

Descemet's Stripping Automated Endothelial Keratoplasty (DSAEK)

John D. Goosey, MD Houston Eye Associates

Introduction

DSAEK is a corneal transplant technique where the unhealthy, diseased, posterior portion of a patient's cornea is removed and replaced with healthy donor tissue obtained from the eye bank. Unlike conventional corneal transplant surgery known as penetrating keratoplasty, (PKP), the DSAEK procedure utilizes a much smaller surgical incision and requires no corneal sutures. This usually results in more rapid visual rehabilitation for the DSAEK patient and also reduces the risk of sight threatening complications that may occur with the PKP procedure such as intraoperative expulsive hemorrhage or post operative traumatic wound rupture.

DSAEK is indicated for those patients who have corneal pathology located on the posterior aspect of their cornea known as the endothelial layer. The endothelial layer of the cornea is a monolayer of cells attached to a basement membrane called Descemet's membrane. A healthy endothelial layer consists of small, hexagonally shaped cells with a density of 2500 to 3000 cells/mm².

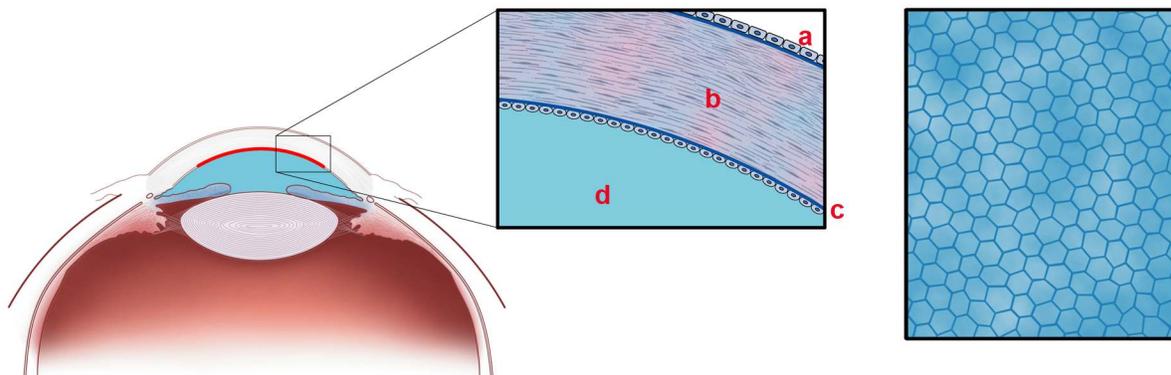


Figure 1a – Healthy monolayer of endothelial cells attached to Descemet's membrane. Red line in the leftmost figure represents Descemet's membrane and endothelium. The middle diagram represents an enlargement of a cross section that from top to bottom includes the epithelial layer (a), stromal layer (b), Descemet's membrane with attached monolayer of endothelial cells (c) and anterior chamber (d). The rightmost diagram illustrates normal size and shape of healthy endothelial cells.

When endothelial cells are healthy, they function as a “pump-leak system” to provide nourishment for the cornea. In other words these cells allow nourishing fluid from inside the eye (aqueous humor) to leak into the cornea. After the corneal cells have been nourished, the cells pump the fluid out of the cornea. If the endothelial pump is compromised for any reason the cornea will over hydrate and become cloudy. This most commonly occurs in patients who have sustained trauma to the endothelial layer

during complicated cataract surgery or patients who have an inherited disease of the corneal endothelium known as Fuch's endothelial dystrophy. When the corneal endothelium is stressed the endothelial cells become larger and sparser. As endothelial cell density falls between 500 to 1000 cells/mm² the pump mechanism can no longer maintain a clear cornea. In the case of Fuchs dystrophy the endothelial cells also start secreting material that makes Descemet's layer thicker and more opaque. Vision eventually deteriorates to a point where these patients feel like they are looking through wax paper. Such patients are good candidates for the DSAEK procedure.

