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. However, in certain scenarios and anatomical conditions, DMEK surgery still remains challenging. 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.

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. Without this diaphragm, both the gas bubble and the thin endothelial graft could easily dislocate into the vitreous cavity. Moreover, even scleral-fixated IOLs do not always prevent dislocation of the gas bubble into the vitreous cavity.

Due to the complexity and higher risk of complications with unacceptable 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). Likewise, simultaneous pupilloplasty and retropupillary iris-claw IOL implantation has been successfully described. 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.
The graft was prepared using the standard liquid bubble technique as previously described. 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 fluorosilicone 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 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. 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 rebubbling 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 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 dehiscence 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 removal of the proliferative vitreoretinopathy (PVR) membranes and patient was pain free. After 3 months the planned vitrectomy with completely cleared within 3 weeks and remained clear after removal of the anterior chamber remained deep. The intermediate central graft maneuver.

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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. 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. B. 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. 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 unavoidable. 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.

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. In addition, dislocation of the suture-fixated IOL can occur under gas pressure.

This is also true for eyes with retropupillary fixed iris-claw IOLs, which show a similar high graft detachment rate after DMEK.
surgery. 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. Yoeruek et al. reported an intraoperative complication rate up to 65%. This is due to the very deep anterior chamber in avitreal 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. Another group proposed inserting an ICL over the iris to create a temporary intraoperative barrier, facilitate graft deployment, and prevent posterior graft dislocation.

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.

However, 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 ando-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
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Authorship
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Declaration of Competing interest

Prof. Peter Szurman has a patent for a Device for preparing and introducing a transplant or an implant into a single center in Germany. Curr Eye Res. 2020;45(10):1199–1204. https://doi.org/10.1080/02713683.2020.1737716.

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References

1. Pluzsik MT, Seitz B, Flockerzi FA, et al. Changing trends in penetrating keratoplasty indications between 2011 and 2018 - histopathology of 2123 corneal buttons in a single center in Germany. Curr Eye Res. 2020;45(10):1199–1204. https://doi.org/10.1080/02713683.2020.1737716.

2. Dapena I, Ham I, Droutsas K, van Dijk K, Moutsouris K, Melles GRJ. Learning curve in descemert’s membrane endothelial keratoplasty: first series of 135 consecutive cases. Ophthalmol. 2011;118(11):2147–2154. https://doi.org/10.1016/j.ophtha.2011.03.037.

3. Seitz B, Daas I, Flockerzi E, Suflo S. ‘Descemet membrane endothelial keratoplasty’ DMER – spender and Empfänger Scheit für Schritt. Ophthalmologe. 2020;117(8): 811–828. https://doi.org/10.1007/s00347-020-01314-1.

4. Ozmen MC, Ozdemir E. Descemet membrane endothelial keratoplasty in an aphakic vitrectomized eye with a large iris defect. JCRS Online Case Reports. 2018;6(1):1–3. https://doi.org/10.1006/jocr.2017.10.003.

5. Heliwa K, Januschowski K, Boden KT, Rickmann A. An unusual case of DMEK graft loss into the vitreous and its successful retrieval and survival. Case Rep Ophthalmol. 2018;9(2):391–397. https://doi.org/10.1159/000492173.

6. Vasquez-Perez A, Brennan N, Ayoub T, Allan B, Larkin DFP, Da Cruz L. Descemet membrane endothelial keratoplasty (DMEK) graft dislocation into the vitreous cavity. Cornea. 2019;38(2):173–176. https://doi.org/10.1097/ICO.0000000000002178.

7. Sontaella G, Sorkin N, Mimouni M, et al. Outcomes of descemert membrane endothelial keratoplasty in aphakic and aniridic patients. Cornea. 2020;39(11): 1389–1393. https://doi.org/10.1097/ICO.0000000000002287.

8. Stem MS, Todorich B, Woodward MA, Hsu J, Wolfe JD. Scleral-fixed intraocular lenses: past and present. J Vitreoretin Dis. 2017;1(2):144–152. https://doi.org/10.1177/247431621695650.

9. Szurman P, Petermeier K, Aisenbrey S, Spitzer MS, Jaisle GB. Z-suture: a new knotless technique for trans scleral suture fixation of intraocular implants. Br J Ophthalmol. 2010;94(2):167–169. https://doi.org/10.1136/bjo.2009.162180.

