenges which may preclude completion of lamellar dissection, postoperative DM detachment or pseudo-anterior chamber formation could be another frustrating complication [2].

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Intraoperative DM perforations could be treated in a variety of ways, including intracameral air injection in the case of small perforations, application of fibrin glue for microperforations [3], and intracameral injection of fibrin glue in the case of larger perforations [4]. Postoperative DM detachment is also commonly managed by intracameral air or other long-acting gas injections [5], but the condition could still be refractory to conventional treatments. Complications like pupillary block, fixed dilated pupil (Urrets-Zavalia syndrome), anterior subcapsular opacities [6], and endothelial cell loss due to toxic effects on the corneal endothelium [7–9] could arise from repeated air injections.

Here we described a surgical technique for the management of peripheral DM perforations during DALK. The technique could be applied intraoperatively or as a secondary measure to manage the persistent pseudo-anterior chamber formation when the condition is not responsive to conventional measures like air or other long-acting gas injections.

Surgical technique

First, a thin stromal patch is prepared from the excised anterior stromal lamellae of the recipient cornea (Fig. 1a) or an anterior stromal layer from a Descemet's stripping automated endothelial keratoplasty (DSAEK) corneal button prepared by the eye bank. For the ease of dissection, the tissue is fixed with cyanoacrylate glue on the back surface of a sterile steel dish. The stromal patch, slightly larger than the perforation size, is dissected by a crescent knife from the fixed tissue (Fig. 1a).

For preparing the recipient bed, after removing the donor graft in the cases of postoperative double anterior chamber or removing the remaining recipient stroma in the cases of intraoperative large perforations, a stromal pocket is made. It is created deep in the trephination edge toward the limbus, along the margin of the perforation (Figs. 1b, 2b). The stromal patch is pulled into the dissected pocket using a double-armed 10-0 nylon suture; it is tied in a mattress fashion, and the knot is preferably buried in the stroma (Figs. 1c, 2b). Then, the internal edge of the stromal patch is trimmed (Fig. 1d). In the final stage, a small amount of fibrin glue is applied to the edges of the stromal patch to fix the tissue to the recipient DM and stroma (Fig. 1e). Then, the anterior chamber (AC) is reformed and the donor button is sutured in place with 16 separate 10-0 nylon sutures.

Figure 2 illustrates the position of the stromal patch and recipient bed pocket in relation to the perforation site.

Case 1

Our first case was a 25-year-old male with a double anterior chamber after DALK for macular corneal dystrophy (MCD). Primarily, air injection into the AC was attempted with induction of pupil mydriasis. However, the patient developed Urrets-Zavalia syndrome with the persistence of the DM detachment (Fig. 3a, b).

At this point, considering the complicated course of the patient, the above technique was considered for the patient. Intraoperatively, after removing the corneal sutures and the donor button, a 1.5 × 1 mm perforation was noted with leakage of the fluid along the perforation site. The perforation was completely sealed after fixation of the stromal patch (Video 1) with a resolution of the double chamber in the postoperative follow-up (Figs. 3c, d and 4).

Case 2

In the second case, this technique was used to address an intraoperative DM perforation in a 30-year-old patient with gelatinous drop-like corneal dystrophy (GDLD) who developed a perforation extending for 6 mm along the rim of trephination. Manual layer-by-layer dissection was performed after suturing the perforation site. However, due to severe anterior chamber collapse with the inability of the air or BSS to keep the AC, a stromal patch with fibrin glue was fixed to the perforation, with complete sealing of the perforation during the rest of the procedure (Video 2). Postoperative images are shown in Fig. 5.

Case 3

The third case was a 27-year-old patient with keratoconus who developed a Descemet's membrane tear during suturing of the graft. Postoperatively, the patient developed a double chamber which persisted despite two attempts of intracameral air injection. At the time of second air injection, fibrin glue was also