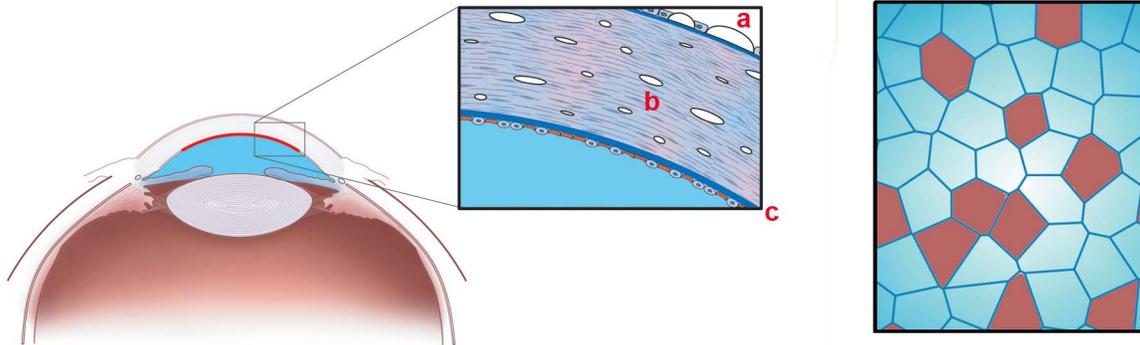


Figure 1b - Unhealthy monolayer of endothelial cells attached to Descemet's membrane. The middle diagram illustrates a cross section of an over hydrated swollen cornea. The top layer of epithelial cells have formed bullae or blisters (a) and the stroma is thickened with vacuolated spaces (b) both of which are the result of over hydration. A sparse covering of stressed endothelial cells lies over a thickened Descemet's membrane (c). The rightmost figure depicts large, low density, irregularly shaped endothelial cells.

Description of the Procedure

The first part of the DSAEK procedure encompasses removal of the unhealthy compromised endothelial cells and attached Descemet's membrane. The second part of the procedure involves replacing this unhealthy tissue with healthy cells from a donor cornea. The entire intraoperative procedure is performed in about 20 to 30 minutes.

Approximately 30 minutes before the DSAEK procedure the patient is sedated with intravenous medication. The IV sedation renders the patient totally unconscious for about 1 to 2 minutes. During this time a local anesthetic is given to completely numb the eye. When the patient awakes, the sensory nerves of the eye have been blocked so the patient will not feel or see anything during the procedure.

After the local anesthetic has taken effect, the patient is taken to the operating room and the eye is draped in a sterile fashion. DSAEK is a microsurgical technique that is performed under a special operating microscope. The first step of the operation involves making a very small (4.5mm) incision at the 12 o'clock position of the corneal limbus using a device called a keratome.

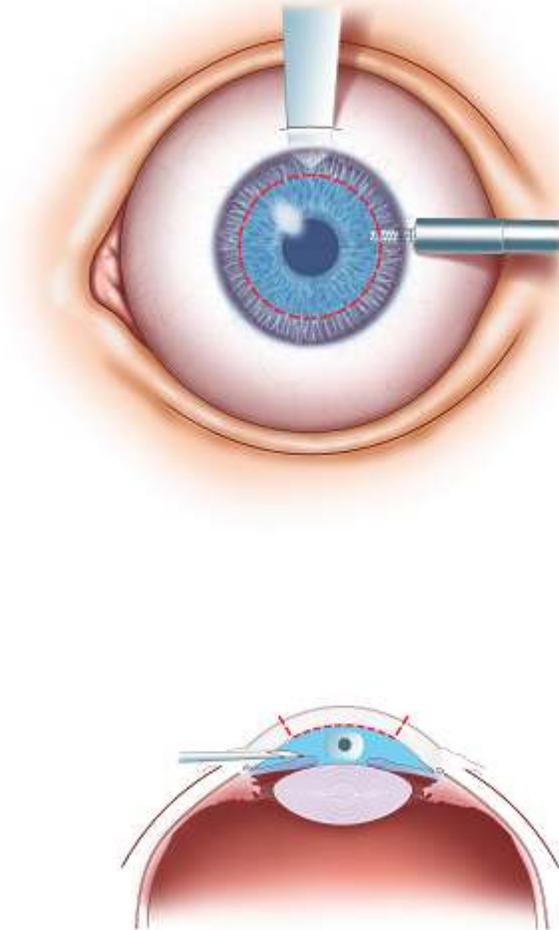


Figure 2 – Top illustration depicts a keratome making a small incision at the 12 o'clock limbus and an AC maintainer at the 3 o'clock limbus. The bottom cross sectional figure shows the opening of the AC maintainer within the small blue space which represents the anterior chamber.

