C-Press Technique to Facilitate Descemet Membrane Endothelial Keratoplasty Surgery in Vitrectomized Patients: A Case Series

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Purpose: To describe an original technique to unfold the graft in vitrectomized eyes undergoing Descemet membrane endothelial keratoplasty (DMEK).

Methods: We performed a retrospective chart and video review of successive cases presenting with corneal decompensation in vitrectomized eyes or aphakic eyes in which DMEK or combined DMEK/scleral-fixated intraocular lens implantation was indicated and in which a specific technique [Cornea-Press (C-Press)] was used to unfold the graft. C-Press is characterized by corneal indentation intended to artificially shallow the anterior chamber and allow the graft to unroll. Best spectacle-corrected visual acuity, central corneal thickness, the time of graft unfolding, endothelial cell count, and the incidence of intraoperative/postoperative complications were analyzed.

Results: Eleven eyes of 11 patients (8 men, mean age: 73 ± 12 years) were included. Corrected distance visual acuity (logarithm of the minimum angle of resolution) improved from 1.44 ± 0.23 preoperatively to 0.77 ± 0.36 6 months postoperatively ($P < 0.001$). Central corneal thickness (CCT) decreased from 644 ± 79 preoperatively to 516 ± 49 μm 6 months postoperatively. The graft unfolding time was 4.4 ± 2.5 minutes. Mean endothelial cell density was 2762 ± 192 preoperatively and 1872 ± 324 cells/mm^2 6 months postoperatively. No eye showed intraoperative complications. Rebubbling for partial detachment was needed in 2 cases (18%).

Conclusions: The C-Press technique enables likely safe and reproducible DMEK surgery in vitrectomized eyes. Further clinical studies with a large number of patients and longer follow-up are required to confirm our preliminary results.

Key Words: DMEK, endothelial keratoplasty, vitrectomized eyes, surgical technique

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Descemet membrane endothelial keratoplasty (DMEK) has been gaining popularity as a preferred treatment for endothelial pathologies such as Fuchs endothelial dystrophy and pseudophakic bullous keratopathy.[1] It has been shown to promote faster and better visual recovery, with reduced rejection rates.[2] Overcoming the learning curve was one of the major limiting factors to the widespread acceptance of this technique, but recent standardization of several crucial surgical steps allowed for increased adoption in conditions such as Fuchs endothelial dystrophy and nonvitrectomized pseudophakic bullous keratopathy.[3–5] The ability to shallow the anterior chamber (AC) in the latter conditions makes for easy endothelial graft unrolling inside the eye. However, vitrectomized eyes are monocameral, with fluid from the posterior segment in direct contact with the anterior segment, making it difficult to shallow the AC and subsequently unfolding the graft.[6–8] Hence, many surgeons still prefer performing Descemet stripping endothelial keratoplasty in this group of eyes. Lately, different techniques have been developed to facilitate unfolding of the graft in vitrectomized eyes. Sorkin et al introduced the use of pars plana infusion to stabilize the anterior segment during DMEK surgery.[8] We presented in 2016 a technique consisting first in injecting an air bubble on top of the graft, helping it to unfold, and then injecting another air bubble under it while widening the paracentesis to release the air from above the graft. This technique is helpful but is not always reproducible. Hayashi et al described the same approach and labeled it "double-bubble" technique.[6] In this article, we present a case series of patients in whom we used a simple, reliable, and previously undescribed maneuver, which helps unfolding the donor graft during DMEK surgery in vitrectomized eyes.

MATERIALS AND METHODS

Patients and Examination

We performed a retrospective chart and video review of successive cases presenting with corneal decompensation in vitrectomized eyes or aphakic eyes in which DMEK or

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combined DMEK/scleral-fixated intraocular lens (IOL) implantation was indicated and in which a Cornea-Press (C-Press) or corneal indentation technique was used to unfold the graft. The data collected included demographic characteristics, best spectacle-corrected visual acuity, central corneal thickness and pachymetry map (Visante; Zeiss Meditec, Jena, Germany) and specular microscopy. Measurements were obtained preoperatively and at 6 months postoperatively. Corneal donor characteristics were retrieved. All cases were recorded, and videos of the surgeries were reviewed and analyzed. The graft unfolding time was measured as the duration from the end of graft insertion to the start of air bubble injection under the graft using the C-Press unfolding technique. Intraoperative and postoperative complications were described. The study was conducted in compliance with the tenets of the Declaration of Helsinki and approved by the Institutional Review Board at the American University of Beirut.