10. Weller JM, Tourtas T, Kruse PB. Feasibility and outcome of descemert membrane endothelial keratoplasty in complex anterior segment and vitreous disease. Cornea. 2015;34(11):1351–1357. https://doi.org/10.1097/ICO.0000000000000625.

11. Bhandari V, Reddy JK, Siddharthan KS, Singhania N. Simultaneous Descemert’s membrane endothelial keratoplasty and posterior iris-cleft-fixed intra ocular lens implantation (IOL) in management of aphakic bullous keratopathy. Int Ophthalmol. 2016;36(3):305–311. https://doi.org/10.1007/s10792-015-0117-z.

12. Gornemann J, Maier A-KB, Klamm MJK, et al. Posterior iris-cleft aphakic intraocular lens implantation and Descemet membrane endothelial keratoplasty. Br J Ophthalmol. 2014;98(9):1291–1295. https://doi.org/10.1136/bjophthalmol-2014-034948.

13. Rock D, Rock T, Bartz-Schmidt KU, Yourek E. Descemet membrane endothelial keratoplasty in cases with existing scleral-sutured and iris-sutured intraocular lenses. BMC Ophthalmol. 2014;14:6. https://doi.org/10.1186/1471-2415-14-6.

14. Mikropoulos DG, Kymionis GD, Grentzelos MA, Voulgaris N, Katsanos A, Konsta AG. Combined pupilloplasty and retropupillary iris-cleft intraocular lens implantation with DSAAK in a patient with traumatic iridoplegia, aphakia and corneal decompensation. Ophthalmol Ther. 2019;8(3):497–500. https://doi.org/10.1007/s40123-019-0198-2.

15. Szurman P, Januschowski K, Rickmann A, Damm L-J, Boden KT, Opitz N. Novel liquid bubble dissection technique for DMEK limbal preparation. Graefes Arch Clin Exp Ophthalmol. 2016;254(9):1819–1823. https://doi.org/10.1007/s00417-016-0077-4.

16. Berger O, Kriman J, Vasquez-Perez A, Allan BD. Safety-net suture for aphakic descemet membrane endothelial keratoplasty. Cornea. 2022;41(6):789–791. https://doi.org/10.1097/ICO.0000000000002923.

17. Phylactou M, Matarazzo F, Din N, Maurino V. Descemet membrane endothelial keratoplasty in vitrectomized eyes: a case series of outcomes and complications. Int Ophthalmol. 2021;41(7):2425–2432. https://doi.org/10.1007/s10792-021-01797-y.

18. Heinzelmann S, Hüther S, Böhringer D, Eberwein P, Reinhard T, Maier P. Influence of donor characteristics on descemet membrane endothelial keratoplasty. Cornea. 2014;33(6):644–648. https://doi.org/10.1097/ICO.0000000000000160.

19. Yourek E, Rubino G, Bayyoud T, Bartz-Schmidt K-U. Descemet membrane endothelial keratoplasty in vitrectomized eyes: clinical results. Cornea. 2015;34(1):1–5. https://doi.org/10.1097/ICO.0000000000000286.

20. Yourek E, Bartz-Schmidt KU. Novel technique for improving graft unfolding in vitrectomized eyes using a temporary diaphragm in descemert membrane endothelial keratoplasty. Cornea. 2018;37(10):1334–1336. https://doi.org/10.1097/ICO.0000000000001614.

21. Shweiki Y, Vasquez-Perez A, Allan BD. Phakic intraocular lens as a temporary barrier in aphakic Descemert’s membrane endothelial keratoplasty. Eur J Ophthalmol. 2019;29(5):566–570. https://doi.org/10.1177/1120672118811743.

22. Gabbay IE, Bahar I, Nahum Y, Livny E. Comparison of Descemet stripping under continuous air flow, manual air injection and balanced salt solution for DMEK: a pilot study. Graefes Arch Clin Exp Ophthalmol. 2017;255(8):1605–1611. https://doi.org/10.1007/s00417-017-3675-0.

23. Wilcock MDP. Microbial adhesion to silicone hydrogel lenses: a review. Eye Contact Lens. 2013;39(1):61–66. https://doi.org/10.1097/ICO.0b013e318275e284.

24. Hall BJ, Jones LW, Dixon B. Silicone allergies and the eye: fact or fiction? Eye Contact Lens. 2014;40(1):51–57. https://doi.org/10.1097/ICO.0b013e3182775e284.