Another instrument called an anterior chamber (AC) maintainer is also placed at the temporal aspect of the limbus (3 o'clock). The AC maintainer is an irrigating port that infuses sterile saline into the anterior chamber of the eye and maintains the eye's shape during the operation. It is within this small space known as the anterior chamber that the DSAEK procedure is performed. The average height of the anterior chamber is only 3.5mm which explains why the magnification of an operating microscope is needed to perform the delicate microsurgical maneuvers of the DSAEK procedure.

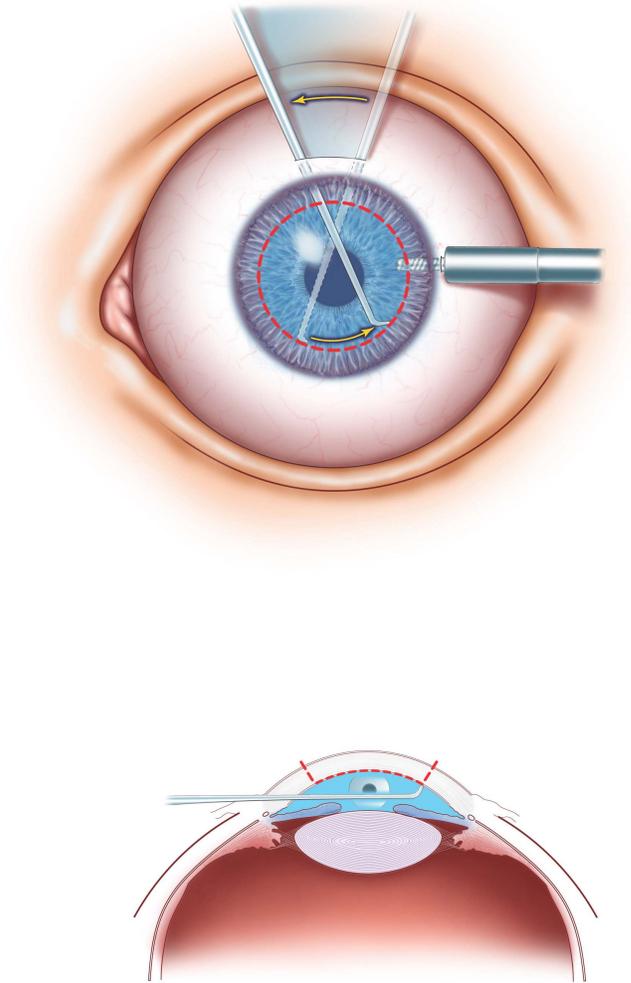


Figure 3 – Depicts a Sinsky hook scoring Descemet's membrane in a circular motion. The bottom figure illustrates how the AC maintainer keeps the small anterior chamber space formed during the maneuver.

An instrument called the reverse Sinsky hook is inserted through the tiny incision site and into the anterior chamber (Figure 3). The Sinsky hook is shaped like a small hockey stick and the tip of the hook is used to score an 8mm diameter circle on the back of the patient's cornea. The hook actually breaks or tears through Descemet's membrane so that the 8mm circle of Descemet's membrane and unhealthy endothelial cells can be removed.

