ASCRS annual meeting 2014

Handout Course 29-204: Tuesday 29th April 2014, Boston

From Basic to Advanced: Deep Anterior Lamellar Keratoplasty

COURSE PROGRAM:

- “Why DALK instead of PK?” Edward Holland, MD
- “Transition from PK to DALK: tips and triks” W. Barry Lee, MD, FACS
- “DALK results and long term graft survival” Enrica Sarnicola, MD
- “DALK standard technique” Clara Chan, MD, FRCSC, FACS, DABO
- “DALK new frontiers: management of complications (perforation, DM rupture, extreme ectasia, disparity of curvature between donor and recipient ecc) and new indications (infection)” Vincenzo Sarnicola, MD
“Transition from PK to DALK: tips and triks.”  W. Barry Lee, MD, FACS, Atlanta

DALK: How Do I Start?

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Financial Disclosures

• Allergan
• Merck
• Bausch & Lomb
• Medevex Imaging Systems
• BioTissue
DALK Indications

- Central Corneal Scar
- Previous Infection
- Previous Trauma
- Anterior Corneal Dystrophy
- Stromal Corneal Dystrophy
- Keratoconus and Ectasia

Corneal Scars

DALK Indications

- Central Corneal Scar
- Previous Infection
- Previous Trauma
- Anterior Corneal Dystrophy
- Keratoconus / Ectasia
Anterior Corneal Dystrophies

DALK Indications
- Central Corneal Scar
- Previous Infection
- Previous Trauma
- Anterior Corneal Dystrophy
- Keratoconus /Ectasia

Kerat...
DALK Techniques

- Manual Dissection

- Microkeratome-assisted DALK
  - Busin et al. Ophthalmology 2005;112:987

- Anwar’s Big Bubble DALK
  - Anwar et al. JCRS 2002;28:398
  - Fogla et al. AJO 2006;141:254

- Femtosecond laser-assisted DALK
  - Mosca et al. Cornea 2008;27:668
  - Yoo et al. Ophthalmology 2008;115:1303

Donor Preparation

- Manual, Microkeratome, or Femtosecond laser
- Donor tissue preparation
  - Place donor tissue in artificial anterior chamber
  - Hand Dissection or Microkeratome to cut anterior donor cap
  - Can alter depth of cut with keratome
    - 90 μ
    - 200 μ
    - 250 μ
    - 300 μ
    - 350 μ
Artificial Anterior Chamber
Advantages of Big Bubble DALK over Automated Lamellar

- Depth of pathology not important
- Less sizing problems with donor and host
- Less risk of interface haze
- Automated Keratome or Femtosecond laser not needed
**DALK Steps**

Partial Thickness Trephination

- Hanna Trephine
- Set at 300 microns

**DALK Steps**

Partial Thickness Trephination

- Hessburg- Barron trephine
- 0.06 mm with each quarter turn
- 0.25 mm with each revolution (4 quarter turns)
DALK Steps

- Air injection into stroma
  - Provides contrast between residual stroma & Descemet’s membrane
- 30-G needle/cannula inserted into graft-host junction
- Needle passed through posterior stroma beyond pupil

Create the Big Bubble
Confirmation of Big Bubble

- Create a paracentesis to release pressure
- Inject small air bubble to confirm “Big bubble”

DALK Steps

- Lamellar dissection
- "Bulk" Keratectomy
- Remove anterior portion of cornea
DALK Steps

- Puncture with stab blade into posterior stroma
- Care to avoid puncture of DM

Stab Incision

Leap of Faith
**DALK Steps - Stromal Removal**

- Remove remaining posterior stroma
- Can be facilitated with viscoelastic
- Use blunt dissector along DM plane
- Blunt scissors to excise stromal tissue
- Highest risk step for perforation
Donor Tissue Preparation

- Punch Donor Button First
- If no perforation, peel DM & endothelium from donor button
DALK Steps

• Secure Donor tissue with preferred suture pattern
  – Interrupted
  – Combined Interrupted and Running
  – Single Running
  – Double Running
pd-DALK

Thank You
Deep Anterior Lamellar Keratoplasty (DALK), which allows a total or subtotal replacement of the stroma, leaving intact the recipient Descemet’s membrane (DM) and endothelium, has been a fundamental change in the recent years. The surgical challenge of DALK surgery is the technical difficulty inherent in separating the anterior stromal layers from DM and endothelium: currently the techniques are manual, and difficult to do, which has limited their widespread adoption.

