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Phacoemulsification Under the Complex Dua Layer–Descemet–Endothelium for Combined Cataract Surgery and Penetrating Keratoplasty After Failed Deep Anterior Lamellar Keratoplasty

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Purpose: The aim of this study was to report the surgical management of an eye with a cataract and a failed deep anterior lamellar keratoplasty (DALK) graft. Given the null visualization of the anterior chamber, instead of performing penetrating keratoplasty (PK) combined with open-sky extracapsular extraction, the cleavage plane of the previous DALK was used to expose the transparent complex including Dua layer (DL)–Descemet membrane (DM)–endothelium and to perform phacoemulsification in a closed system; then, PK was completed after the surgical removal of the complex DL–DM–endothelium.

Methods: This study is a case report.

Results: A 45-year-old woman with corneal opacity due to Acanthamoeba keratitis underwent multiple ($n = 2$) DALK surgeries. The second DALK graft underwent failure, with the development of severe corneal edema; a dense opacity of the lens was also present. The patient was scheduled for combined PK and cataract surgery. Because the cornea was too opaque to allow closed-system cataract surgery, a partial trephination was performed with the purpose of reopening the old donor–host junction and finding the deep cleavage plane. This maneuver permitted the exposition of the complex DL–DM–endothelium that was completely transparent, thus allowing standard phacoemulsification using the phaco-chop technique. A full-thickness corneal graft was then positioned and sutured.

Conclusions: This case confirms the toughness of the complex DL–DM–endothelium and reveals the transparency of this complex even in the presence of a failed endothelium, thus highlighting distinct advantages of our surgical approach over the conventional one involving PK combined with open-sky extracapsular extraction.

Key Words: cataract, penetrating keratoplasty, Dua layer, deep anterior lamellar keratoplasty

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Cataract surgery performed in the setting of full-thickness corneal diseases is a complex procedure that requires advanced surgical skills. In some cases, a combined approach with penetrating keratoplasty (PK), known as a “triple procedure,” can be preferred over sequential strategies as it avoids multiple operations while allowing shorter periods of visual disability and fewer follow-up visits.^{1–3} However, a combined approach bares an elevated risk of intraoperative complications if cataract surgery is performed open-sky, mostly related to the lack of pressure in the anterior chamber.⁴

We present herein a unique case showing that the complex Dua layer (DL)–Descemet membrane (DM)–endothelium is sufficiently resistant to sustain closed-system phacoemulsification and completely transparent to allow optimal visualization of the anterior chamber details during phacoemulsification, even in the presence of a decompensated endothelium.

MATERIALS AND METHODS

We reviewed the case of a 45-year-old woman who underwent multiple deep anterior lamellar keratoplasties (DALKs) and ultimately developed cataract and endothelial failure with graft edema.

RESULTS

The patient first presented to our center with decreased vision, intense redness, and pain in her left eye. The diagnosis of Acanthamoeba keratitis was reached by means of corneal biopsy (Fig. 1A) and targeted medical therapy was administered. Six months later, the eye was quiet but the persistence of a corneal opacity significantly impaired visual acuity (Fig. 1B). The patient was therefore scheduled for DALK (graft diameter 8.50 mm) that was performed using the big-bubble (BB) technique, as previously described.⁵ Surgery was completed uneventfully with the formation of a type-1 BB. The postoperative course was regular until 10 months

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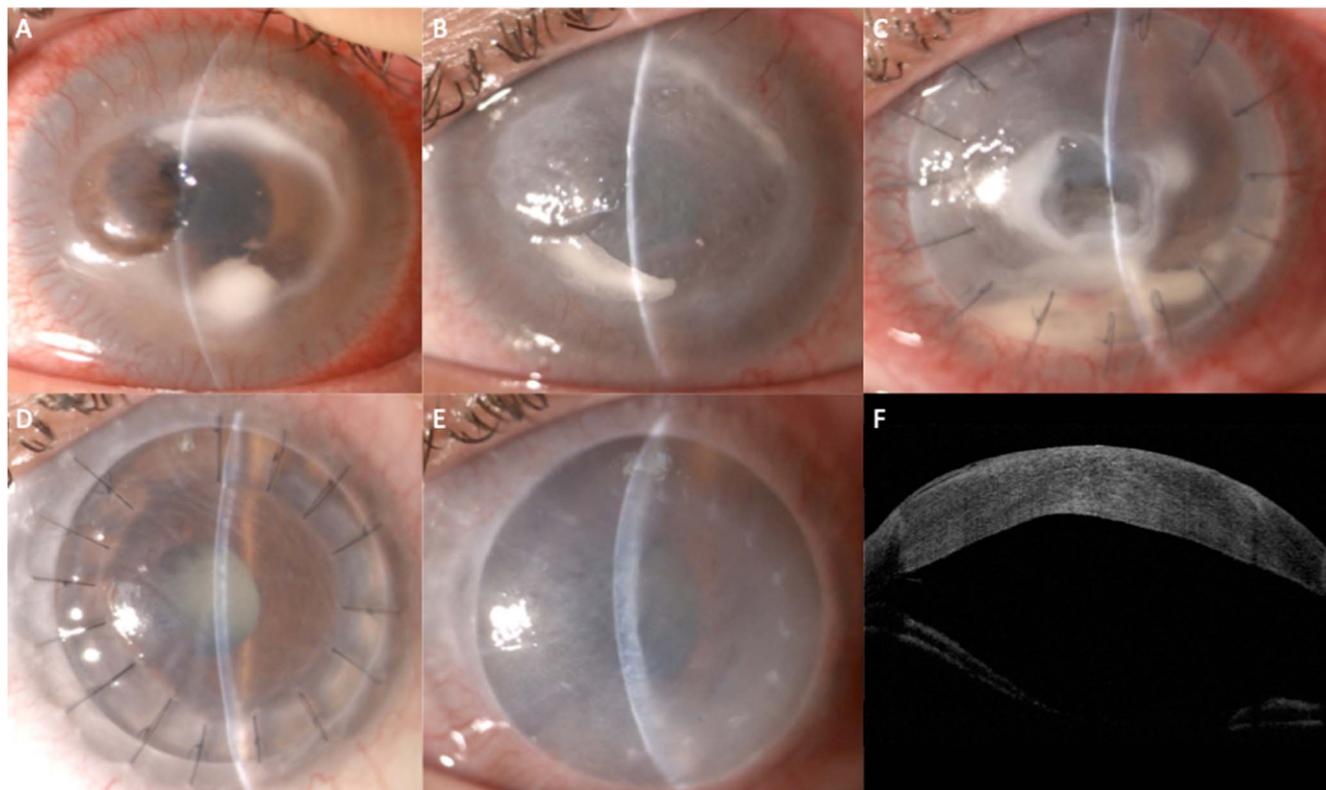