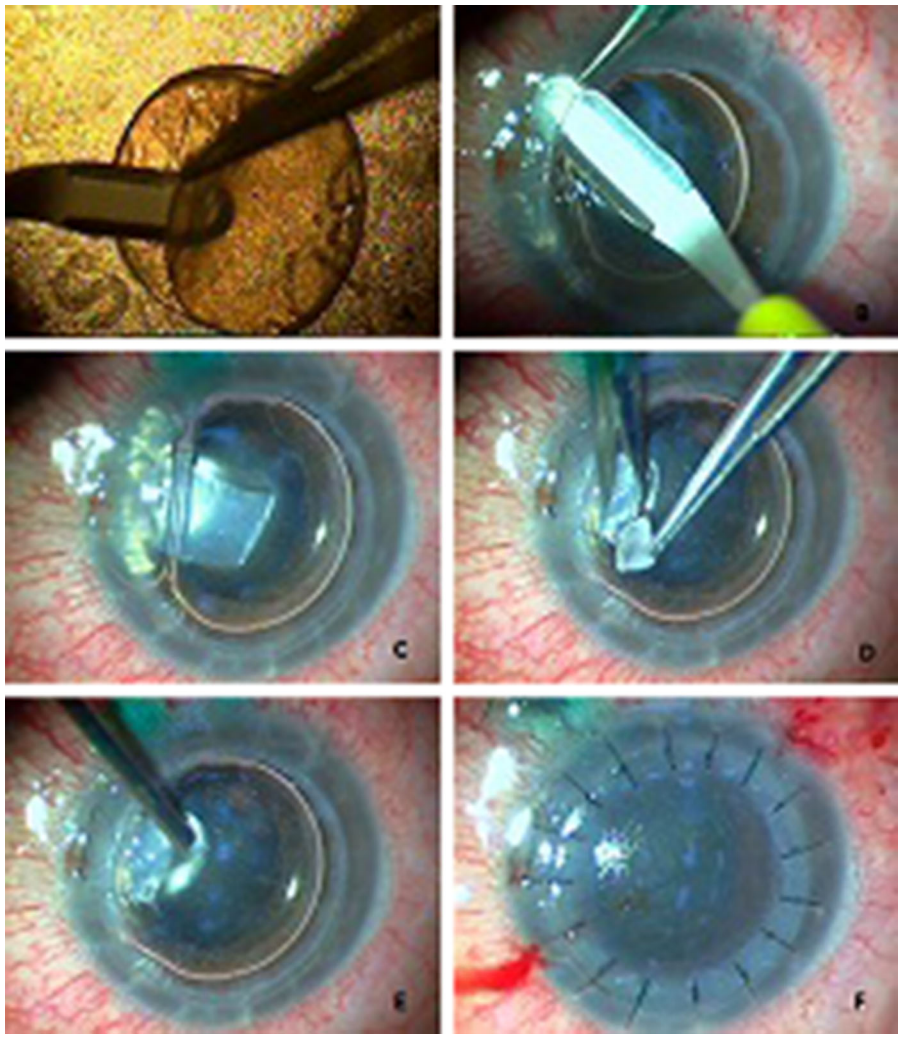

Fig. 1 Surgical technique. **a** A thin stromal patch is dissected from the corneal button fixed with cyanoacrylate glue to a steel surface, **b** a stromal pocket is formed in the trephination edge along the perforation site, **c** stromal patch is secured in the dissected pocket with a double-armed 10-0 nylon suture, **d** the edge of the stromal patch is trimmed, **e** fibrin glue is applied to the edges of the stromal patch, and **f** the donor cornea is sutured into the recipient bed

used in the interface at the site of perforation. Although the graft was clear on the following day, the seal was opened after 5 days when fibrin glue was absorbed, the double chamber recurred, and the graft became edematous. After fixing a stromal patch with fibrin glue using the mentioned technique, the seal was permanently closed and the DM detachment resolved (Fig. 6). Figure 7 shows corneal topography 6 months after the surgery.

Discussion

DM perforation and subsequent double anterior chamber are among the most challenging complications of DALK. Surgeon learning curve plays an important role. Huang et al. [10] in a large series of DALK patients reported a rate of 18.7% intraoperative DM perforations; of them, 38.6% developed DM detachments postoperatively. The most common steps at which DM perforation occurs during DALK are deep lamellar dissection (31.7%), air injection (26.7%), and suturing (20.8%).