At this point it is critical to understand what is intended with dDALK and pdDALK. **Descemetic DALK (dDALK)** is a deep anterior lamellar keratoplasty that remove all the host stroma and preserve only DM and endothelium. **Predescemetic DALK (pdDALK)** results when the surgeons, in the attempt to expose DM, fail to reach it and leave a thin layer of stroma over DM and endothelium. This usually occurs with manual dissection, layer by layer, technique. [1] According to different studies data, **BSCVA** after DALK results to be 20/40 at least, up to 20/20 (49% of cases in one study and 64.3% in another study) and comparable with PK results. [2,3]. Conflicting opinions arise about BSCVA after dDALK and that after pdDALK. Sarnicola et al studied BSCVA after DALK in 120 eyes. Sixty-one eyes were dDALK and fifty-nine eyes were pdDALK. Visual outcome was not statistically different between descemetic DALK and pre-descemetic DALK, although visual recovery was slightly delayed in second group. At the 30,4 month follow-up BSCVA in the dDALK group was 20/30 or better in 85% of cases, and 20/20 in 49% of cases,. BSCVA in the pdDALK group was 20/30 or better in 80% of cases, and 20/20 in 49% of cases. The mean BSCVA was 0.88 in the dDALK group and 0.86 in the pdDALK group (P = 0.40) [2]. Another study reports that pdDALK visual recovery is worse than that with dDALK. Fontana et al compared BSCVA between three groups, PK (22 patients), descemetic DALK (28 patients), and predescemetic DALK (32 patients). In their casistic, quality of vision after DALK was comparable to that after PK when descemetic DALK was achieved, and inferior to vision after PK when layers of stroma where left adherent to DM. The percentage of eyes with 20/20 BSCVA or better was 4 times higher in PK and descemetic DALK eyes than in predescemetic DALK eyes. [4].

A precise definition of what is intended as predescemetic DALK is probably the key interpreting the differences between the results mentioned above. In 1971 José Barraquer already out-lined the necessary rules to achieve good visual results with LK: achieve the deepest possible interface to reduce scarring, achieve a posterior layer of uniform thickness, perform smooth surface sectioning of both the graft and bed, make the graft tissue of appropriate thickness, obtain the highest quality donor material, insure good coaptation of the edges and uniform traction of the sutures, and make sure there is perfect cleanliness of the interface [5]. He was clearly talking about pdDALK approach, since DM is already smooth, regular and uniform in thickness.

The residual host bed thickness was not reported in any of the cited studies. A differences in Host bed residual stroma thickness could be the key to interpretate the different opinion about pdDALK visual recovery. Ardjomand et al said infact, that eyes with a recipient corneal bed thickness <20µ had VA comparable with PK results, whereas those with a thicker recipient corneal bed, >80µ, had significant reduced VA [6]. Reinhart et al, in a review about published literature on DALK, reported also that “There was no significant difference in postoperative visual acuity between DALK or PK eyes as a group, although there was a tendency for lower visual acuity in DALK eyes in which DM was not bared and residual stroma in the bed exceeded 10% of total stromal thickness” [7].