FIGURE 1. Clinical course of the patient from the initial presentation to the development of graft failure. A, Acanthamoeba keratitis confirmed by corneal biopsy; (B) corneal opacity after resolution of the infection strongly impaired vision; (C) a bacterial infection subsequently produced corneal graft opacity, requiring repeated DALK; and (D) after the second transplant the cornea was clear, its clinical course was uneventful until (E–F) endothelial failure caused the development of severe corneal edema.

postoperatively, when the patient developed a persistent epithelial defect of the graft that was complicated with bacterial superinfection (Fig. 1C). After resolution of the infectious process, a corneal opacity was once again present, requiring a repeated DALK procedure for visual rehabilitation. Figure 1D depicts the DALK graft 1 week after the second surgery. One year later, the DALK graft was still clear and epithelialized, and sutures were removed. Subsequently, the corneal graft became progressively opaque with increased thickness (central corneal thickness 1052 μ m) and formation of severe corneal edema (Figs. 1E, F); a dense opacity of the lens was also present. Given the null visualization of the details of the anterior chamber, the patient was therefore scheduled for combined PK and cataract surgery. Anterior segment optical coherence tomography scan obtained preoperatively showed a cleavage plane between the posterior stroma of the DALK graft and the recipient bed (complex DL–DM–endothelium) that had a thickness of 41 μ m (Fig. 2). All steps of this surgery are shown in Supplemental Digital Content 1 (see Video, <http://links.lww.com/ICO/B565>). A Hessburg–Barron vacuum trephine (JedMed, Saint Louis, MO) centered on the previous graft was used to obtain a partial trephination (approximately depth of 800 μ m), with the purpose of reopening the old donor–host junction and finding the deep cleavage plane, as already described.⁶ This

maneuver permitted the exposition of the complex DL–DM–endothelium that was completely transparent (Fig. 3A), thus allowing a good visualization of the details of the anterior chamber. Standard phacoemulsification using the phaco-chop technique was performed after synechiolysis and staining of the anterior capsule with trypan blue; a 3-piece hydrophobic soft acrylic intraocular lens [Avansee PU6A (Kowa, Nagoya, Japan)] was then implanted in the capsular bag (Fig. 3B). The sclerocorneal tunnel was secured with a

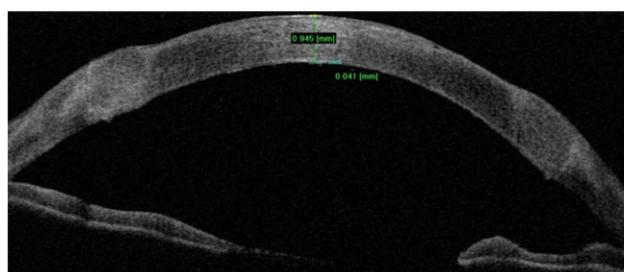


FIGURE 2. Anterior segment optical coherence tomography scan obtained before combined corneal and cataract surgeries. The cornea is edematous and the cleavage plane between donor graft and recipient bed (thickness of 41 μ m) is clearly visible.