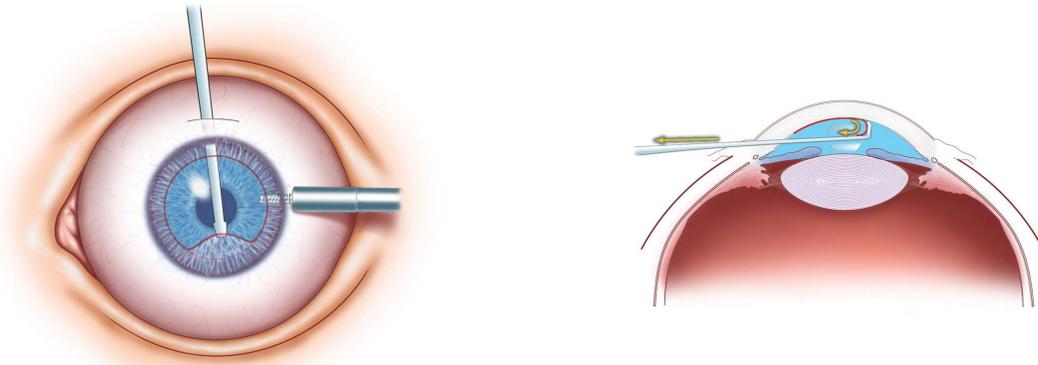


Figure 4 – Depiction of the delicate stripping of diseased Descemet's membrane with the microsurgical rake. The figure on the right is a cross sectional view of the same maneuver.

The actual removal of the circle of Descemet's tissue is done with a device called a Descemet's stripper. This device looks like a small garden hoe or rake. This microsurgical rake is used to delicately strip away an 8mm diameter circle of diseased Descemet's membrane with attached endothelial cells. The anterior chamber maintainer infuses sterile fluid into the eye as Descemet's membrane is stripped away. All of these maneuvers are done within the small space of the eye known as the anterior chamber. As Descemet's membrane is stripped away it is pulled through the small incision site and removed from the eye. This delicate membrane with its attached endothelial cells is only 20 to 30 microns thick! As mentioned earlier the endothelial cells attached to this delicate membrane must function properly to maintain corneal clarity. So once the unhealthy tissue has been stripped off the back of the patient's cornea it must be replaced with healthy tissue from a donor cornea.

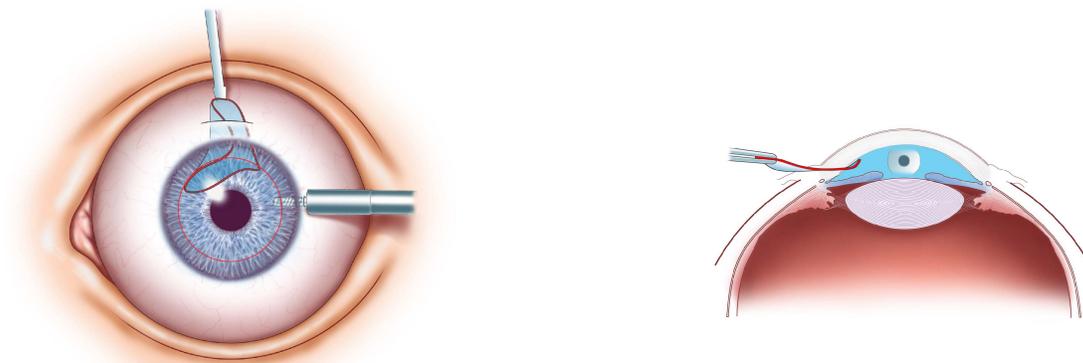


Figure 5 - Illustration of removal of an 8mm circular disk of diseased Descemet's membrane from the anterior chamber through the tiny incision site. The figure on the right is a cross sectional view of the same maneuver.

Preparation of the donor tissue has been greatly facilitated by the use of the microkeratome. The microkeratome has been used for decades in refractive surgery and is most commonly used today to cut the flap in LASIK surgery. The microkeratome works like a mini-carpenter's plane. The microkeratome can be adjusted to cut various thicknesses of cornea. For the DSAEK procedure the thickness of the cut removes the top 80-90% of the cornea. The bottom 10-20% is then used to prepare an 8-9mm disc of donor tissue. This donor tissue is machine cut rather than hand cut and has a very smooth surface which enhances visual recovery. The endothelial cells of the donor tissue are coated with a protective gel and then the donor disc is folded like a taco with the endothelial cells on the inside.