The more successful technique achieving DM exposure is the “Big bubble technique” (BB), first described by Anwar and Teichmann [8]. We like to call it “**needle BB**” and it is a fast and reliable
way of baring the DM. A suction trephine is used to perform a partial thickness corneal trephination at about 60-80% of depth. A 27 or 30 gauge needle, attached to an air-filled syringe, is inserted deeply into paracentral stroma through the bottom of the trephination groove, and advanced so the bevel stays parallel to the DM and facing down. At this point air is injected, forming a large air bubble between DM and corneal stroma in most of cases (60-70%). After anterior keratectomy is performed, a small opening in the center of the anterior wall of the bubble is made. This should be performed using a sharp tip of a pointed blade held almost parallel to the surface. Collaps of the air bubble then happens and the knife is quickly withdrawn. The remaining stromal layers are lifted with an iris spatula, severed with a blade, and excised with scissors. Sometimes can happen that air injection causes corneal emphysema. In this case, the whitening of the cornea not allows to see if the big bubble is successfully achieved or not. Parthasarathy et al [9] described a technique to immediately determine it, that we like to call “bubble test”. A small air bubble is injected into anterior chamber via limbal paracentesis. If the small air bubble is then seen at the anterior chamber periphery, it confirms that the big bubble separation of DM has been successfully accomplished, as the convexity of the bubble will protrude posteriorly forcing the small anterior chamber bubble to the periphery. If the small anterior chamber bubble is not seen in the anterior chamber periphery, this means that it is present centrally, beneath the opaque corneal stroma, and therefore the big bubble has not been achieved. The use of special blunt cannula [10] has been proposed to let surgeons go as deep as possible into corneal stroma, not being afraid of DM perforation as with a pointed instrument. This technique has been called “cannula BB” More deeply the air is injected, then higher are the chances of getting a BB. Sarnicola and Toro described the surgical steps. These are similar as the previous described for the needle BB, but with two important modifications. After a partial corneal trephination, a smooth spatula is inserted at the deepest point in the peripheral trephination groove. It is moved forward trying to reach the predescemetic plane going deeper and deeper toward the centre of the cornea. When the predescemetic plane is reached, two important signs are frequently observed: reduced resistance of the advancement of the spatula and appearance of DM folds. The spatula can then be removed leaving a corneal tunnel, where to insert a 27 gauge cannula, attached to a 5cc air-filled syringe. The cannula has a port facing down, so air can push DM posteriorly. After advancing the cannula to the center of the cornea, air is injected. Literature reports that using a cannula to inject air has the highest rate of successfully BB accomplishment. Fournié et al indicate 76.9% of successful big bubble in a study over 13 eyes [11]. Sarnicola and Toro reported 86% of big bubble formation in a study over 28 eyes [10].

The BB opening technique has been refined by Goshe et al [12] by coating the overlying stroma with cohesive viscoelastic prior to entering the big bubble. A 1.0 to 1.5 mm incision is then created with a 1.0 mm diamond knife using only the tip of the blade with a “lifting” motion. Goshe et al say that this opening technique has two advantages. First, when the stroma is incised to enter inside the big bubble, minimal to no air escapes from the bubble, preventing a sudden collapse of the bubble, which can result in the blade perforating Descemet membrane. Second, an air–viscoelastic exchange can be performed to maintain space in the bubble to facilitate sweeping the peripheral interface and subsequently resecting the residual cap. Our modification [unpublished data, presented at AAO annual meeting in 2011] of this new opening of the bubble involves the use of cataract knife. After covering the corneal surface by OVD, a cut from the bottom upwards is made. This kind cut limits even further the release of air from the bubble. Then we inject OVD inside the bubble to create a safe space between stroma and DM, so the corneal stroma removal can be performed with less risks.

Air-viscobubble (AVB) [10] is a technique designed for those cases where BB formation failed. In those eyes for which air dissection did not resulted in big-bubble formation, superficial keratectomy
is made with a Golf knife. A new deeper tunnel is made into the stroma using the same spatula. The same cannula used for the air injection is now attached to a viscoelastic-filled syringe, and a viscodissection is tried as a second approach to separate DM from the corneal stroma. Sarnicola et al reported the percentage of dDALK obtained with this combined technique: AVB helped to gain 7% more dDALK dissection in addition to the 86% of cases achieved with cannula BB, reaching the total of 93% dDALK.

Although BB DALK is the most used technique, others have been described.

**Dry manual dissection**, layer by layer, is probably the oldest technique of LK, which has regained force when Tsubota et al [13] have applied the principles of “divide-and-conquer” from cataract surgery. After trephination, the recipient cornea is divided into four quadrants to facilitate lamellar dissection at approximately 70% of depth. This procedure of division is continued until the DM is exposed in the central area (about 5 mm in diameter). The Authors reported almost 6% of DM ruptures, repaired injecting air into anterior chamber.

