Visco-bubble technique for deep anterior lamellar keratoplasty

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PURPOSE: To describe a modification of the deep anterior lamellar keratoplasty (DALK) surgical technique.

SETTING: Instituto de Microcirugía Ocular in Barcelona, Spain and Clínica Clofán in Medellín, Colombia.

METHODS: Design: Retrospective interventional case series. Study population: 21 eyes from 21 patients who underwent visco-bubble technique for DALK, which involves the injection of ophthalmic viscosurgical devices (OVDs) into the deep stroma to form a visco-bubble to separate Descemet’s membrane from the posterior stroma. Surgeries were performed between May 2010 and January 2013. Main outcome measures: Preoperative and postoperative best spectacle-corrected visual acuity (BSCVA) and complication rate.

RESULTS: At 6 months, BSCVA improved from 20/100 (logMar 0.7) preoperative to 20/32 (0.20) postoperative. There were no intraoperative complications. This technique reduces the risk of intraoperative corneal perforation and maintains visibility during visco-bubble formation.

CONCLUSIONS: Visco-bubble technique for DALK gives better visualization, reduces the risk of perforation, and is reproducible.


Corneal transplantation has changed rapidly in recent years, with increasing use of more disease-specific procedures such as endothelial keratoplasty and anterior lamellar keratoplasty. Deep anterior lamellar keratoplasty (DALK) is an alternative to penetrating keratoplasty (PKP) for corneal diseases in eyes with healthy endothelia such as corneal ectasia (keratoconus, keratorefractive surgery ectasia, pellucid marginal degeneration), anterior corneal opacities and corneal dystrophies not affecting the endothelium. The main advantages of this technique are: extraocular surgery, no risk for endothelial rejection, preservation of the host endothelium, faster wound healing, and a short topical corticosteroid regimen¹. Pre-Descemet’s plane lamellar dissection, leaving Descemet’s membrane and the endothelium in place, reduces the incidence and severity of interface-related complications. Deep corneal cleavage techniques, which often use adjuvant materials to manual dissection (air, saline solutions, ophthalmic viscosurgical devices [OVDs]) have been used since 1985²-⁵.

Anwar and Teichmann⁵ described the big-bubble technique, which consists of injecting air into the corneal stroma to isolate Descemet membrane. This technique significantly improved DALK outcomes and rekindled interest in lamellar surgery worldwide. Complete removal of the overlying stroma created a clear graft interface with no irregularities. Visual outcomes are excellent, and postoperative interface problems are minimal.

Parthasarathy et al.⁶ describe a modification of Anwar and Teichmann’s technique in which a portion of the anterior stroma is dissected from the recipient cornea before the big bubble is formed. This makes it easier to judge the needle depth for air injection and reduces the amount of stromal tissue incised to locate Descemet’s membrane under the big bubble. Furthermore, less

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stromal thickness needs to be excised at the wound margin, making scissor placement and excision of the overlying stroma from the bed more efficient.

We present a technique, which we call the visco-bubble technique. Unlike that of Anwar and Teichmann, this modified technique employs a cohesive OVD, using the pressure of the device to detach Descemet’s membrane from the deep stroma. It has several advantages over the big-bubble technique.

**METHODS**

A retrospective study was performed in which clinical data were retrieved from computerized database. A total of 21 eyes from 21 patients with anterior corneal pathology (14 keratoconus, 4 anterior corneal scars, 3 stromal dystrophies, 1 keratorefractive surgery ectasia) underwent visco-bubble DALK technique between May 2010 and January 2013. J. Güell from the Instituto de Microcirugía Ocular, Barcelona, Spain, performed the procedure on 19 eyes of 19 patients. D. Aristizábal at Clínica Clofán in Medellín, Colombia performed the procedure on 2 eyes of 2 patients.

Keratoconus and refractive surgery ectasia was clinically diagnosed from history, slit-lamp examination, topography, and refraction. Anterior corneal opacities and corneal dystrophy was clinically diagnosed from history and slit-lamp examination. Indication for grafting in all patients was poor visual function and intolerance of other methods for optimal optical correction such as spectacles and rigid gas permeable contact lenses.

An exclusion criterion for visco-bubble DALK was any pathology that affects the endothelium. Outcome measures analyzed were visual acuity (VA), and intraoperative complications.

Visual acuity was measured using the Snellen visual acuity chart. Results were analyzed in logarithm of the minimum angle of resolution (logMAR) equivalent units.

**Surgical technique**

The procedure is performed under the surgeon's preferred anesthesia; we commonly performed it under retrobulbar anesthesia. Nontransfixing trephination is performed with a Hessburg-Barron suction trephine (Katena, New Jersey, USA), which cuts 0.635 mm downward per one quarter of a turn, or alternatively with a femtosecond laser; we have been using the VisuMax® ML (Carl Zeiss Meditec, Germany) for this purpose. Trephination depth is determined by preoperative ultrasonic pachymetry, aiming at 75% of corneal thickness. A portion of the anterior stroma is resected with a crescent knife (in the absence of femtosecond laser); this helps judge needle depth for the OVD injection.

