American Journal of Ophthalmology Case Reports 7 (2017) 126–128

Contents lists available at ScienceDirect

American Journal of Ophthalmology Case Reports

journal homepage: http://www.ajocasereports.com/

Case report

An unusual case of acute angle-closure glaucoma following deep anterior lamellar keratoplasty using the "big bubble" technique

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ARTICLE INFO

Article history:
Received 13 December 2016
Received in revised form
11 April 2017
Accepted 20 June 2017
Available online 22 June 2017

Keywords:
DALK
Acute angle closure glaucoma
Double bubble technique

ABSTRACT

Purpose: To report the first case of acute angle closure due to a high-pressure Descemet membrane detachment following deep anterior lamellar keratoplasty (DALK) using the "big bubble" technique.
Observations: A 25-year-old man underwent DALK surgery for keratoconus using the "big bubble" technique in which an air bubble is injected in deep stroma to promote dissection of underlying Descemet membrane from stroma. Surgery was uneventful and the patient was discharged home in good conditions. On post-operative day 1, the patient came back with severe periocular pain. Intra-ocular pressure was found to be 38 mmHg. Anterior-segment OCT revealed a "double anterior chamber" created by a high-pressure Descemet detachment that was occluding the pupil and causing secondary acute angle closure glaucoma. The patient was brought back promptly to the operating room where the high-pressure chamber was properly evacuated, allowing Descemet membrane to properly reattach to stroma.
Conclusions and importance: Inability to recognize stroma from Descemet membrane during the dissection of the "big bubble technique" can result in failure to evacuate the high-pressure Descemet membrane detachment, putting the patient at risk for acute angle closure glaucoma from occlusion of the pupil. Proper dissection of stroma from underlying DM is a challenging and crucial step in the "big bubble" technique. Several methods, such as the injection of small bubbles in the anterior chamber or the use of intra-operative anterior segment OCT could be employed to prevent such a complication.

1. Introduction

Deep anterior lamellar keratoplasty (DALK) is a relatively novel lamellar keratoplasty that involves selective transplantation of the corneal stroma, leaving the native Descemet membrane and endothelium intact. It is indicated in diseases that involve the corneal stroma in the presence of healthy endothelium, such as in corneal ectasia (e.g. keratoconus), anterior corneal scars and corneal stromal dystrophies. Advantages of DALK over standard penetrating keratoplasty (PKP) include a stronger donor-recipient wound and most importantly a virtually inexistent risk of endothelial rejection. However, the technique is much more complex and difficult to perform, often warranting intra-operative conversion to standard PKP. While several surgical techniques have been described in the literature, the "big bubble" technique has become the most popular worldwide.[1] The mainstay of this technique involves injection of an air bubble in the deep stroma, causing a separation of Descemet membrane from the overlying anterior cornea, allowing an easier dissection of the stroma. The most common complication encountered with this technique is iatrogenic perforation of DM. Other less common complications have been described in the literature. We describe in this article a first report of an unusual complication associated with this technique.

2. Case report

A 25 year-old man known for bilateral keratoconus underwent DALK surgery in his left eye using the "big bubble" technique. During the surgery, air was injected in a deep groove created by a Hanna trephine at 70% of stromal thickness using a 27G needle. The injected air bubble allowed dissection of the recipient's corneal stroma from the underlying DM without any complications. The stroma was then carefully removed and the donor's corneal graft

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http://dx.doi.org/10.1016/j.ajoc.2017.06.013

was successfully secured in place with 16 10-0 nylon sutures. Overall, the surgery went well without any complications.

On post-operative day 1, the patient presented with left peri-ocular pain associated with a headache and nausea. His visual acuity was hand motion (HM) in the left eye, and his intraocular pressure (IOP) was at 38 mmHg. His left pupil was mid-dilated and poorly reactive to light. Anterior segment examination of the left eye revealed a ciliary flush with a diffusely hazy and edematous corneal graft (Fig. 1). The anterior chamber (AC) was deep centrally but very shallow peripherally at 360°. It was difficult to assess for the presence of inflammation in the AC because of corneal edema. The iris appeared to have a concave configuration. The red reflex was normal but details of the fundus were impossible to examine. The patient was promptly started on glaucoma drops to lower his IOP.