**Hydrodissection** has been described by Sugita and Kondo in 1997 [14]. Firstly, a trephine blade is used and turned downward through the cornea until three quarters of its depth, and then a lamellar keratectomy is performed with a Golf or Pauфique knife. The cut is made with the blade moving as if stroking this area. A small cut/depression is created in the deeper stroma. A 27-gauge needle attached to a syringe is inserted at the bottom of the depression, and BSS is injected into the stromal bed. The solution penetrates between the collagen fibres, which whiten and swell and can be safely removed by further spatula delamination (using spatula, forceps and scissors). As the DM is approached, it bulges forward and can be recognized from its shiny, smooth appearance. Perforations are common at this stage (39.2% in this study) and can be managed by air injection into anterior chamber.

Melles et al, in 1999, described a technique that uses viscoelastic injection to separate DM from the stroma (**viscodissection**). A 30 gauge needle attached to a viscoelastic-filled syringe is inserted into the corneal stroma as close to DM as possible. To visualize the depth of corneal incision and lamellar dissection during surgery, they create an air-to-endothelium interface that behaves as a convex mirror by exchanging anterior chamber aqueous with air [15]. Between the blade tip and the light reflex, a non-reflective dark band is seen, representing the non-incised corneal tissue between the blade and the air-to-endothelium interface. Because the dark band become thinner with advancement of the blade into the deeper stromal layers, the corneal depth of the blade can be judged from the thickness of the dark band. When the tip of the needle appears to touch the light-reflex (the posterior corneal surface), viscoelastic can be injected into the cornea to separate DM from the overlying posterior stroma. The progression of the viscoelastic between these two layers is outlined by a typical reflex (we call it “golden ring” [1]). After a corneal pocket filled with viscoelastic is created, a suction trephine is centered over the anterior corneal surface. The blade is turned downward until viscoelastic is seen to escape from the pocket through the trephine incision. The stroma over the pocket is excised and the recipient bed is thoroughly irrigated to remove all viscoelastic and debris [16]. Although this technique has good results, is not always easy to identify the reflex.

**Donor preparation** is the same, no matter of which DALK technique is used. DM has to be removed from the donor. Swabs and forceps can be both used to do this step, although forceps seem to determine less stromal damage, which could result in a temporary stromal haze due to keratocytes activation. Coloring DM with Trypan blue ink can help the removal.

There are still conflicting opinions about the right donor diameter size. A 0.25mm oversized diameter is the most used, but it is also related with higher postoperatively myopia. Same size and
smaller size donor generate less postoperatively myopia, although the second one can also cause DM wrinkles.

Heterogeneous opinions are also present about suturing technique. In our opinion, interrupted suture has some evident advantages over the continuous ones, as an easier managements of postop astigmatism and DM ruptures.

The purpose of a better graft survival explains why surgeons choose a surgery with a difficult learning curve. The two most important advantages in favour of DALK rather than PK are: endothelial cell count (ECC) and lower immunological rejection.

**Endothelial cell loss** (ECL) is lower than with PK surgery (11%), and, most important, it occurs just in the first 6 month postoperatively and then become stable. [2,7,17,18].

**Endothelial rejection** cannot happens, as the self endothelium is not replaced. Epithelial, subepithelial and stroma rejection can still occur, but they are easily reversible by using steroid drops, most of the times.

Since the most common causes of secondary graft failure are endothelial failure (29%) or immunologic endothelial rejection (respectively 29% and 27% in a retrospective study about 3992 eyes [19]), is easy to understand why the predicted DALK graft survival is longer than PK.

Sarnicola et al [2] published data about the largest DALK series (660 eyes) in eyes with various diagnosis. The mean follow-up was 4.5 years (range 0.5-10 years). Graft survival average was 99.3% (range 98.5-100%) up to 10 years follow-up. Graft failure rate was 0.6% and occurred only within the first year post-op, mostly due to ocular surface problems. One year after surgery, ocular surface differences were restored and ECD was good and stable. This may indicate that, after the first postoperatively year, DALK graft survival become not “time dependent” and will probably last lifetime.

