This outline reviews the steps for DMEK in a Pseudophakic patient. It is not intended to be a comprehensive resource and is not intended to replace time spent in a practice lab, or with a mentor in the OR but it is my hope that it will shorten your learning curve and help you provide this great surgery to your patients.

1. **Patient Selection**
   a. DMEK can be used to treat any cause of endothelial failure but is much more difficult in certain circumstances where it is probably best to utilize DSAEK. DMEK is best with a bicameral eye with a normal AC volume and intact lens iris diaphragm.
      i. Eyes with the following conditions are best avoided: iris abnormalities, glaucoma filtration surgeries, aphakia, unstable IOL, sulcus IOL, vitreous prolapse.
      ii. Eyes with hyperdeep anterior chambers such as high myopes are best approached with caution as graft unfolding and manipulation is harder in a deep AC.
      iii. Post vitrectomy eyes are best avoided as it is difficult to shallow the AC
   b. DMEK can be completed under topical anesthesia, retrobulbar block, or general anesthesia at the reference of the surgeon and patient. I strongly recommend one of the latter 2 modalities for initial cases and find that patients are most comfortable with a block.

2. **Selection of the graft tissue.**
   a. Pre-stripped tissue in the eye bank is preferred as it allows for post processing validation
      i. Diabetic tissue has been shown to be harder to prepare and is best avoided when possible to avoid torn grafts.
   b. Tissue age
      i. Younger tissue tends to scroll tighter and can be difficult to unscroll and position.
      1. I recommend using tissue from donors aged 50 and above for DMEK – especially when first learning DMEK. We currently use donor tissue up to 80 years old.
   c. Cell count, death to preservation time, cut to use time, etc...
      i. All tissue deemed acceptable by EBAA guidelines is acceptable for DMEK. Higher cell counts and other special requests have not been shown to improve results.
      ii. If the tissue has an s stamp it is best to use it within 72 hours of preparation for best visibility of the orientation stamp.

3. **Prepare the DMEK injector of your choice.** I currently prefer the Jones tube modified for DMEK by GuntherWeiss (no financial interest)
   a. I mount it onto a 3cc syring using 14fr nasogastric tubing. A video of its assembly can be found here: [https://youtu.be/qO6G_CCHtqE](https://youtu.be/qO6G_CCHtqE)
4. Preparation of the host eye.
   a. Use a fine tip marking pen to mark incision locations so that they will be easier to find when needed
   b. Create 2 paracentesis sites one inferior to an one superior to the main incision
      i. All wounds for DMEK should be self sealing as this greatly aids in chamber stability and subsequent manipulation and attachment of the graft. Self-sealing paracenteses are facilitated by making the incision parallel to the iris plane resulting in a square wound architecture.
   c. Inject cohesive viscoelastic (Healon) to pressurize the AC if needed
   d. Create a 3.25mm groove 250 to 300 microns deep at the temporal limbus for the main incision.
      i. The cornea is of greatest dimension horizontally, therefore the temporal approach facilitates creation of an incision that will not interfere with placement of the graft
      ii. Create the main incision through the earlier groove with a keratome and enlarge the opening to the full 3.25mm if using the modified Jones tube.
      iii. Check that the incision size is adequate for the injection device and enlarge if needed. It should be a tight fit.  
           1. If the incision is too large you may “torque” the injector to point inferiorly or superiorly to seal the incision when it is time to inject the graft.
   e. An inferior PI is used to prevent pupillary block from the air bubble.
      i. There are several options for creating an inferior PI
         1. A laser iridotomy can be created preoperatively
            a. Be sure to pass an instrument through it intraoperatively to be sure it is patent.
         2. A surgical PI may be created with a bent 30ga needle
            a. Inject Miochol to bring the pupil down.
               i. Do not use miostat or pilocarpine as they can promote posterior synechiae formation
               b. Bend the tip of a 30 ga needle (like a reverse cystatome).
                  i. Place it behind the iris and in front of the IOL near 6:00. Healon can be used to create space for this maneuver
                  ii. Scratch down on to the tip of the needle with a sinskey to create the PI. Stretch it side to side to be sure it is patent.
                  iii. Avoid excess traction on the iris root and avoid any obvious vessels
iv. If bleeding occurs, tamponade it with Healon. It is best to create the PI early in the case so that any bleeding can be managed and cease well before the tissue is inserted. See video at 1:30 mark https://youtu.be/J85evznXNSk?t=1m30s