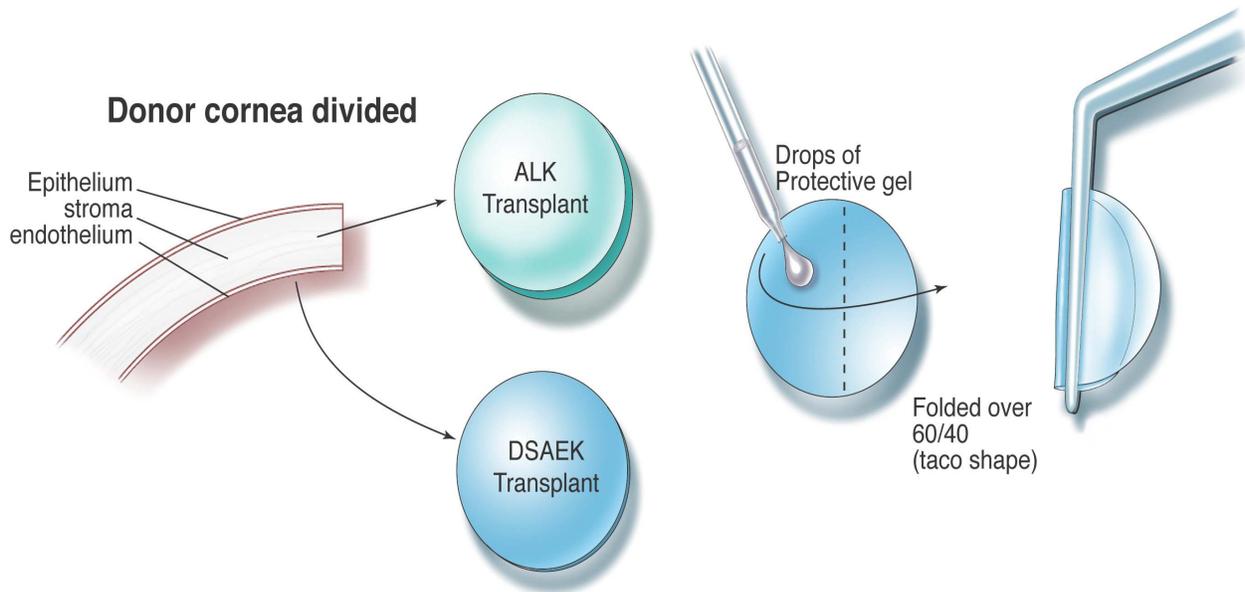


Figure 6 – Illustration demonstrating the division of a full thickness cornea into two parts. The top 80% of this divided cornea can be used for anterior lamellar transplants and the bottom 20% is used to prepare donor tissue for DSAEK. This division of tissue is accomplished with a specialized instrument called a microkeratome. Protective gel is placed on the endothelial side of the DSAEK transplant and then it is folded like a taco.

The folded donor tissue is then inserted through the surgical incision site into the anterior chamber of the patient's eye. Once the folded tissue is inside the eye the anterior chamber maintainer is used to deepen the front of the eye and unfold the tissue through gentle irrigation. The tissue is opened so that the donor endothelial cells are oriented to the posterior or backside of the tissue.