DM ruptures are the most common complication during DALK surgery, even in expert hands. Different kind of ruptures can happen. **Microperforation** is a small DM lesion that usually occurs during pdDALK approach, when the surgeon tries to go “deeper and deeper” with the spatula. **Macroperforation** instead, is a DM rupture that determines an anterior chamber collapse. It generally occurs during the removal of residual peripheral stroma using corneal scissors in a dDALK approach. All the DM ruptures were repaired by our study group during the last 8 years. The ability to repair DM ruptures improves when the surgeon gradually become more expert. Ruptures management should follow few simple rules: complete the stromectomy, don’t inject air into anterior chamber (it would enlarge the rupture), suture the donor graft, and then put air into anterior chamber.

REFERENCES


**“DALK standard technique” Clara Chan, MD, FRCSC, FACS, DABO, Toronto**

Deep anterior lamellar keratoplasty (DALK), while technically more challenging than traditional penetrating keratoplasty (PK), is an excellent technique for the visual rehabilitation of corneal disease in patients who have normal endothelium. For example, young patients with keratoconus, stromal dystrophies, post- refractive surgery ectasia, and corneal scars are ideal candidates for DALK. Endothelial immune graft rejection cannot occur after DALK, and the procedure allows for preservation of endothelial cell density when compared to PK. As an extraocular procedure, DALK also has important theoretical safety advantages such as less intraoperative choroidal hemorrhage risk. A report published by marking of the cone using a marking pen to ensure that the entire cone will be resected the American Academy of Ophthalmology1 concluded that DALK is equivalent to PK for the outcome measure of best Snellen corrected visual acuity, particularly if the surgical technique yields minimal residual host stromal thickness. There is no advantage to DALK for refractive error outcomes.

Various techniques in DALK have been reported with Anwar's big bubble technique being the most popular.2 The femtosecond laser may also assist with the procedure in the creation of stepped corneal wounds3 or in the creation of a lamellar pocket and intrastromal channel for air injection.4 Although instrumentation has improved over the years to assist with the procedure, creation of the big bubble to separate Descemet’s membrane (DM) and endothelial layers from the anterior stromal and epithelial layers remains the greatest challenge. In the following section, key steps of performing DALK along with some surgical tips are reviewed.

1. Marking the cone and sizing the graft: In my practice, the most common indication for performing DALK is for patients with advanced keratoconus. In these patients, if the iron line created by the cone is visible, I like to mark it with a marking pen to ensure that the trephine size selected encompasses the entire cone (Figure 1).

Frequently, these cases require a larger diameter trephination. I prefer to oversize the donor by 0.5 mm if the host trephination is less than or equal to 8.5 mm. If the host cornea trephination is 8.75 mm or larger, no oversizing is required. The donor tissue (PK quality, in case unsalvageable perforation of DM occurs) is prepared on a side table and left in storage media for use later on.

2. Trephination, tunnel formation, big bubble formation: Trephination of the host cornea may be performed freehand using a manual Weck trephine, using the Hanna trephine system (Moria Surgical, Doylestown, Pa.) with a set depth (usually 400 microns), or any other trephine of the surgeon’s choice. If using the Hanna trephine, I have found it to be helpful to have a Pentacam scan (Oculus, Lynnwood, Wash.) to determine the thinnest point of the cornea.5 I then set the Hanna trephine to 100 microns less than the thinnest pachymetry reading. A set of tires may be used to check that you are around 80% corneal depth. Being deep enough in the cornea is a key aspect of achieving a successful big bubble. To cut down deeper and to initiate the plane in which the air injection would occur, an angled 15 blade against the trephine edge can be used to cut a half clock hour slit into the posterior stroma (Figure 2).
The surgeon will notice that the posterior stromal fibers are much smoother.