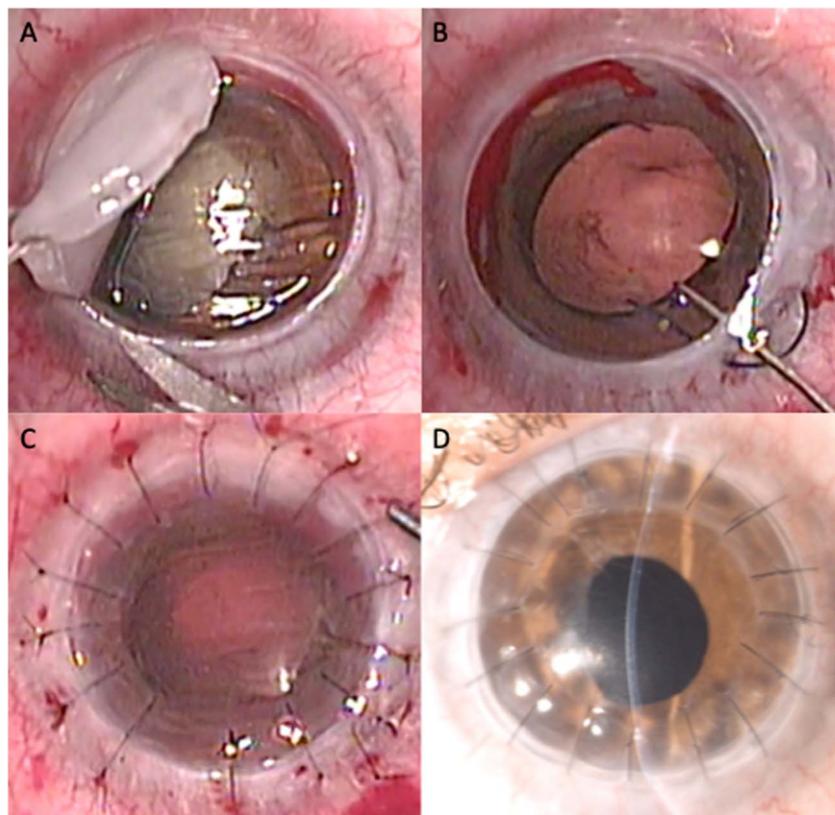


FIGURE 3. Intraoperative and postoperative images of combined PK and cataract surgery. (A) Edematous graft removal with exposure of the transparent DL-DM-endothelium complex; (B) 3-piece hydrophobic soft acrylic intraocular lens implantation in the capsular bag; (C) whole-thickness graft apposition and suturing; and (D) 1 week postoperative result.

10-0 nylon suture and the complex DL-DM-endothelium was removed using scissors. A full-thickness corneal graft of the same diameter (8.5 mm) was positioned, and 16 single sutures were applied (Fig. 3C). The surgery was uneventful as no intraoperative nor postoperative complications were recorded. One week postoperatively, uncorrected visual acuity was 20/120, corneal graft was transparent, and intraocular lens was well positioned in the posterior chamber (Fig. 3D).

DISCUSSION

This unique case demonstrates the resilience of the complex DL-DM-endothelium in withstanding cataract surgery while ensuring clear visualization of the anterior chamber details even in the presence of a failed endothelium. In the past, a possible solution proposed for cases with cataract and corneal edema due to Fuchs endothelial dystrophy was performing a microkeratome-assisted lamellar corneal dissection (about 60%–80% of the corneal thickness), followed by phacoemulsification and suture of a new lamella.⁷ However, this approach can only partially improve visualization of the anterior chamber details, leaving in place deeper opacities of the cornea. More recently, thanks to the redefinition of the human corneal anatomy with the demonstration of a novel pre-Descemet layer (namely DL),⁸ the feasibility and safety of a triple procedure consisting of DALK and phacoemulsification through bare DL owing to its strength and clarity after removing the entire corneal stroma when a type-1 BB (but not type-2) is achieved has been described in 2 eyes with

cataract and virgin opaque cornea (with a healthy endothelium).⁹ In our case, even in the presence of a full-thickness diseased cornea, the cleavage plane obtained with the previous type-1 BB-DALK was used to expose the complex DL-DM-endothelium and perform safe phacoemulsification under a closed system; subsequently, the complex including the failed endothelium was removed and a PK graft was secured. Because it has been demonstrated that DL is much tougher and resilient than DM, being able to withstand a pressure of around 700 mm Hg,⁸ phacoemulsification performed under this roof can be performed in experienced hands using fluidic parameters of routine cataract surgery. Conversely, DM alone is not able to withstand the pressure of a conventional cataract surgery, and its rupture has been described at the beginning of the surgical attempt at the time of viscoelastic injection, already before phacoemulsification.⁹

The main limitation of the present case is the lack of the *ex vivo* histologic examination of the complex DL-DM-endothelium that would have provided further insights into the anatomical characteristics of DL in this specific case. In fact, it is known that alterations in the DL for infiltration of keratocytes, myofibroblasts, fibroblasts, and/or inflammatory cells can occur in the setting of chronic corneal diseases.¹⁰

In conclusion, this case confirms that the toughness of the complex DL-DM-endothelium is sufficient to perform phacoemulsification under a closed system, as already demonstrated⁹; furthermore, this case reveals for the first time that the transparency of this complex is maintained not

only in the presence of extensive stromal scarring⁹ but also in the presence of a failed endothelium, highlighting distinct advantages of our original approach over the conventional one involving PK combined with an open-sky extracapsular cataract extraction.

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