Small-Bubble Deep Anterior Lamellar Keratoplasty Technique

Vincenzo Scorcia, MD; Jacqueline Beltz, MD, FRANZCO; Massimo Busin, MD

Stromal disease (ectasia, opacities, scars, or melting) that occurs after penetrating keratoplasty (PK) can variously affect visual outcome. To date, even in the presence of healthy endothelium, this type of complication has been treated with subsequent PK. Instead, the selective replacement of the diseased stroma by means of deep anterior lamellar keratoplasty (DALK) using pneumatic dissection (big bubble) has not been attempted, mainly because of the extreme likelihood of breaking the descemetic scar at the junction between the donor and host cornea. We describe a new surgical technique (small-bubble DALK) that uses pneumatic dissection to bare Descemet membrane (DM) only in a central optical zone and preDescemet manual dissection to remove the surrounding peripheral stroma.

Methods

We reviewed the medical records of all patients with post-PK complications who had undergone small-bubble DALK at the Department of Ophthalmology, University of Magna Graecia, Catanzaro, Italy, from July 1, 2010, through January 31, 2012. The study followed the tenets of the Declaration of Helsinki and was approved by the ethics committee of the University of Magna Graecia; all patients gave written informed consent by signing detailed informed consent forms. Uncorrected visual acuity, best spectacle-corrected visual acuity, endothelial cell density (EM-3000, Tomey Corporation), and corneal topography (anterior segment optical coherence tomography; SS-1000 CASIA, Tomey Corporation) were assessed preoperatively and after complete suture removal. A t test was used to evaluate the statistical significance of the changes recorded (P < .05 was considered statistically significant).

Surgical Procedure

In all patients, anesthesia was administered with peribulbar injection of a mixture of 5 mL each of lidocaine hydrochloride, 2%, and bupivacaine hydrochloride, 0.5% (Video). A Barron suction trephine (Katena Products Inc) was centered on the corneoscleral limbus, and a circular incision 8 to 9 mm in diameter was made, taking care to include the original PK wound (Figure 1A and B); thus, the graft size was enlarged compared with the original PK in an at-

![Figure 1. Surgical Steps of Small-Bubble Deep Anterior Lamellar Keratoplasty](https://jamaophthalmology.com)

A, Recurrent ectasia in an eye with a decentered penetrating keratoplasty (arrowheads). B, Trephination, 8.5 mm in diameter, up to 70% to 80% of peripheral corneal thickness. C, Air injection into deep stroma by means of a blunt 27-gauge cannula to achieve a bubble 5 to 6 mm in diameter. D, After removal of the superficial stroma, baring of the Descemet membrane with blunt corneal scissors. E, Manual preDescemet dissection and removal of the residual peripheral deep stroma. F, Fixation of donor tissue with 2 running 10-0 nylon sutures.
tempt to minimize postoperative astigmatism. To minimize the risk of perforation, trephination to approximately 70% to 80% of the thickness measured by anterior segment optical coherence tomography was purposely performed outside and not inside the often irregular PK wound. A blunt 27-gauge cannula was inserted at the base of the incision and advanced centripetally across the PK wound; air was injected with minimal pressure to obtain a bubble within the margin of the PK wound (Figure 1C). After manual removal of the superficial stroma, the bubble was entered with a 30° blade, and the deep stroma was excised, baring DM over an optical area 5 to 6 mm in diameter (Figure 1D). Predescemetic dissection of the residual peripheral rim was performed manually (Figure 1E).

A Barron donor punch (Katena Products Inc) was used to prepare a full-thickness graft (same size as the trephination in the recipient cornea) from which DM and endothelium were stripped off using a dry Weck-Cel sponge (Beaver Visitec International). The donor tissue was fixed with 4 cardinal sutures that were removed after completing the procedure with a double running 10-0 nylon suture (Figure 1F). These sutures were removed in all cases within 12 months.