At this point, the surgeon begins to create a tunnel into the posterior corneal stroma using the DORC red spatula (Dutch Ophthalmic Research Center, Zuidland, the Netherlands). The deep posterior stroma should feel smooth and the spatula, when wiggled back and forth, should progress without too much resistance. If small bubbles are noted to form adjacent to the spatula edge, this indicates the correct deep stromal plane (Figure 3).

This tunnel is then lengthened by insertion of a cannula or bent 30-gauge needle attached to a 3 cc syringe with air. My preference is to use the Tan DALK 27-gauge cannula (Asico, Westmont, Ill.), which is curved to follow the shape of the cornea and has a bevel-down opening and a tip that is just sharp enough to help with passage through the corneal stroma, but blunt enough so that it will not puncture. The cannula should progress through the deep stroma smoothly using a gentle wiggle between the fingers, with only a minimal sensation of resistance. The apex of the cone in a case of keratoconus should be avoided as this is usually the thinnest point, which can easily perforate from the pressure built up during the injection of air (Figure 4). Just prior to the air injection to create the big bubble, the cannula tip should be angled downward. Pushing on the syringe with a constant pressure until a sudden feeling of resistance giving away creates the big bubble.

3. Anterior chamber decompression and "double bubble": When a successful big bubble is achieved, the stroma will whiten and the eye becomes very firm (Figure 5). Do not continue to inject air once you see that the white ring has reached the extent of the trephined edge. You do not want the DM to be completely dissected apart out to the limbus. Using a 0.12 forceps to help with counter traction, pull the cannula out and take care not to allow air to escape, which would collapse the big bubble. A posterior paracentesis is performed at this time using an MVR blade to release some aqueous fluid and to decompress the eye pressure. Take care not to perforate the DM, which has been displaced into the anterior chamber.

Injecting some small air bubbles into the anterior chamber through the paracentesis at this time allows for confirmation that the DM is pushed posteriorly if the bubbles remain in the periphery (Figure 6). Leaving some air in the anterior chamber throughout the remainder of the case helps the surgeon to see that the DM is intact.

4. Stroma removal and the "quick nick": Removal of stroma is performed in two steps. First, the anterior stroma using a crescent blade is dissected off (Figure 6). A uniform layer of thin posterior stroma is left, and it is important to keep the field dry so that any fluid egress observed will alert the surgeon to a microreroperforation. A 15 blade is then used to create a "quick nick" through the posterior layer of remaining stroma, which collapses the big bubble.
I have found that by using a marking pen to mark the site for the "quick nick" and a dollop of viscoelastic to seal the incision site, the "nick" is more easily visible and can be made in a slower, more controlled fashion. The surgeon will notice that the DM edge shrinks and the anterior chamber's peripheral bubbles coalesce into the center (Figure 7). Viscoelastic is then injected through the "nick" to push the DM posteriorly. The air bubbles should visibly move again to the periphery.

Radial cuts with blunt Vannas or Fogla DALK scissors (Bausch + Lomb, Storz, Rochester, N.Y.) into the remaining posterior layer of stroma allow the wedges to be removed. A peripheral skirt of posterior stroma does not cause any problems and is not noticeable once the stromal edema settles down in the post-op period. It is important to rinse off all the viscoelastic, which can lead to problems with DM adherence to the graft.

5. Preparing and securing the donor tissue: The donor tissue endothelium may be stained with vision blue or the marking pen. This aids in the removal of the donor DM using dry wecks. When securing the donor tissue, it is important that deep bites on the host side are taken to ensure good apposition of the graft-host junction (Figure 8). Take care not to puncture the host DM in the periphery. Once all the sutures are in place, an air bubble may be left in the anterior chamber to tamponade the DM detachment and to prevent a double anterior chamber (Figure 9). If it is only a small area, this can be observed. However if the area is large, a rebubble procedure may be needed. The anterior chamber can be filled completely with air and the patient left supine for 10 minutes or more. The air bubble can then be titrated to cover the diameter of the graft for the patient to be discharged with instructions to continue remaining supine until the bubble resolves.

While the learning curve for DALK may be quiet steep initially, it is a rewarding procedure when successful. Conversion to PK is straightforward should a mac perforation of the DM be unsalvageable. In patients with corneal disease who have normal endothelium, this procedure must be considered.