f. Indent the surface of the cornea with an optical zone marker, avoid overlap with the incisions
   i. I most commonly use an 8mm optical zone marker
   ii. Rinse any Healon from the surface. Dry the indentation
   iii. Mark the indentation with a fine tip marking pen

g. Strip the host DM
   i. Use a Terry reverse sisnkey hook or similar device to score the DM under the 8mm template that was previously marked on the epithelial side of the cornea
      1. Take great care to use enough pressure to break through the DM but do not engage the stroma.
         a. Stroma fibrils may prevent attachment of the graft. The stromal bed should be as smooth as possible.
      2. It is easiest to use both paracenteses to accomplish this step
      3. Strip the DM from the stroma. Work from the edges to the center. Try to remove it in one piece. Place pressure on the folded portion of the DM to drag it centrally and avoid touching the stroma
      4. Remove the DM from the main incision with forceps

h. Thoroughly evacuate the viscoelastic from the AC.
   i. The I&A tip can be used to gently aspirate the posterior corneal surface to be sure no tags of DM are left behind.

i. Prior to preparing the graft, review your checklist and ensure that:
   i. DM stripping completed
   ii. Patent PI
   iii. Constricted pupil
   iv. Injector fits through the main incision
   v. All Healon removed from the eye
5. Preparation and loading of the donor graft at the sterile back table
   a. Remove the corneoscleral cap from the transport chamber.
      i. Grasp the pre-stripped donor by the scleral rim near the area of DM attachment. Elevate graft from the storage media and allow the stripped tissue to lie flat. Sponge away extra fluid.
      ii. Apply trypan blue to the tissue for approximately 30 seconds to highlight the edges of the graft and any damaged areas.
      iii. Sponge away trypan and check that the graft is lying flat
      iv. Place graft onto the punch block and position it under the blade
      v. Look down the bore of the blade but do not engage the tissue yet. The graft edges should be within the zone of the punch and the punch blade should not cross over the stromal window of the S stamp.
   b. Lower punch blade on to the block slowly while assuring appropriate centration. Contact the DM lightly with the blade. Tap firmly on all edges of the punch attempting to make a partial thickness punch through DM and into but not through the stroma.
      i. I prefer the moria punch as it is sharper and easier to make a partial thickness cut.
      ii. I usually use a 7.5 mm Moria punch. The DMEK graft cut with this punch is only slightly smaller than the 8mm template marked onto the corneal surface.
iii. Inspect the punch to see that it is complete for 360 degrees. This can be done by gently pulling peripherally outside of the punched area and looking for a separation.

c. Remove the peripheral DM and place it into BSS to use to later test the injector.
   i. Remove it by grasping the peripheral DM opposite the graft hinge with 2 forceps and breaking it. Then peel this away from the graft using a similar technique to tearing a rhexis.

d. Elevate the DMEK graft by directing short bursts of BSS at the edge of the DMEK graft opposite the hinge. Grasp this free edge and elevate it toward the hinge and complete the separation of the graft.

e. Add trypan blue to the corneoscleral cap and place the punched graft into this mix. It should be a roughly 50:50 mix of trypan blue and BSS. Let the graft sit undisturbed for 3-4 minutes

f. While the graft is staining, use the discarded peripheral pieces of the graft to practice using the injector. Use a petri dish lid filled with BSS for this step. The petri dish may also be used if the graft needs to be re-floated and loaded for any reason.

g. Use a sponge to remove the stain from the well
   i. The sponges work best if you pre-moisten and wring them out first.
   ii. Approach the graft end-on and not from the side. This makes it less likely to jump onto your sponge. If the graft does attach to the sponge, simply dip it into a well of BSS and it will gently float off.
   iii. Carefully tilt the cap as needed to remove all stain.

h. Add BSS to the corneoscleral cap to float the stained graft in BSS
   i. At this step additional drops or jets of BSS can be used to change the conformation of the graft and attempt to get a double scroll.

i. Aspirate the graft off of the punch block and into the tip of the injector using small controlled movements of the plunger.
   i. I find it easiest to orient the bevel sideways in relation to the graft.
   ii. If you are having trouble with this step, place the graft into the dish of BSS and practice aspirating from this larger pool of BSS.
   iii. If you aspirate the graft too far up the tube simply hold the tube vertically, tip down, and the graft will slowly move toward the tip.
   iv. Sit the graft and injector down and make sure the tip is not in contact with any surface. This will avoid any fluid wicking out of the tip.