Anterior segment OCT (AS-OCT) (Fig. 2) showed a corneal graft resting on a residual posterior stromal bed. The AC looked deep centrally but the iridocorneal angle was completely sealed peripherally. A thin membrane was noted overlapping the pupil. It was hypothesized that this membrane represented the host's DM, and that the apparent AC was indeed a double AC created by a Descemet membrane detachment (DMD).

The patient was promptly taken to the OR where the grafted cornea was removed and the residual posterior stroma was carefully dissected, evacuating the underlying trapped air bubble. The DM remained intact, and the graft was secured back in place with no complications. At the end of the procedure, the sutures were watertight and the AC was properly formed.

His subsequent post-operative course was uneventful. His best-corrected visual acuity (BCVA) improved and his IOP normalized without glaucoma drops. At one-year follow-up, the patient's DALK was still clear, his BCVA was 20/80 and his IOP was 14 mmHg on no drops.

3. Discussion

We describe the first reported case of an acute angle-closure glaucoma precipitated by a high-pressure double AC following DALK.

The big bubble technique of DALK is a challenging technique that involves injection of air in the host's deep stromal tissue in order to achieve separation of DM from the corneal stroma.[1] This step is only successful 65–69% of the time[2,3] and is associated with a high risk of iatrogenic perforation of DM, often warranting a conversion of DALK into a standard PKP.[4]

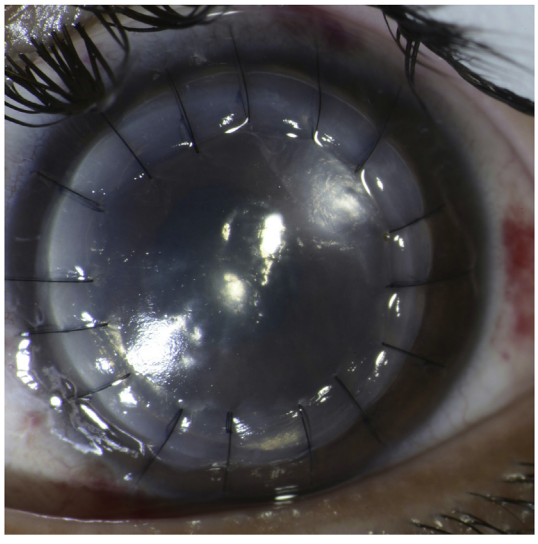

Fig. 1. Anterior segment photograph of the left eye demonstrating ciliary flush and edematous deep-anterior lamellar keratoplasty graft.

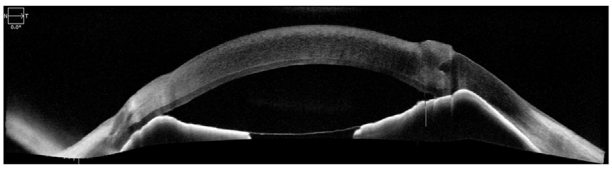

Fig. 2. Anterior segment-OCT (AS-OCT) demonstrating a corneal graft resting on a residual posterior stromal bed. The iridocorneal angle appears to be sealed while central anterior chamber is deep. A Descemet membrane can be noted overlapping the pupil and the iris appears to have a concave configuration.

In our case, the big bubble technique was successful in the separation of DM from the stroma without creating any iatrogenic perforations. During the removal of the stroma, a dissection was carried out at the wrong plane, leaving behind a residual clear and translucent posterior stroma that appeared like DM. The underlying bubble separating the host's DM remained intact and unnoticed, creating a high-pressure double AC. The remaining 30 minutes of the surgery were uneventful, devoid of any evident warning signs of impeding angle closure glaucoma. We hypothesize that after discharge, the high-pressure double AC remained in place, pushing posteriorly on the pupil and blocking the flow of aqueous humor from the posterior chamber (PC) into the AC. Overtime, the pressure in the PC built up, and pushed the iris anteriorly along its periphery, where resistance is least given the convex nature of the double AC. The angle was progressively sealed, precipitating a secondary acute angle closure glaucoma attack. Meanwhile, the double AC kept on pushing downward centrally against the iris, warranting the concave configuration of the iris that was noted on slit lamp examination and OCT.

