

Temporary iris-lens diaphragm to assist descemet membrane endothelial keratoplasty in aphakic patients

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ABSTRACT

Purpose: Presenting a simple technique using an inversely implanted contact lens to create a temporary diaphragm to assist DMEK surgery in aphakic, partially aniridic and vitrectomized eyes.

Observations: The postoperative course was without pressure abnormalities and the anterior chamber remained deep. The cornea completely cleared within 3 weeks and remained clear after removal of the contact lens showing a corneal thickness of 544 μm and an intact endothelial cell pattern on endothelial cell microscopy after 3 months.

Conclusion and Importance: The inversely implanted contact lens provides an easily accessible temporary diaphragm, making DMEK surgery a safer procedure even in complex eyes without an adequate posterior barrier.

1. Introduction

Over the past years, Descemet membrane endothelial keratoplasty (DMEK) has emerged as a preferred treatment of endothelial pathologies of the cornea.¹ However, in certain scenarios and anatomical conditions, DMEK surgery still remains challenging.^{2,3} This is especially true for aphakic eyes which lack the posterior plane of the anterior chamber, making these eyes unicameral and making graft unfolding and attachment more challenging.⁴

The main challenge encountered in these eyes is the absence or reduced stability of the iridolenticular

Diaphragm that supports the graft during deployment and holds the gas bubble within the anterior chamber.⁴ Without this diaphragm, both the gas bubble and the thin endothelial graft could easily dislocate into the vitreous cavity.^{5,6} Moreover, even scleral-fixated IOLs do not always prevent dislocation of the gas bubble into the vitreous cavity.⁷

Due to the complexity and higher risk of complications with unacceptably high detachment and failure rates after DMEK in such cases, it is advisable to combine DMEK with iridolenticular diaphragm support. In aphakic patients with inadequate capsular support, intraocular lens (IOL) implantation can be performed with, for example, anterior chamber IOLs, iris-fixated IOLs and scleral-fixated intraocular lenses (SFIOLs).⁸⁻¹³ Likewise, simultaneous pupiloplasty and retropupillary iris-claw IOL implantation has been successfully described.¹⁴ However,

these procedures are not always possible in cases of advanced corneal decompensation with significantly reduced vision. Therefore, we present a simple technique using an inversely implanted contact lens to create a temporary diaphragm to assist DMEK surgery in an aphakic, vitrectomized eye with multiple iris defects.

1.1. Case report - surgical technique

A 40-year-old patient was referred for DMEK surgery due to a pronounced bullous keratopathy (1077 μm , VA hand movement). The cause was multiple previous surgeries due to retinopathy of prematurity with retinal detachment, secondary glaucoma and congenital cataract. Aphakia had been present since 1982. In addition, an old central tractional retinal detachment was present, so the visual prognosis was limited.

Due to poor insight a two-step approach was planned. First, only DMEK surgery should be performed in combination with implantation of a temporary diaphragm for compartmentalization and temporary creation of a stable anterior chamber during the graft implantation and tamponade phase. Only in a second step, when the cornea has cleared, a PVR surgery with silicone oil and possibly implantation of a scleral fixed IOL should follow. The patient has been informed about the off-label use of the contact lens and written informed consent was obtained from the patient in this individual attempt at healing.

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The graft was prepared using the standard liquid bubble technique as previously described.¹⁵ The lamella was marked with a triangular shark fin mark and then loaded contactfree into the DMEK cartridge (Geuder, Heidelberg, Germany).

After epithelial removal and descemetorhexis, a standard fluoro-silicone hydrogel contact lens (Air Optix Night & Day AQUA, Alcon, Switzerland) was punched to 10mm (vertical white-to-white corneal diameter minus approx. 1mm) (Fig. 1a), rolled up using implantation forceps, and then implanted inversely via the clear cornea incision (Fig. 1b and c). The contact lens should be inserted into the anterior chamber so that it unfolds by itself on the iris surface as a concave diaphragm by anchoring stably in the chamber angle, forming a compartmentalized anterior chamber (Fig. 1d). We did not perform an iridectomy because of the preexisting iris defects.