References

“DALK new frontiers: management of complications (perforation, DM rupture, extreme ectasia, disparity of curvature between donor and recipient …) and new indications”

Vincenzo Sarnicola, MD, Grosseto (Italy)

Since the evolution of the surgical techniques allowed a good and comparable with PK visual results, DALK became the gold standard technique to treat all the corneal stroma diseases with healthy endothelium. However, the technical difficulties in separating the anterior stromal layers from Descemet’s membrane (DM) and endothelium, had limited this surgery widespread adoption [1]. Be able to perform a DALK procedure, means give a probably lifetime lasting graft to the patient. For this reason we discuss some tips and trick to manage intraoperative and postoperative complications, that could help the surgeons during the learning curve.

DM rupture is the most common complication performing DALK surgery, even in expert hands. Microperforation is a small DM lesion that usually occurs during pdDALK approach, when the surgeon tries to go “deeper and deeper” with the spatula. Macroperforation instead, is a DM rupture that determines an anterior chamber collaps. It generally occurs during the removal of residual peripheral stroma using corneal scissors in a dDALK approach [2].

In our casistics (more than 1000 DALK surgeries), all the DM ruptures were repaired [unpublished data]. The ability to repair DM ruptures improves when the surgeon gradually become more expert. Knowing that DM rupture can be fixed, lets the surgeon to be more confident going “deeper and deeper” trying to reach DM. Our personal tip to deal with this complication, is that stromectomy has to be completed first. Stromal “steps” don’t allow a good and rapid donor-recipient attachment, and can let the DM rupture open. We also suggest that the site of the DM break should be dissected as the last, because completing the stromectomy can enlarge the rupture. Small breaks are easier to repair than larger ones. For this reason, it doesn’t make any sense inject air into anterior chamber before suturing the donor graft. The surgeon doesn’t have any information from this approach and he just risks to enlarge the rupture. After suturing the donor graft, air can then be injected into anterior chamber. It is also useful to move the eye in order to remove interface fluid. The air
bubble has to be left into the anterior chamber for few hours, positioning the patient’s head so that the DM break is tamponated (semi-sitting position, chin hyperextension with a pillow under the shoulders, etc). We recommend to carefully monitor the patient every two hours in order to drain the air in case of pupillary block, preventing a fixed dilated pupil (Urrets-Zavalia syndrome).

Even if DM rupture and its management can cause an higher endothelial cell loss (ECL) than with DALK without these complications, we believe that a self endothelium with an higher ECL is still better than one from a donor.

The purpose of a complete and good stromectomy is to let the donor tissue can be laid on the recipient bed without any stress. However, in some cases, the traction made by the suture can be another important factor. If the suture makes a non-uniform compression, it let the ruptures stay open, and determine the non-attachment of the DM in the rupture’s site. Once the air into anterior chamber is reabsorbed, a double chamber occurs between host DM and donor graft. In this case it is necessary to remove and replace the sutures that were too tight. Air into anterior chamber has to be left at this point to tamponate the ruptures, and it helps the surgeon to verify if the suture’s compression is homogeneous.

Nevertheless, the repair of DM ruptures can be very difficult in some cases. A very flat or very steep recipient bed, because the disparity of curvature between donor and recipient, avoid the correct recipient-donor adhesion, leaving the ruptures open. Our study group presented (in the recent ASCRS and AAO meetings) a technique suitable to repair DM ruptures in these kind of situations, by performing a full-thickness total or subtotal circular cut of the recipient bed in order to eliminate any tension and adherence problems:

“Full-thickness subtotal circular cut of the recipient bed” is a technique indicated to manage DM ruptures that happens in pdDALK cases where the recipient bed is significantly flatter than the donor graft. In these cases a full-thickness and subtotal circular cut of the recipient bed, that saves few millimeters of tissue at 6 o’clock, allows, after suturing the donor and injecting an air bubble into anterior chamber by a limbal paracentesis at 6 o’clock, the attachment between recipient bed and donor graft [unpublished data].