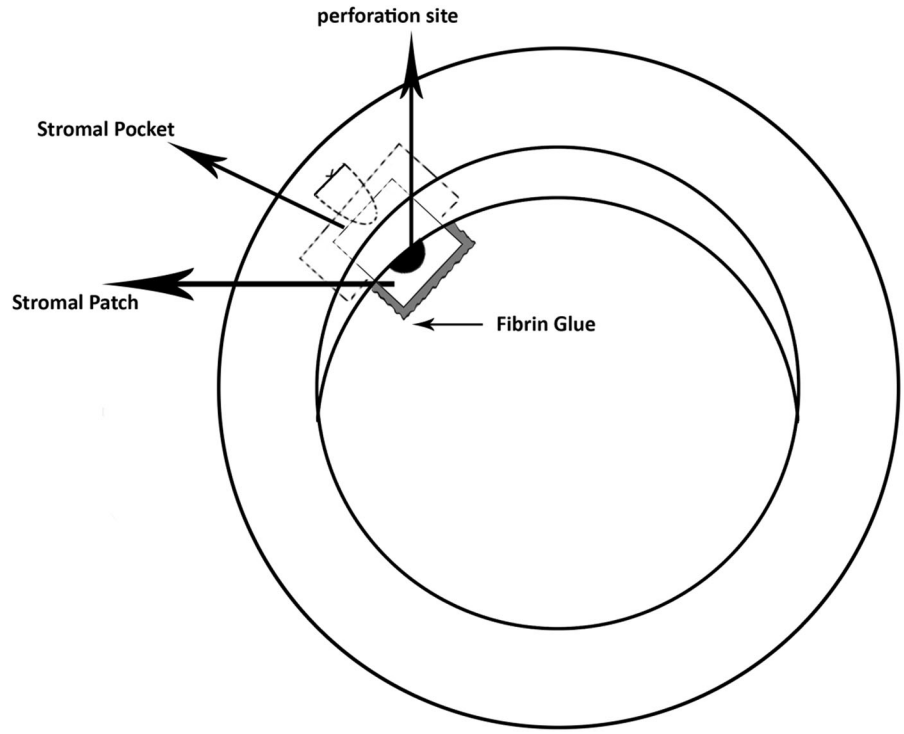

Fig. 2 Schematic illustration of the stromal patch and recipient bed pocket in relation to the perforation site. **a** Peripheral perforation site, **b** and **c** stromal patch sutured into the recipient rim pocket covering the perforation site

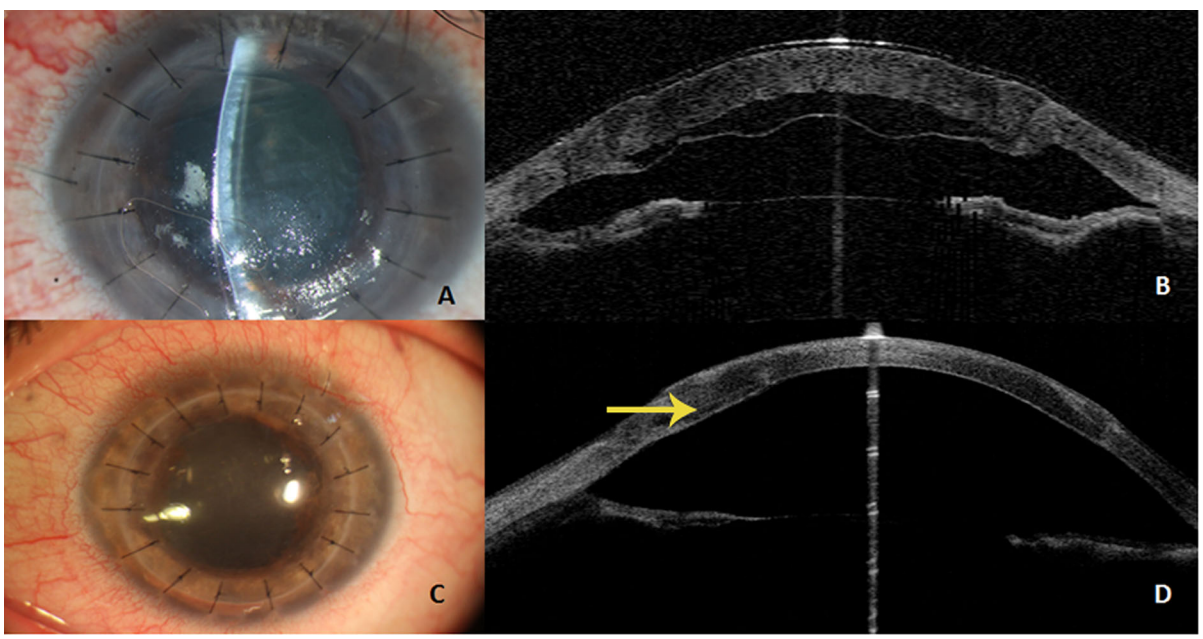

Fig. 3 **a** Graft edema due to total Descemet's membrane detachment, **b** anterior segment optical coherence tomography showing detached Descemet's membrane and double anterior chamber, **c** clear graft 2 months after reattachment of Descemet's membrane. The arrow shows the stromal patch in the interface, **d** anterior segment optical coherence tomography showing attached Descemet's membrane and resolved double anterior chamber. The arrow shows the stromal patch in place