The lamellar graft was then implanted, unrolled and fixed in the anterior chamber with a 10% sulfur hexafluoride (SF6) bubble (Fig. 1e-i). Unfolding of the lamella was slightly more difficult than usual because the concave diaphragm did not allow flattening of the very deep anterior chamber, but ultimately succeeded and the gas was stable in the anterior chamber. The procedure was performed without complications.

The cornea cleared on schedule in the early postoperative period, but there was significant gas loss in the anterior chamber 6 days after implantation with incipient central detachment of the graft, so a re-bubbling with SF6 10% was performed. Subsequently, the cornea cleared completely and corneal thickness normalized. After 3 weeks, the contact lens was removed from the anterior chamber. For this purpose, the original clear cornea incision was reopened with a blunt spatula (Göttinger spatula, Geuder, Germany) under topical anesthesia, and the contact lens was grasped with a crocodile forceps and explanted. The graft remained untouched and attached to the stroma during this maneuver.

The postoperative course was without pressure abnormalities and the anterior chamber remained deep. The intermediate central graft desiccance was successfully reattached by re-bubbling. The cornea completely cleared within 3 weeks and remained clear after removal of the contact lens (Fig. 2), showing a corneal thickness of 544 µm and an intact endothelial cell pattern on endothelial cell microscopy with 1752 cells/mm² after 3 months. Visual acuity improved to 20/800 and the patient was pain free. After 3 months the planned vitrectomy with removal of the proliferative vitreoretinopathy (PVR) membranes and silicone oil implantation could be performed optimally and with good insight. During the 3-month silicon oil tamponade, there was no known

migration of silicon into the anterior chamber. However, a safety-net suture technique¹⁶ could be considered in the course of other patients to avoid silicone oil migration. Visual acuity improved to 20/125 at the final examination 7 months after the vitrectomy. The cornea remained clear and endothelial cell count was 1328 cells/mm².

2. Discussion

We present a simple option to create a temporary iris-lens diaphragm to safely perform DMEK surgery in eyes with aphakia and/or partial aniridia. The inversely implanted contact lens forms a stable, concave-shaped diaphragm from chamber angle to chamber angle, creating a well-compartmentalized anterior chamber in which the gas bubble remains until natural resorption.

Especially aphakic, aniridic and vitrectomized eyes have a high risk of complications in the execution of DMEK, as intraoperative challenges and graft dehiscence, graft dislocation, additional endothelial cell loss, and graft failure can occur.^{11,12} The importance of a stable compartmentalization was also highlighted in a study by Santaella et al. who demonstrated a graft dislodgement rate of 67% and an overall failure rate of 88% after DMEK in 9 eyes with aphakia and aniridia.⁷

The feasibility of implantation, unrollment, and secure attachment of the graft depends on three morphologic features of the eye: the depth of the anterior chamber, the stability of the iris-lens diaphragm, and the status of vitreous support.¹⁰ Our patient's situation was very complex, so all factors of difficulty were present, as well as poor visual acuity.

Without an adequate iris-lens diaphragm, dislocation of the gas bubble from the anterior chamber to the posterior chamber is inevitable. Typically, the gas migrates behind the iris segment and pushes it anteriorly toward the cornea, aided by the supine position of the patient, which can lead to extensive iridocorneal adhesions and ocular pressure peaks.¹²

The implantation of a transsclerally fixated IOL was not safely feasible in our patient due to the severe advanced bullous keratopathy and furthermore not primarily reasonable due to the previous history and the existing reduced visual prognosis. Nevertheless, a scleral-fixated IOL alone does not form a stable diaphragm anyway, especially in eyes with additional partial aniridia, and still shows a high rate of gas bubble dislocation, primary graft failure, and dislocation of the graft into the vitreous cavity.⁵ In addition, dislocation of the suture-fixated IOL can occur under gas pressure.¹⁰

This is also true for eyes with retropupillary fixed iris-claw IOLs, which show a similar high graft detachment rate after DMEK