“Full-thickness total circular cut of the recipient bed” is technique suitable to manage DM ruptures that happen in pdDALK cases where the recipient bed is significantly steeper than the donor graft. In these cases, after stromectomy has been completed, the recipient bed is cutted 360° full-thickness and attached, by using fibring glue, to the graft button denuded from its endothelium. Graft made by donor button and recipient’s endothelium is then sutured, and an air bubble is left into anterior chamber [unpublished data].
DM ruptures can also happen as a consequence of an excessive trephination. Luckily, this is a rare complication. It can be avoided by a careful examination of the patient, with a pachymetric map, and verifying the trephine calibration. However, if it happens, can still be repaired. BB technique and viscodissection are not indicated. Manual dissection after suturing the perforated area is the best suited procedure. The layer by layer delamination should be performed from the periphery toward the center, not dissecting the perforated area. At this point donor graft can be sutured except in the perforated and not dissected area. Stromectomy can then be completed in the perforated area and donor graft can be finally completely sutured. Inject air into anterior chamber and move the eye in order to remove interface fluids are the last steps [unpublished data].

**Puncturing of the DM** is a possible complication during a needle BB. Moreover, the fear of perforating the DM with the needle let some surgeons not go deep enough to obtain the big bubble. This problem has been eliminated with the introduction of the cannula BB technique [3].

**DM disinsertion** in a quadrant is another rare, but possible, complication. We believe that it is related to the path that air, injected into the corneal stroma, can take when it reaches the corneal periphery. In the vast majority of cases, air reaches the anterior chamber through trabecular meshwork, as micro-bubbles. In very rare cases, air can cause DM disinsertion in a quadrant of the cornea. In our casistic it happened in 2 cases over more than 1000 DALK [unpublished data]. In both of these cases the surgery has been successfully completed. In one of the two cases, DM was rolled up on itself (in the same way that happens during DMEK donor preparation) after 20 days postoperatively. It was probably due to strong eye rubbing by the patient. It was corrected with an air bubble into anterior chamber, injected right after a surgical re-distension of the DM [unpublished data].

All these surgical triks can help to limit the numbers of PK conversion, and can also allow to perform DALK surgery in difficult cases. Once the surgeon become more expert and is able to achieve a DALK procedure in any case, the indications for DALK surgery can be enlarged.

It’s a true and common opinion that DALK has big advantages as a treatment for corneal pathologies affecting young people because of the long term graft survival[4-8]. The corneal diseases characterized by an higher rejection risk, take actually even more benefit from DALK procedure.
Extreme corneal diseases that require large transplant, where the proximity between donor graft and recipient limbus cause a very high risk of rejection, are one example. [6,9].

Infectious stromal keratitis unresponsive to medical treatment, are often characterized by inflammation and corneal neovascularization. In these cases DALK, if performed as an early therapeutic approach, not only avoids endothelial rejection and failure, but also limits the intraocular spread of the infection [10-12]. The pathological examination of the removed lamella is very important to understand the radicality of the surgery.

DALK in post-herpetic stromal scar is perhaps the most emblematic example. In this case rejection can cause recurrence of the infection, and vice versa. Combining DALK procedure with the correct antiviral prophylaxis gives excellent results. No episodes of rejection or graft failure were observed in one of the largest series (52 eyes, 31 months follow-up). The medical antiviral approach consisted in preoperative long-term therapy with acyclovir 800 mg/day, along with steroid eye drops once a day. Postoperative antiviral protocol was also described. It consisted of both topical antibiotics and corticosteroid 4 times a day, along with acyclovir (800 mg) 3 times a day for the first month. During the second month, the regimen was changed to dexametasone drops (3 times) with acyclovir 800 mg twice daily. After this point, long-term therapy consisted of acyclovir 800 mg once a day and dexametasone drops twice daily [13]. Various other studies [14-17] report that DALK is a good treatment for post herpetic stromal scar. The postoperative prophylactic treatment was shorter in time and it is probably the reason why a certain percentage of recurrence is reported in these studies. However they support that DALK has less recurrence and rejection rate than with PK, and an higher graft survival.

REFERENCES