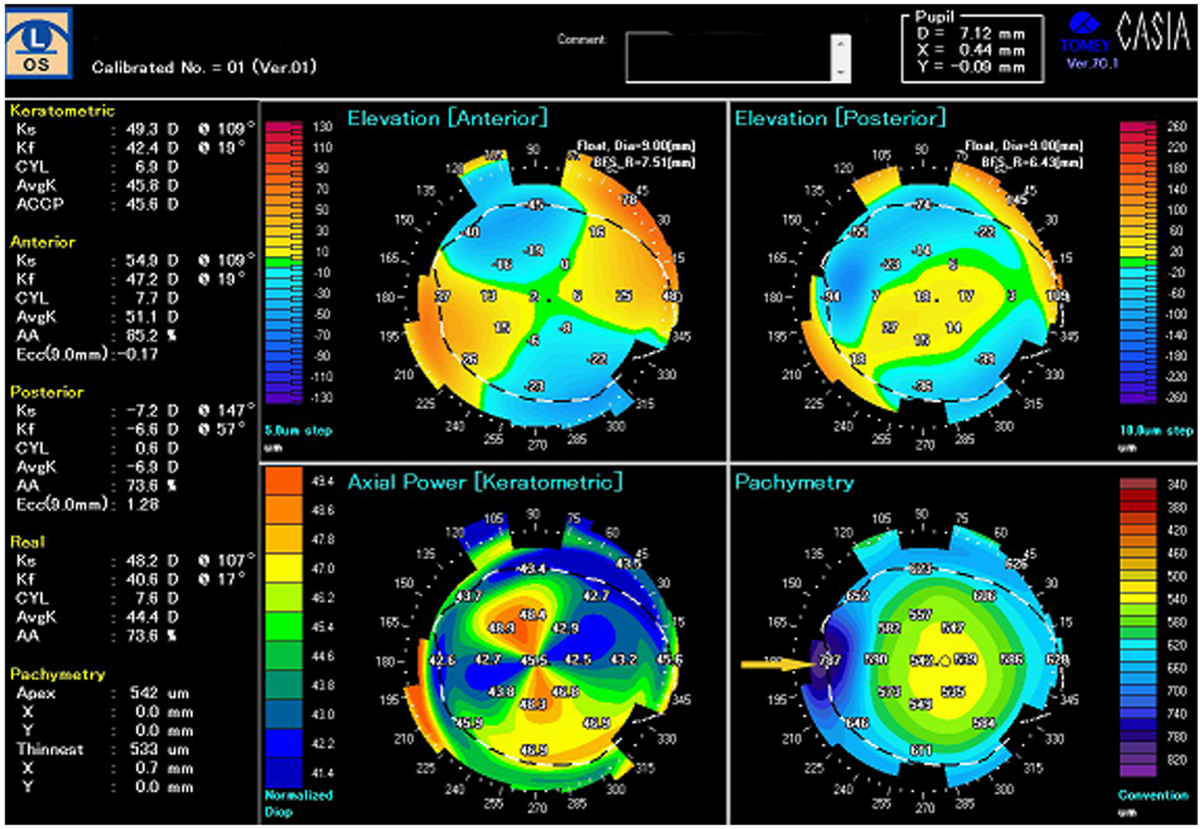

Fig. 4 Postoperative corneal topography 6 month after surgery showing regular astigmatic pattern. On the pachymetry map, an area of localized stromal thickening is seen on the stromal patch site (arrow)

Fig. 5 **a** Clear graft 1 week after surgery. **b** Anterior segment optical coherence tomography showing attached Descemet's membrane. The stromal patch is barely visible in the interface