Our initial differential diagnosis included primary pupillary block angle closure glaucoma, angle closure glaucoma secondary to air that accidently escaped when performing the big bubble technique, Urrets-Zavalia syndrome and malignant glaucoma. Primary pupillary block could not be ruled out based only on the exam despite the absence of a typical iris “bombé” that could have been concealed by the high-pressure DMD pushing on the iris. Similarly, we could not rule out the presence of air under the iris only based on exam and OCT. However, the presence of a deep central AC essentially rules out malignant glaucoma as a potential cause. In the setting of post-keratoplasty with a fixed and dilated pupil accompanied with a rise in IOP, one should also consider the diagnosis of Urrets-Zavalia (UZ) syndrome, a rather uncommon but serious complication after corneal transplantation that is believed to be due to iris ischemia or to damage to the parasympathetic fibers of the iris sphincter muscle. This syndrome is characterized by a fixed and dilated pupil, iris atrophy and often formation of peripheral anterior synchiae (PAS) with secondary angle closure glaucoma.[5] The pupillary and iris findings of UZ can potentially manifest as early as post-operative day 1 but the rise in IOP typically occurs starting post-operative week 1, allowing time for PAS to form. In our case, the rapid occurrence of angle closure glaucoma on post-operative day 1 as well as the absence of anterior iris atrophy on exam made UZ syndrome less likely.

Evacuation of the double AC in the OR was the only treatment modality that would allow simultaneous resolution of the IOP spike and removal of the remaining stromal bed in order to achieve best visual outcomes. A laser peripheral iridotomy (LPI) would not have been successful in treating the acute angle closure in this case because the double AC would have occluded the patent LPI,

preventing aqueous humor flow from the PC. In addition, if DM was accidently perforated with the Nd:YAG laser at the site of the LPI, air could potentially dissipate from or into the double AC, depending on the pressure differential between the PC and the double AC. A trial of cycloplegics would not have been successful in resolving the angle closure in this case because of the absence of posterior pushing mechanism in this type of glaucoma. Similarly, removal of the air bubble with a cannula or treating the IOP spike with glaucoma drops and acetazolamide while waiting for the air bubble to dissipate would have acutely resolved the high IOP, but would not have restored optimal visual outcomes due to the persistence of a residual host corneal stroma.

Our clinical suspicion to such a mechanism was very low. AS-OCT was essential in the proper diagnosis of this situation, and prompted the appropriate action of taking the patient back to the OR for evacuation of the air bubble. Fortunately, DM was undamaged, allowing proper reformation of the AC and securing the DALK graft back in place. In the event where a perforated DM was noted, the patient would have needed a standard PKP.

The challenge of the big bubble technique comes partly from the inherent unpredictability of the air bubble, but also from the dissection of very minute planes within the cornea at low visibility. In this case, it was very difficult to differentiate the appearance of the very thin layer of residual posterior stroma from DM. Prevention of such a complication can be done by injecting small air bubbles in the AC before dissection with the big bubble technique. If DM is properly detached, it will protrude posteriorly, forcing the small AC bubbles to the periphery. Once proper dissection of the stroma is carried out, and the big bubble is evacuated, the bubbles will shift back centrally.[6] However the “shifting bubble” sign could not work in some pseudophakic and aphakic eyes. In these cases, injection of vision blue that stains Descemet membrane could be of help to better monitor the big bubble intra-operatively. More recently, intraoperative AS-OCT has been shown to successfully plan and monitor the surgical steps of this delicate surgery.[7]

4. Conclusions

We described the first reported case of acute angle closure glaucoma due to a high-pressure DMD following DALK using the big bubble technique. This complication should always be kept in mind during the learning curve of DALK, as it can be easily missed in what appears to be a successful surgery. Prompt diagnosis and OR evacuation are necessary and should not be delayed by attempts of other treatment modalities that can result in sub-optimal visual recovery.

5. Patient consent

Consent to publish the case report was not obtained. This report does not contain any personal information that could lead to the identification of the patient.

Acknowledgments and discolosures

Funding

No funding or grant support.

Conflict of interest

The following authors have no financial disclosures: SJ, AM, YA, MHD.

Authorship

All authors attest that they meet current ICMJE criteria for Authorship.

Acknowledgements

None.

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