A 30-gauge disposable needle attached to a syringe filled with cohesive OVD such as Healon® GV (AMO, Illinois, USA) is inserted into the central cornea from the trephination. The needle bevel is oriented downward. Cohesive OVD is injected to produce the visco-bubble corneal separation between the stroma and Descemet membrane.

The needle can be inserted straight to the corneal center or at a slight angle. The needle must be penetrate the deep stroma far enough to prevent OVD reflux (Figure 1). The end of the needle is placed in an occlusion position against the stroma. Cohesive OVD is then slowly injected at a relatively high pressure.

The detachment visco-bubble progresses slowly and centrifugally so that the visco-bubble border extends slightly beyond the trephination circumference, allowing the surgeon to view bubble formation (Figure 2) (Video).

Once the detachment bubble forms, a stromal cut is made with the sharp tip of a blade, this step is much easier than the big-bubble technique because the consistency of the OVD reduces the risk of perforation (Figure 3). After the stromal cut is made, we use specially design DALK scissors (e-Jannach, Como, Italy) (Figure 4) in which the lower blade has a blunt tip and is smaller than the upper blade. With these scissors we divide the stroma into 4 quadrants. A side port incision is usually made to reduce intraocular pressure (IOP) and formation of the visco-bubble is checked by injecting air in the anterior chamber and visualizing that air bubble in the periphery is unable to reach the center (Figure 5). Then the residual stroma is excised along the circumference using curved microscissors. For this purpose, we used Karzin left and right keratoplasty scissors which allow the surgeon to make a more vertical cut, and because the visco-bubble is slightly larger than the trephination, the risk of perforation is again minimized due to the release of any peripheral bridges. The corneal donor button is stripped of Descemet’s membrane and endothelium (which can be used for a Descemet’s membrane endothelial keratoplasty DMEK technique, as we regularly do in our practice) and sutured to the recipient's corneal bed after the OVD is thoroughly washed out.

**Figure 1.** Image of cohesive OVD and a 30 gauge disposable needle used for the visco-bubble technique. Entrance site for the needle (bevel down) for the formation of the visco-bubble.
RESULTS

Twenty-one eyes from twenty-one patients were included in the study. The mean follow-up period was 21 months, and mean age at visco-bubble DALK procedure was 35.5 years (range 25 to 48 years).

VA results were all analyzed by converting Snellen values to logMAR notation. All VA results refer to best spectacle-corrected visual acuity (BSCVA). The mean preoperative BSCVA of eyes treated with visco-bubble DALK was 0.70. At 6 months after surgery, the mean BSCVA was 0.20.

Visco-Bubble Deep anterior lamellar keratoplasty was first performed in May 2010 and continued till January 2013. Indications for all procedures were poor functional vision and intolerance to spectacles and rigid contact lenses. All Visco-Bubble cases were analyzed.

No incidence of microperforation or macroperforation was encountered during surgery. One case of subsequent development of a double anterior chamber (AC), probably due to an overlooked microperforation or residual OVD in the interface, was managed with intracameral air injection and surface venting incisions that achieved complete tamponade of the DM. One case of epithelial allograft rejection was seen and managed with frequent steroids drops until complete resolution of the episode. No cases of endothelial rejection were encountered. One case of suture-related microbial keratitis was managed with a combination of antibiotic/steroid ointment.

DISCUSSION

Patients with normal endothelia and any corneal disease located in the anterior parts of the cornea are candidates for DALK. Optimal visual acuity will be achieved when the Descemet's membrane is completely bared. To date, the major drawback of Anwar's big-bubble technique is that it is impossible to visually control air bubble formation due to the whitening of the stroma, and neither the necessary volume of air nor the velocity of the injection can be foreseen or visually controlled. Therefore, air may enter the anterior chamber via the chamber angle. Furthermore, air may enter the uvea during big bubble formation.
In our opinion, the visco-bubble technique has several advantages:
1. Visualization during visco-bubble formation is almost always preserved.
2. The procedure allows surgeons to decide when to halt formation of the visco-bubble, particularly when it is slightly larger than the trephination, which helps free the bridges that can remain near the circumference when separation is smaller.
3. Due to the consistency of the OVD, once the visco-bubble is formed it is much easier and safer to cut.
4. The technique is reproducible and easy to learn.

The aperture position at the end of the needle (bevel down) ensures good occlusion against the stroma while orienting the aperture downward to facilitate OVD diffusion into pre-Descemet’s space instead of into the overlying planes.

Incidence of ocular hypertony during visco-bubble formation is lower than with the air bubble due to the more controlled injection of OVD. This was confirmed by testing the hardness of the globe with simple pressure, and can be explained in several ways. Visual control during bubble formation prevents over-injection of OVD. The previously thinned residual cornea is relatively permeable to OVD in case of high pressure. We sometimes noted an OVD leak before the bubble reached full size, or OVD can escape if necessary via the entrance of the needle. If ocular hypertony does occur, it is of short duration.

In conclusion, the visco-bubble technique described here combines the advantages of the big-bubble technique with the benefits of the OVD transparency. It is characterized by ease of performance and fewer, particularly intraoperative, complications, it does not require major adaptation on the part of surgeons already accustomed to the big-bubble technique, and will be more successful in reaching the Descemet’s plane, which has historically hampered the development of this approach to corneal grafting.

REFERENCES