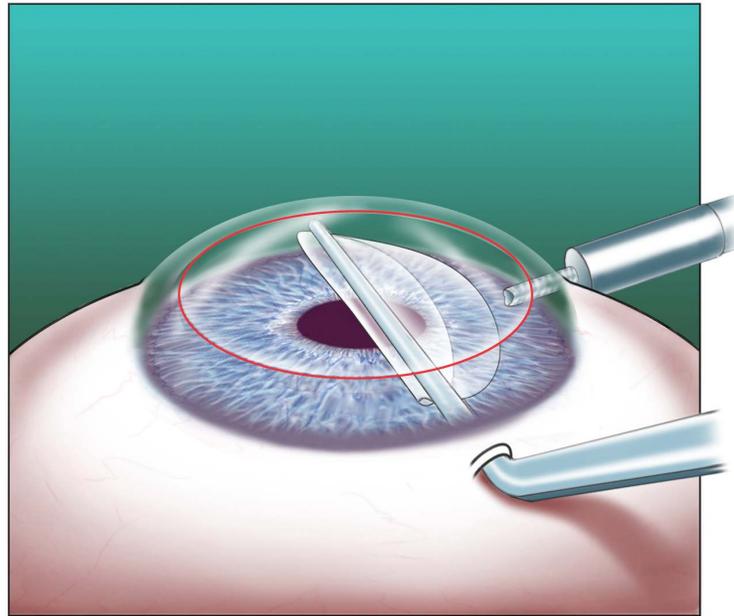


Figure 7 – The taco shaped DSAEK donor tissue is inserted into the anterior chamber through the tiny surgical incision.

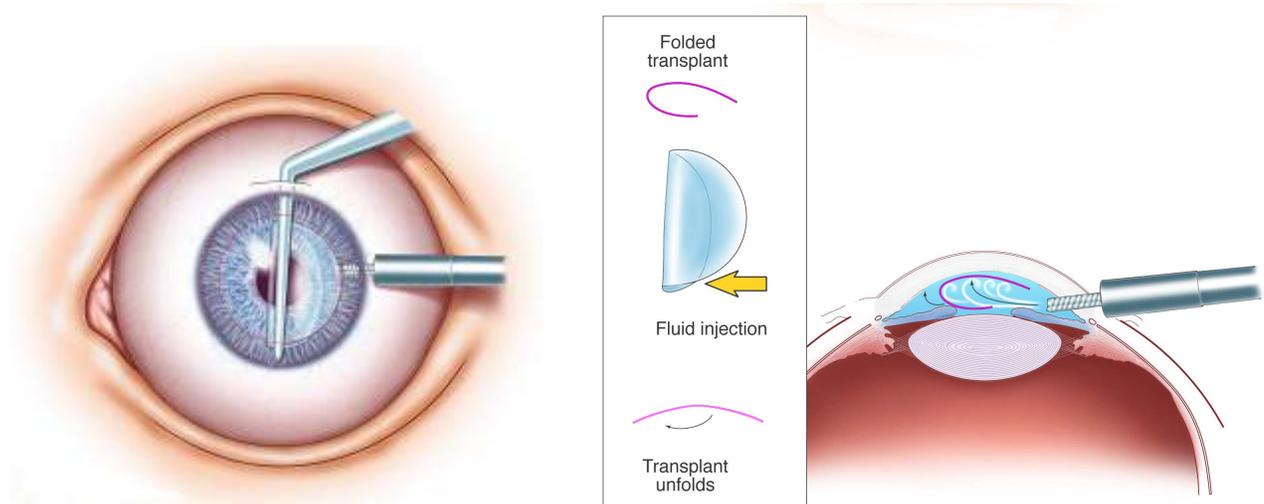


Figure 8 – DSAEK donor tissue has been inserted into the anterior chamber and the gentle flow of fluid from the AC maintainer is used to unfold the taco. The bottom figure shows a cross section of the same.

After the tissue has been unfolded it is positioned to cover the area of the previously stripped Descemet's membrane. Then the anterior chamber is filled with air.

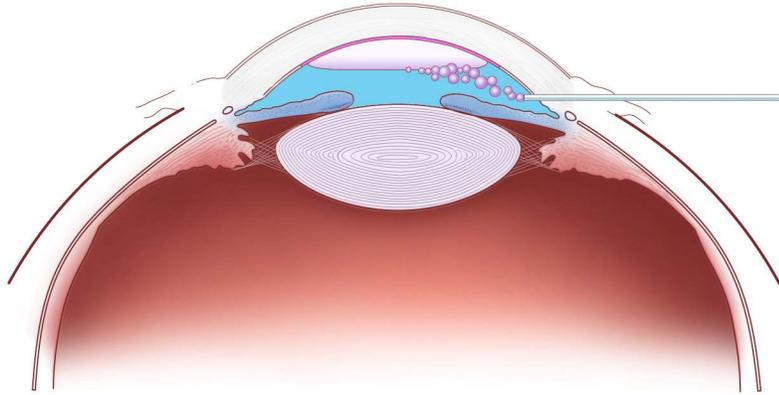


Figure 9 – Shows a cross sectional view of the injection of air into the anterior chamber from a cross sectional view.