Surgical Technique

Preparation of the graft was performed as previously described.[9] When surgery was combined with scleral-fixated IOL implantation, a 25-gauge trocar was inserted into the inferotemporal quadrant 3.0 mm from the limbus, creating a shelved incision, followed by connection of a 25-gauge posterior infusion cannula. Posterior vitrectomy was completed, and scleral-fixated IOL implantation was performed using the glued IOL[10] or the Yamane technique.[11] The rest of the surgery was similar whether it was DMEK only or DMEK combined with scleral-fixated IOL implantation. No peripheral iridectomies were performed. The descemetorhexis size was marked on the cornea. In the presence of 3 paracenteses (9, 11, and 2 o'clock), descemetorhexis was performed using an inverted Sinskey hook under air for better visualization. The recipient's Descemet membrane was removed, and iOCT (Rescan; Zeiss Meditec) was turned on to ensure removal of Descemet membrane remnants. The 7.75- to 8.5-mm donor Descemet membrane (the size was chosen according to the recipient's corneal size) was loaded into a glass cannula (Geuder AG, Heidelberg, Germany) and injected into the AC through a 2.2- or a 3-mm (if combined with a scleral-fixated IOL) clear corneal incision. If present, the infusion cannula was closed during graft insertion for all the remaining steps unless the eye collapsed. Graft orientation was assessed using iOCT (Fig. 1A). If the graft was not in the right orientation, fluid injection was performed through one of the paracenteses in a specific orientation to rotate the graft. Once the correct graft orientation was assessed, a cannula (A) was inserted inside the graft (descemetic side) (Fig. 1B) and moved left and right to open the graft while irrigating with balanced salt solution. Simultaneously, a second cannula (B) was used with the other hand to press on the epithelium centrally (Fig. 1C). Thus, the AC was artificially shallowed, and the graft remained opened (Fig. 1D). Cannula A was removed from the AC (Fig. 2A). A cannula (C) mounted on a 1-ml syringe was inserted under the graft, and a 20% sulfur hexaflouride (SF) 6 gas bubble was injected (Fig. 2B). Graft adhesion to the posterior stroma was confirmed by iOCT images (Fig. 2C). Corneal wounds were sutured using 10-0 nylon if

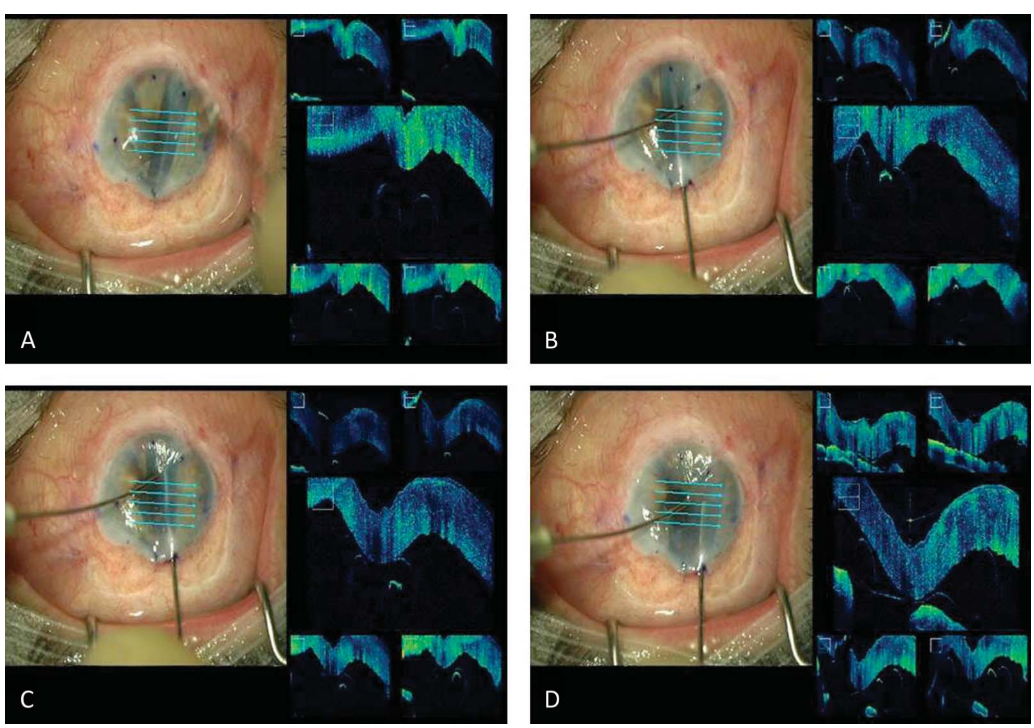

FIGURE 1. A, Assess graft orientation using iOCT. B, Cannula A is inserted inside the graft and moved laterally to unfold the graft. C, Cannula B is used to press on the epithelium and depress the AC while unfolding the graft with cannula A. D, Cannula B prevents the roll to form again.