Air or gas injection into the anterior chamber is usually the first step in the management of the problem. Haung et al. [10] managed 87.1% of postoperative double anterior chamber by intracameral air tamponade, 7.9% of which unresolved or recurrent DM detachments required repeat intracameral air tamponade. Most of the perforations in their series were microperforations. However, the air or gas can cause pupillary block and anterior lens opacities [6]. They are not always effective, and the procedure

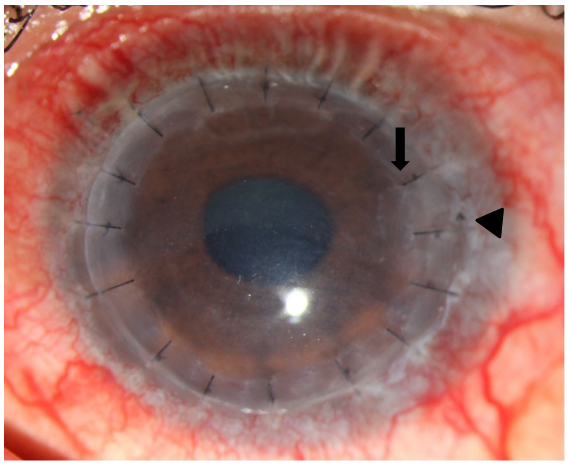

Fig. 6 Clear graft 1 week after surgery. Stromal patch (arrow) and patch suture (arrow head)

may need to be converted to PKP in cases with macroperforations. Also multiple air injections might be associated with endothelial cell loss [11].

Alternative options include the use of fibrin glue in the interface, but this technique may not be effective in large perforations or perforations with special configurations. As in our first case, the primary attempt of air injection and fibrin glue application in the interface failed to resolve the double anterior chamber. It also seems that the temporary effect of fibrin glue before absorption may not be adequate. As in our third case despite the initial success of fibrin glue in closing the perforation, the sealing effect was lost after absorption of fibrin glue and double anterior chamber recurred after 5 days. Small perforations with a slit-like configuration are probably most amenable to fibrin glue alone.

Suturing the DM defect is another reported procedure for managing large perforations [10].

When perforation is present or happens pre- or during air injection, centripetal layered dissection from periphery toward the perforation site and leaving a small stromal tissue on the perforation site can help