The air filled anterior chamber is needed to hold the transplant tissue in position

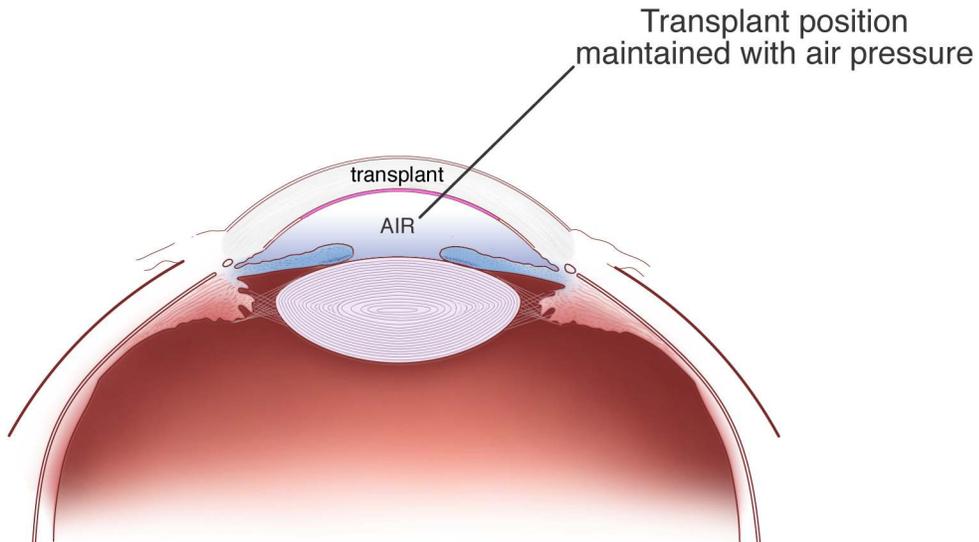


Figure 10 – Depicts anterior chamber full of air with a well-positioned DSAEK transplant.

The small incision site is closed with 2 or 3 sutures and the patient is then sent to the recovery room where the patient lies on his back, face up, for one hour so that the air in the anterior chamber can help fix the transplant into place. After one hour the patient returns to the clinic where the air bubble is removed. The patient is then sent home with instructions to return the following day.