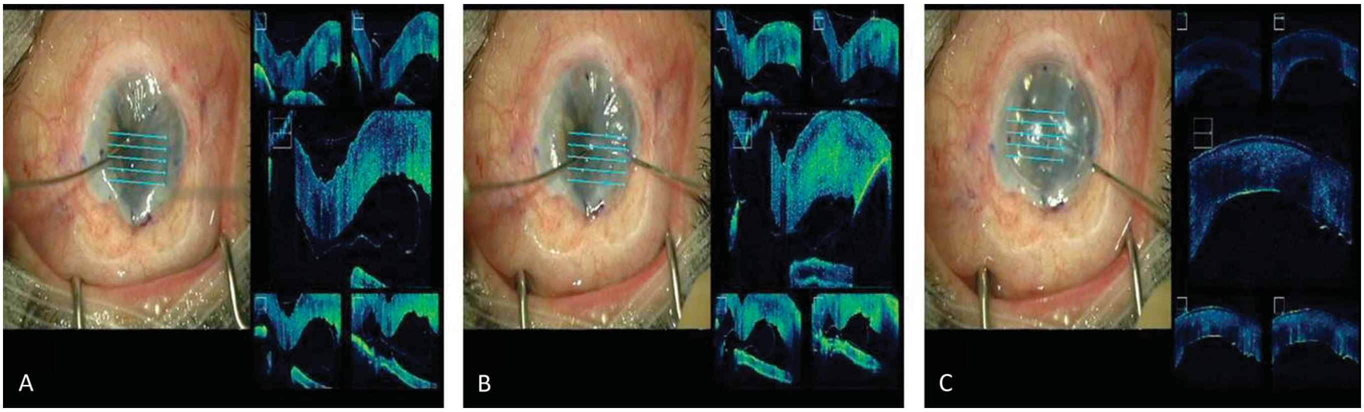

FIGURE 2. A, Cannula A is removed while cannula B is still pressing on the epithelium. B, Cannula C is inserted under the graft to inject air. C, The air bubble under the graft and cannula B is released.

needed, and, when present, the sclerotomy site was sutured using 8-0 Vicryl (Ethicon Inc, Somerville, NJ) after removal of the trocar in the event of a non–self-sealing wound. No peripheral iridectomy was performed.

Patients remained strictly supine for 2 hours, and then they were examined for graft adhesion and intraocular pressure, before being discharged home, and instructed to remain supine most of the time for 48 hours. Prednisolone acetate 1% and moxifloxacin 0.5% eye drops were started 4 times per day each in the operated eye. Moxifloxacin was stopped 1 week after surgery, and prednisolone was slowly tapered down to once daily during a 3-month period. Follow-up visits were conducted at day 1, 1 week, and 1 month postoperatively.

Statistical Analysis

Data were recorded in Microsoft Excel (2010) and analyzed using SPSS. The Wilcoxon test or paired *t* test was used to compare the mean preoperative and postoperative values, where appropriate.

RESULTS

Eleven eyes of 11 patients (8 men, mean age: 73 ± 12 years) were treated by DMEK in this study. Indication for DMEK was bullous keratopathy due to complicated cataract surgery. Four eyes were aphakic, 4 were pseudophakic with a scleral-fixated IOL, and 3 eyes had an AC-IOL. Aphakic eyes were treated with simultaneous combined scleral-fixated IOL implantation and DMEK surgery. In eyes in which an AC-IOL was present, the AC-IOL was removed and replaced by a scleral-fixated IOL, and DMEK surgery was performed at the same time. The donor's age was 66 ± 4.6 years.

Corrected distance visual acuity (logarithm of the minimum angle of resolution) improved from 1.44 ± 0.23 preoperatively to 0.77 ± 0.36 6 months postoperatively ($P < 0.001$). Central corneal thickness (CCT) decreased from 644 ± 79 to 516 ± 49 μm 6 months postoperatively. The graft unfolding time was 4.4 ± 2.5 minutes. Mean endothelial cell density was 2762 ± 192 preoperatively and 1872 ± 324 cells/mm^2 6 months postoperatively (31.9% loss). No eye showed intraoperative complications. Rebubbling for partial detachment was needed in 2 cases.