6. Injection of the donor graft
   a. The AC should be formed but soft
   b. Grasp the anterior lip of the main incision with a 0.12 forcep and insert the injector bevel down.
c. Avoid gaping the incision and avoid losing any AC volume.
d. Controlling the injector with both hands, deliver the tissue with short bursts of BSS.
   i. Do not overpressurize the AC. Decompress a paracentesis as needed by depressing on it with a cannula.
   ii. The injector may be pointed slightly toward 6 or 12 in the incision to rotate the scroll perpendicular to the incision. The perpendicular position is ideal as it minimizes the risk of the graft following the injector out of the incision.
   iii. Remove the injector while pressing downward on the roof of the incision with a cannula to trap the tissue inside of the eye.
   iv. With experience it is possible to examine the conformation of the graft in the glass injector and inject it in the right side up orientation.
e. Suture the main incision shut.
f. If the AC is so flat that the graft is compromised, carefully add BSS through a paracentesis prior to suturing. Avoid gaping the main incision as the graft may flow out of it quickly.

7. Opening and centering of the donor graft. There are numerous techniques for this step. I will attempt to provide some starting points and advice but I highly encourage you to view as many videos as possible, practice in a wet lab, and if possible spend time with a mentor in the OR. All of the techniques rely on external forces or bubbles to manipulate the tissue into the correct position and conformation. Here are the basics of the technique I use:
   a. The AC should be shallow but not flat. A shallow AC allows the iris act as a 3rd finger to keep the graft from rolling back up on itself.
   b. This can be accomplished by depressing the posterior lip of an incision or by withdrawing fluid with a syringe and cannula. In some eyes (especially high myopes) the AC is hard to shallow and placement of light pressure on the temporal equator of the globe may help bring the lens iris diaphragm forward. This technique does not work well in vitrectomized eyes or in cadaveric eyes if the vitreous is overly liquefied.
   c. Use short jets of BSS and tapping on the corneal surface to open the graft. The aim of these maneuvers is to create small currents inside of the eye to move dance the graft into position and unscroll it.
   d. It is best to maintain gross centration of the graft while unfolding it to avoid losing the graft into the angle. Sometimes the graft can become stuck in the angle and irrigation is needed to move it back toward the center of the eye.
   e. In addition to centration, orientation is of utmost importance. The endothelium must be positioned facing toward the iris with the tissue scrolling up toward the stroma (see image below)
i. There are multiple tissue orientation techniques, they can be divided into two broad groups: see video: https://youtu.be/-tTeZbvo5wI

1. Scroll based that depend on the tissue scrolling as it is “susposed” to:
   a. visual inspection alone
   b. hand help slit beam or microscope mounted slit beam
   c. Moutsouris sign
   d. Intraoperative OCT
2. DMEK scroll marking techniques – work well no matter what the scroll conformation is
   a. S stamped tissue
      i. A S stamp is applied to the nonendothelial side of the graft in the eyebank at the time of tissue processing. The mark is intuitive, highly visible, safe for the endothelium, and is my preference for all DMEK cases.
   f. After the graft is open, finely adjust centration, then secure it in position with a full air (or gas) fill.
      i. Aim for perfect centration. Areas of overlap between the graft and host tend to be the most problematic for graft separation. Superior decentration of the graft is more forgiving than inferior decentration as the superior area has the most support from the bubble that will be placed at the end of the case.
      ii. Put the air/gas cannula into a paracentesis and move it along the surface of the iris to the center of the graft then smoothly inject the air.
1. Be sure the eye is in primary position while injecting or the graft will decenter toward the higher limbus

**Key videos to review:**

My YouTube channel: https://www.youtube.com/channel/UC79YJPwjFU8a_cXkyLp9g8Q

Tips and techniques video: https://youtu.be/NuC7ZiHGICc
Pearls for success video: https://youtu.be/J85evznXNSk
Graft Orientation video: https://youtu.be/-tTeZbvo5wI
DMEK injector assembly video: https://youtu.be/q06G_CCHtgE
Tips:

Taps for unscrolling and positioning should be very staccato

Grasp the sides of syringe plungers and move them with your fingers, do not push on them with your thumb. This affords more control than using ones thumb.

DMEK tissue tends to scroll with the endothelium on the outside of the scroll.
Upside Down Graft Orientation

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