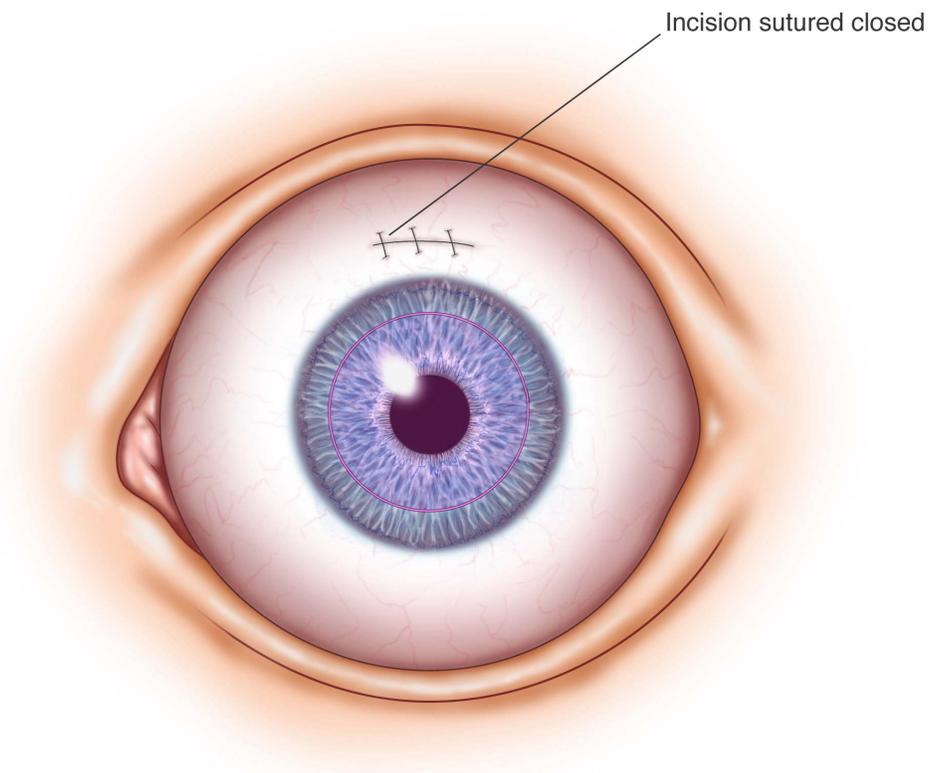


Figure 11 – The DSAEK transplant is in excellent position and the small incision is closed with 3 sutures. Note that there are no corneal sutures present which helps to minimize post operative astigmatism.

Commonly Asked Questions

1. Where is the procedure performed?

DSAEK is performed in an outpatient surgicenter. No hospitalization is required.

2. How long does the procedure last?

The total time the patient will be in the surgicenter is approximately 2 to 2.5 hours. Once the patient is taken to the operating room the procedure is completed in 20 to 30 minutes. Additional time may be necessary if other procedures are also planned ie cataract surgery or intraocular lens replacement. After the procedure is completed the patient is taken to the recovery room where they must lie on their back for 45 to 60 minutes. This allows the air that has been placed in the anterior chamber of their eye to fix the transplant into position.

3. When will I need to return for a followup office visit?

The first office visit is scheduled about 1.5 to 2 hours after the DSAEK procedure has been completed. After leaving the surgicenter you will be taken to my office. The visit is necessary so that I can remove the air that was placed in your eye. Since your eye is still totally numb you will not experience any pain while I remove the air. Removal of the air only takes a few seconds and is necessary so that you do not experience an intraocular pressure spike during your first post op evening. Removal of all the air is not required and some air usually remains in the eye to help maintain the transplant in proper position.

You will also return for a follow up visit the next day after surgery. During this visit the health and position of the new transplant will be checked. If everything is in proper order you will start your post op eye drops as directed and return for a follow up visit in 1-2 weeks.

4. What type of eye drops will I need after surgery?

You will continue using antibiotic eye drops (Vigamox) that you started three days prior to surgery. Use the Vigamox 4x per day for one week after surgery unless otherwise instructed. You will also use a steroid eye drop (Econopred 1% or Pred Forte) 4x per day until otherwise instructed. The steroid drops are required to prevent rejection of your new transplant. If you are also using glaucoma eye drops continue to use them after surgery unless otherwise instructed.

5. When will I see an improvement in my vision?

Visual recovery varies depending on the severity of your corneal cloudiness prior to surgery. Most patients notice improvement in their vision during the first two weeks after surgery with continued improvement during the next four to six weeks. This recovery represents a dramatic improvement over the time required following conventional corneal transplant surgery (PKP), which usually takes six to twelve months. Some DSAEK patients may not notice visual improvement as quickly as they would like, because they have other ocular conditions such as cataract or retinal problems that must be addressed.

6. Can my DSAEK transplant undergo rejection?

Although the rate of rejection with DSAEK does not appear to be any higher than rejection rates with PKP, endothelial rejection can occur following DSAEK. The signs and symptoms of such rejection episodes are the same as they are for PKP patients. Briefly, if you experience redness, photophobia (light sensitivity) and blurred vision assume that you are having a rejection episode and call my office so that you can be evaluated immediately. Most rejection episodes are successfully terminated by using steroid eye drops. The sooner a rejection is treated the better chance for transplant survival.