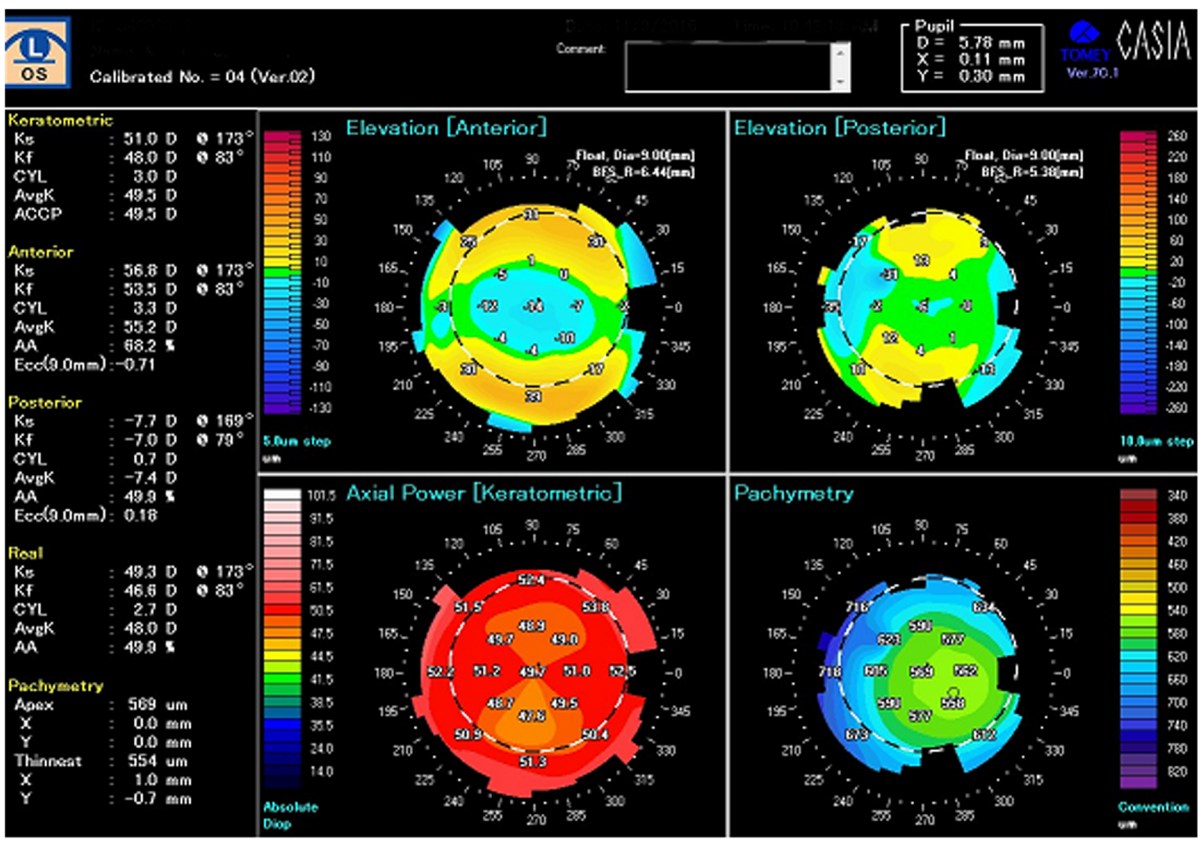

Fig. 7 Postoperative corneal topography 6 month after surgery showing acceptable regular astigmatism

to seal even macroperforations and avoid conversion to PKP [12].

We describe a novel technique to manage DM perforations in DALK. In this technique, the peripheral perforation is sealed by placing a stromal patch in the graft interface. The patch covers the perforation site and is pulled into a peripheral pocket in the recipient rim with 10-0 nylon suture. Even large perforations can be managed by this method, if they are located peripherally, near the recipient rim.

Tips for successful application of this technique include preparation of a thin stromal patch, deep location of the dissected pocket in the recipient rim to ensure proper alignment of the graft without override, and adequate length of the pocket to ensure full coverage of the perforation area.

Por et al. [4] also reported a technique of intracameral injection of fibrin glue for large corneal perforations in patients undergoing therapeutic DALK, allowing completion of the dissection. In comparison with their technique, our method obviates the need for an intracameral fibrin glue injection.

One of the concerns in using this technique may be the effect of the patch on suturing and on the final graft astigmatism and topography. One to 2 weeks after the surgery, with a resolution of edema, the patch becomes very thin (as it is clearly shown in the anterior OCT of case 1, Fig. 3d), minimizing the effect on corneal topography and graft astigmatism. Figures 4 and 7 also show the acceptable topography of cases 1 and 3 with regular astigmatism that can be managed with selective suture removal after adequate wound healing in the graft interface.

The patch could not seal the most peripheral perforations, unless it overlaps the perforation. Creating a pocket extended peripherally from the deep trephination edge and pulling the patch into the pocket facilitate proper positioning of the patch to support and achieve complete coverage of the most peripheral perforations.

This technique can be used for even large perforations, but it is most suitable for peripheral perforations not too extensive to involve the visual axis. Smaller perforations are more likely to respond to conservative measures like intracameral air injection.

This technique could be used in perforations happening either before or after completion of the dissection. In case 1, the perforation occurred in the middle of dissection, in case 2 before beginning the dissection, and in case 3 during suturing.

The anatomic and visual outcomes were good in all of our cases. Previously described methods including air injection into anterior chamber and fibrin glue application were all failed in our cases. Converting the procedure to full thickness keratoplasty was the only remaining option. In case 1, endothelial rejection because of a history of multiple graft rejections in the fellow eye and, in case 2, recurrence of gelatinous opacities and need for consecutive graft were important concerns for conversion to PKP.

During the follow-up period, we did not observe any toxic or allergic reactions to fibrin glue; however, despite the widespread use of fibrin glue in ophthalmology, the possibility of allergy to fibrin glue components or the possible risk of infection transmission should be considered [13].

In conclusion, the described technique was safe and effective for sealing peripheral DM perforations both intraoperatively and postoperatively for repairing a persistent double anterior chamber in our patients.

We recommend this technique for the management of peripherally located corneal perforations extending to the recipient rim when simple measures like air injection or direct application of fibrin glue to the perforation site are not effective.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in this study were approved by the ethical committee of Farabi Eye hospital and were in accordance with the tenets of the Helsinki Declaration.

Human and animal rights This article does not contain any studies with animals performed by any of the authors.

Informed consent Informed consent was obtained from all individual participants included in the study.

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