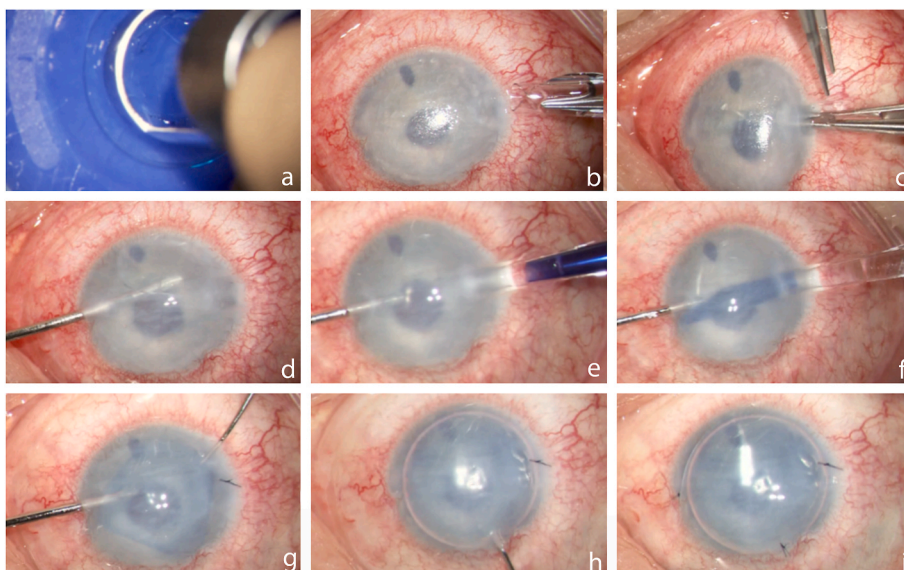


Fig. 1. After epithelial removal and descemetorhexis, a standard contact lens was punched to 10mm (a), rolled up using implantation forceps, and then implanted inversely via the clear cornea incision (b, c). The contact lens spread on the iris surface as a concave diaphragm by anchoring stably in the chamber angle, forming a compartmentalized anterior chamber (d). The lamellar graft was then implanted, unfolded and fixed in the anterior chamber with a sulfur hexafluoride (SF6) tamponade (e-i).