DISCUSSION

Unfolding of the endothelial graft during DMEK surgery in vitrectomized eyes remains one of the most challenging and least reproducible steps of the DMEK technique, mainly because of the inability to shallow the AC in these monocameral eyes. Yoeruek et al reported their surgical results in a group of 20 previously vitrectomized eyes in which a classic DMEK procedure[7] was performed. In their series, shallowing the AC was achieved by applying digital pressure at the equatorial plane. They reported that 65% had intraoperative complications, which required corrective measures. They also found that the unfolding process needed more time in these eyes and was associated with iatrogenic intraocular damage in some cases.[7] In an article published in 2016, we described our learning curve during DMEK procedures.[4] Looking back at our database, we found that of 109 included cases, 7 were previously vitrectomized with no AC-IOL in place. The graft unfolding time in this vitrectomized group of patients for which a standard unfolding technique was used was 18.1 ± 9.4 minutes, whereas the graft unfolding time in the whole study population was 9.8 ± 8.0 minutes. In this case series, the graft unfolding time from the moment we applied the C-Press technique was 4.4 ± 2.5 minutes, which is at least similar and even lower than the one reported with the simple DMEK procedure. The significant decrease in the unfolding time (18.1 vs. 4.4 minutes) might also be due to the surgeon's experience, as the first series was reporting our learning curve. However, the use of the C-press systematic steps certainly played a role in the fast unfolding time obtained in this series.

1. First, unfolding the graft in the correct orientation is needed. Although this step can be achieved in non-vitrectomized patients by shallowing the AC and tapping on the epithelium, a similar technique cannot be performed in vitrectomized patients because fluid

keeps coming from the posterior segment to the anterior segment, preventing the AC from shallowing. Thus, in vitrectomized patients, after confirming the correct orientation of the graft, the roll is positioned parallel to one of the paracenteses or to the main incision. Then, a cannula is inserted inside the graft (descemetic side) (Video 1, Supplemental Digital Content 1, http://links.lww.com/ICO/A818; Fig. 1B). Sliding the cannula left and right allows the graft to unfold while irrigating the AC if needed; at this stage, the roll would form again as soon as the cannula is taken out of the AC, as the latter remains deep from fluid coming from the posterior segment.

2. Thus, we use a second cannula (B) to press on the epithelium and depress the cornea, which artificially shallows the AC and prevents the roll from forming again (Video 1, Supplemental Digital Content 1, http://links.lww.com/ICO/A818; Fig. 1D).
3. Then, the other side of the graft is unrolled by sliding cannula A toward it, whereas cannula B is still depressing the AC.
4. When the graft is completely unrolled, cannula A is removed, and the graft remains unrolled, as cannula B is still depressing the cornea and shallowing the AC.
5. Finally, a 20% SF6 gas bubble is injected under the graft and the pressure on the epithelium is slowly released.

All these steps were effectively reproduced in all the cases. It was first performed by 1 surgeon in 10 cases and then successfully reproduced in 1 case by another surgeon. Sorkin et al described an unfolding technique in vitrectomized eyes in which they used pars plana infusion.[8] Although we found in our experience that pars plana infusion is very helpful to maintain the AC stable, it did not allow us in a reproducible way to shallow the AC and unfold the graft easily. The double-bubble technique[6] can be very helpful but may not be reproducible in all cases. In addition, accurate graft centration is not guaranteed while the unfolding time remains relatively long (10.1 $\pm$ 4.5 minutes).[6]

Early postoperative positioning was similar to that used in "classic" cases, namely 2 hours of supine position before discharging the patient. However, in our vitrectomized patients, we used a 20% SF6 gas bubble as opposed to the air bubble we use in bicameral cases. The main reason for SF6 use is to keep the gas tamponade for a longer period, especially as it is difficult to obtain acceptable tamponade pressure in these eyes. At the end of the procedure, we left a full gas bubble in the AC, but we avoided overfilling the eye so that the gas does not move posteriorly. Care was taken to keep patients in a strict supine position 2 hours postoperatively to avoid migration of the bubble to the posterior segment. At their visit on day 1, when examined in a sitting position at the slit lamp, some eyes did not show any bubble in the AC. However, in all cases, a partial bubble moved back to the AC when reclining the slit lamp chair to put the patient in a supine position. In case of minor graft detachment, a strict supine position was recommended for the next 24 or 48 hours, and reassessment was planned. Rebubbling for partial ($>$ 1/3) graft detachment, persistent at 1 week, was required in 2 cases.

Using the C-Press technique, the endothelial cell count loss and the rebubbling rate are lower than previously reported in similar conditions,[6] possibly because of minimal graft manipulation in this technique. Pressing on the cornea did not lead to any IOL dislocation or other complications even in combined surgery (simultaneous scleral-fixated IOL implantation + DMEK).

In conclusion, DMEK can be successfully performed in vitrectomized eyes using the C-Press technique. Clinical outcomes such as corrected distance visual acuity and decrease in central pachymetry were comparable to other described techniques, but with a lower unfolding time and complication rate.[6] Further studies on a larger cohort and with a longer follow-up period are needed to confirm our preliminary results.

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