Results
Nine eyes from 9 patients with a history of PK who had undergone small-bubble DALK were identified. The indications for subsequent surgery were corneal ectasia (n = 4), scarring after stromal melt (n = 2), post-photorative keratectomy haze (n = 2), and recurrence of dystrophy (n = 1) (Figure 2). In all cases, the pathologic findings did not extend outside the PK wound.

Intraoperative complications included failure to form the bubble (n = 1) and microperforation that occurred during manual dissection of the peripheral stroma (n = 1). In both cases, the procedure was completed by means of manual dissection, even in the former case obtaining a final central thickness of the recipient bed of approximately 30 μm as measured postoperatively by anterior segment optical coherence tomography.

Demographic data and results are summarized in the Table. At the latest follow-up examination (14 months after surgery), all sutures had been removed in all 9 eyes, and best spectacle-corrected visual acuity had improved by at least 4 Snellen lines; refractive astigmatism had improved in all 4 patients with corneal ectasia and in 3 of the 5 eyes with stromal opacities. Endothelial cell density was not significantly affected by surgery. No postoperative complications were recorded.

Discussion
Anterior lamellar keratoplasty (ALK) is becoming increasingly popular because of its main intrinsic advantage of replacing diseased stroma while sparing healthy endothelium. Although microkeratome-assisted ALK in post-PK eyes is relatively simple and quick to perform, it is not recommended for stromal lesions that extend beyond a depth of 200 μm or for advanced corneal ectasia because of the risk of perforation. Instead, manual dissection is a painstaking maneuver, often yielding disappointing visual results and requiring conversion to PK in a relatively high number of cases.

The small-bubble DALK technique uses an approach similar to that of the big-bubble technique described originally by Anwar and Teichmann. However, pneumatic dissection with small-bubble DALK is limited only to the central 5 to 6 mm, thus eliminating the risk of bursting the bubble when the scar between donor and recipient DM is reached. The size of the optical zone with bare DM was suffi-
Table. Preoperative and Postoperative Data for Patients Undergoing Small-Bubble Deep Anterior Lamellar Keratoplasty

<table>
<thead>
<tr>
<th>Patient No./Sex/ Age, y</th>
<th>Indication for Surgery</th>
<th>BSCVA Preoperative</th>
<th>Postoperative</th>
<th>ECD, Cells/mm² Preoperative</th>
<th>Postoperative</th>
<th>Mean Topographic Keratometric Reading, D Preoperative</th>
<th>Postoperative</th>
<th>Refractive Cylinder, D Preoperative</th>
<th>Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/M/42</td>
<td>Post-PRK scar</td>
<td>20/200</td>
<td>20/20</td>
<td>1024</td>
<td>980</td>
<td>40.1</td>
<td>44.5</td>
<td>6.3</td>
<td>3.1</td>
</tr>
<tr>
<td>2/M/51</td>
<td>Granular dystrophy</td>
<td>20/80</td>
<td>20/25</td>
<td>1345</td>
<td>1360</td>
<td>46.3</td>
<td>45.3</td>
<td>3.2</td>
<td>4.7</td>
</tr>
<tr>
<td>3/F/62</td>
<td>Ectasia</td>
<td>20/400</td>
<td>20/30</td>
<td>1540</td>
<td>1487</td>
<td>54.8</td>
<td>46.7</td>
<td>10.5</td>
<td>4.1</td>
</tr>
<tr>
<td>4/F/53</td>
<td>Ectasia</td>
<td>20/200</td>
<td>20/20</td>
<td>1124</td>
<td>1086</td>
<td>52.5</td>
<td>44.9</td>
<td>9.6</td>
<td>1.7</td>
</tr>
<tr>
<td>5/M/42</td>
<td>Poststromal melt scar</td>
<td>20/100</td>
<td>20/25</td>
<td>NA</td>
<td>1460</td>
<td>39.2</td>
<td>43.7</td>
<td>5.3</td>
<td>2.5</td>
</tr>
<tr>
<td>6/F/31</td>
<td>Post-PRK scar</td>
<td>20/400</td>
<td>20/25</td>
<td>NA</td>
<td>1356</td>
<td>44.5</td>
<td>42.7</td>
<td>2.1</td>
<td>3.9</td>
</tr>
<tr>
<td>7/M/42</td>
<td>Poststromal melt scar</td>
<td>20/200</td>
<td>20/20</td>
<td>1380</td>
<td>1410</td>
<td>38.2</td>
<td>44.3</td>
<td>6.2</td>
<td>0.8</td>
</tr>
<tr>
<td>8/F/39</td>
<td>Ectasia</td>
<td>20/400</td>
<td>20/30</td>
<td>1685</td>
<td>1590</td>
<td>62.0</td>
<td>48.1</td>
<td>13.7</td>
<td>6.2</td>
</tr>
<tr>
<td>9/M/42</td>
<td>Ectasia</td>
<td>20/200</td>
<td>20/40</td>
<td>1246</td>
<td>1210</td>
<td>57.6</td>
<td>46.3</td>
<td>7.8</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Abbreviations: BSCVA, best spectacle-corrected visual acuity; D, diopters; ECD, endothelial cell density NA, not available; PRK, photorefractive keratectomy.