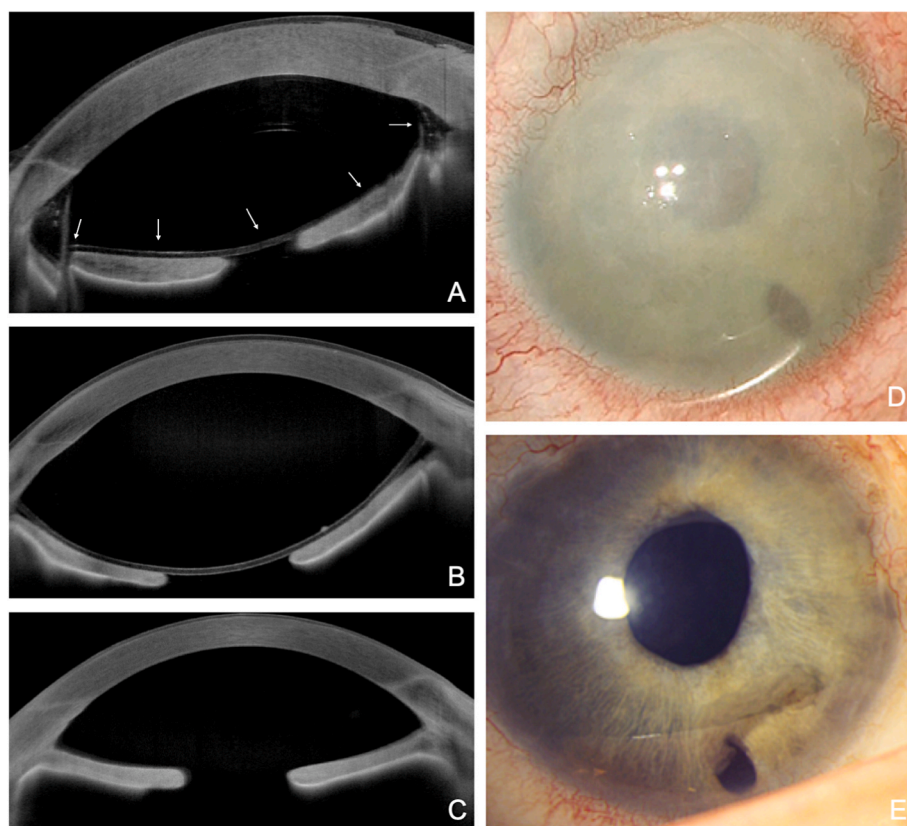


Fig. 2. Anterior chamber spectral-domain optical coherence tomography (SD-OCT, (Spectralis, Heidelberg Engineering, Heidelberg, Germany) showing the stable contact lens (arrows) at the first postoperative day (A), after 3 weeks (B) and 3 months after removal (C). The pronounced bullous keratopathy (D) completely cleared within 3 weeks (E).

surgery.^{11,12,17} In addition, an incision of 5.5–6 mm for IOL implantation may complicate the lamella deployment maneuver.

Also, vitrectomized eyes show higher complication detachment rates during DMEK surgery.¹⁸ Yoeruek et al. reported an intraoperative complication rate up to 65%.¹⁹ This is due to the very deep anterior chamber in avitreous eyes, which makes graft unfolding difficult. Yoeruek and Bartz-Schmidt proposed a technique in which a hydrophilic methacrylate sheet measuring 12.8 mm is temporarily placed in the anterior chamber for flattening the anterior chamber and facilitating graft unfolding.²⁰ Another group proposed inserting an ICL over the iris to create a temporary intraoperative barrier, facilitate graft deployment, and prevent posterior graft dislocation.²¹

The new technique described here represents a simple way of ensuring compartmentalization and stably sealing the natural anterior chamber in a very complex case of a vitrectomized and aphakic eye. Unlike the approaches described above (methacrylate sheet and ICL), which are intended only to assist the unfolding process and are removed at the end of surgery, the inversely implanted contact lens was left in place without complications throughout the tamponade period until the graft was healed. This is important because the risk of dislocation of the gas bubble or graft is not only intraoperative, hence a compartmentalization is mandatory throughout the entire tamponade period. Likewise, additional manipulation at the end of the operation with removal of the contact lens increases the risk of dislocation of the graft or even loss of the tamponade. An alternative to remove the contact lens directly at the end of the surgery to avoid escape of gas and dislocation of the graft during its removal could be a continuous air infusion into the anterior chamber via an anterior chamber maintainer connected to an air pump that inflates the chamber with air while performing manipulations in the chamber.²²

However, even though the biocompatibility and immunological

response of the contact lens used is well known for the epithelium,^{23,24} the impact on intraocular use is unclear, so this should therefore be thoroughly investigated in advance.

The disadvantage is that it must be removed again in a second procedure after a few weeks as degradation may occur. However, this is a short, minimally invasive procedure under topical anesthesia that does not damage the graft but the necessity of a second procedure must be communicated to the patient. Another disadvantage is that spreading and unrolling of the lamella is slightly more difficult than usual because the concave diaphragm does not allow flattening of the anterior chamber. However, the maneuver ultimately succeeded. Even though we did not have a problem with the eye pressure because of the pre-existing iris defects, in future patients it would be advisable to perform an and-iridectomy into the contact lens so that pupillary block does not occur.

In summary, the inversely implanted contact lens provides an easily accessible temporary diaphragm, making DMEK surgery a simple and safe procedure even in complex eyes without an adequate posterior barrier.

Patient consent

Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

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Authorship

All authors attest that they meet the current ICMJE criteria for

Authorship.

Declaration of Competing interest

Prof. Peter Szurman has a patent for a Device for preparing and introducing a transplant or an implant into a living body, in particular for ophthalmological interventions: EP2533724 B1; WO2012065602 A3.

All other authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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