As with any procedure that uses pneumatic dissection, creation of the bubble may fail but can be handled more easily, as was done in one eye of this series, because the critical maneuver of barring DM by hand is required over a much smaller area than with conventional big-bubble procedures. In addition, Lim and Lim have reported the use of manual dissection of the peripheral residual recipient stroma between bare DM and the trephination cut to manage incomplete bubble formation. Their method, proposed for eyes without previous PK surgery, supports the same concept applied by us in post-PK eyes: dissection does not need to further expose DM but rather simply modify the recipient bed to allow proper allocation of the donor tissue. Large grafts of 9 mm or larger in diameter can therefore be used with the same risk of smaller grafts, while increasing the chances of a more regular postoperative corneal curvature. Finally, if microperforations or a dehiscence of the PK wound occurs, completion of the procedure by manual dissection can be attempted similarly to the big-bubble technique.

Conclusions
Small-bubble DALK is a viable and effective procedure for treating recurrence of ectasia or stromal opacities that develop after PK; visual acuity is significantly improved, and complications can be managed with no need for conversion to full-thickness transplantation.

ARTICLE INFORMATION

Author Affiliations: Department of Ophthalmology, University of Magna Graecia, Catanzaro, Italy (Scorcia, Busin); Centre for Eye Research Australia, Royal Victorian Eye and Ear Hospital, Melbourne, Australia (Beltz, Busin); Department of Ophthalmology, Ospedale Privato Villa Igea, Forlì, Italy (Busin).

Corresponding Author: Vincenzo Scorcia, MD, Department of Ophthalmology, University of Magna Graecia, Via dei Crociati 40, 88100 Catanzaro, Italy (vsccoria@libero.it).

Submitted for Publication: February 24, 2014; final revision received April 7, 2014; accepted April 8, 2014.


Conflict of Interest Disclosures: Dr Busin reported receiving travel expense reimbursement and royalties from Moria (Antony, France). No other disclosures were reported.

REFERENCES
5. Patel AK, Scorcia V, Kadyan A, Lapenna L, Ponzin D, Busin M. Microkeratome-assisted superficial anterior lamellar keratoplasty for anterior stromal scar in post-PK eyes: dissection does not need to further expose DM but rather simply modify the recipient bed to allow proper allocation of the donor tissue. Large grafts of 9 mm or larger in diameter can therefore be used with the same risk of smaller grafts, while increasing the chances of a more regular postoperative corneal curvature. Finally, if microperforations or a dehiscence of the PK wound occurs, completion of the procedure by manual dissection can be attempted similarly to the big-bubble technique.

Conclusions
Small-bubble DALK is a viable and effective procedure for treating recurrence of ectasia or stromal opacities that develop after PK; visual acuity is significantly improved, and complications can be managed with no need for conversion to full-thickness transplantation.

JAMA Ophthalmology November 2014 Volume 132, Number 11

Copyright 2014 American Medical Association. All rights reserved.