Newer Trends In Lamellar Keratoplasty

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Newer trends in lamellar keratoplasty

Last decade has seen a renewed interest in lamellar keratoplasty with several modifications to improve visual outcome. This involves a partial thickness of the cornea that is transplanted to selectively replace only the diseased portion leaving the rest of the healthy cornea of the patient undisturbed. It is therefore a less invasive procedure but involves finer surgical skill and more refined instrumentation. Lamellar keratoplasty is of two types:

1. Deep anterior lamellar keratoplasty (DALK)
2. Deep lamellar endothelial keratoplasty (DLEK)

Deep anterior lamellar keratoplasty (DALK) is a partial thickness corneal graft, that is used in eyes where the pathology is confined to the anterior layers of the cornea, eg. Superficial corneal scars and certain congenital or developmental disorders such as epithelial and stromal dystrophies. The advantages of this technique over the 'conventional' full thickness graft are: fewer sutures, quicker rehabilitation, less medication, almost negligible chances of a graft rejection and a more secure wound.

Deep lamellar endothelial keratolasty (DLEK) is also a partial thickness corneal graft, that is used to replace endothelium. LEK is a more intricate surgical procedure than DALK, and was introduced as recently as 1998 by an innovative Dutch surgeon, Dr. Gerrit Melles and popularized in the US by an Ohio-based surgeon Dr. Mark Terry. The benefits of the technique, over the conventional corneal transplant include a better quality of vision, a more comfortable post operative period and a quicker visual rehabilitation. This form of corneal transplant can even be performed through a wound as small as a modern cataract surgery wound and can be done without sutures.

The techniques can be discussed as

1. Microkeratome assisted anterior and posterior lamellar keratoplasty
2. Manual anterior and posterior lamellar keratoplasty

Microkeratome assisted anterior and posterior lamellar keratoplasty

Automated lamellar therapeutic keratoplasty

The advent of new microkeratomes (both manual and automated) has allowed therapeutic lamellar keratoplasty to be readily performed in a reproducible manner. The microkeratomes are adapted from those available for laser in-situ keratomeilusis and are commercially available although it is desirable to have a micro keratome with variable depth plates. In addition, anterior chamber maintainers are available for use with corneoscleral buttons if whole eyes are not available. Therapeutic automated lamellar keratoplasty can be used both for anterior stromal pathology and endothelial dysfunction.

Automated anterior lamellar keratoplasty

The indications for this procedure are opacification in the anterior to mid-stromal portions of the cornea (ranging from herpetic scarring to anterior stromal dystrophies)

The cornea needs to be of relatively normal thickness. The advantage of this technique over other lamellar techniques is the relative ease of surgery and the low incidence of interface scarring and irregular astigmatism.

The automated microkeratome (without the stop screw so that a free flap is produced) is used to cut the donor lenticule, as well as the corneal disc in the recipient eye. The thickness of the cut can be adjusted in relation to the depth of the lesion, by choosing the proper plate size; (up to 450 um). The cut made by the automated micro, keratome is regular and the lenticule fit is usually good but not perfect (even though they have the same nominal diameter and thickness). As the donor lenticules tend to be fairly thick, either an overlay suture for a few days or a standard suturing technique can be used.

In a situation where there is a midstromal opacity only, an alternative technique can be used. A thinner flap of 160-180 um is cut with a hinged flap. A partial thickness trephination and lamellar dissection is performed either manually or with the aid of an excimer laser. The donor lenticule is prepared by two microkeratome passes: one thin and one thick, aiming to produce a difference in thickness equal to the lamellar dissection on the host. The donor stromal button is transplanted onto the host bed and the flap replaced and sutured.

The visual recovery with these techniques is extremely rapid: often in the order of a few days. Sutures can be removed within a few weeks at most. There is relatively low postoperative astigmatism and the optical quality of the graft is excellent, most patients preferring the visual quality from this procedure to that of a standard penetrating keratoplasty.

Automated posterior lamellar keratoplasty

The automated microkeratome can also be used in posterior keratoplasty for corneal decompensation secondary to endothelial dysfunction . In this technique, A hinged anterior stromal flap approximately 350 um (250-450 um) thick is first cut in the host cornea, and the diseased posterior cornea is trephined (the trephine size used depends on the diameter of the flap and hinge width). The donor cornea is then prepared using the same microkeratome (without the stop screw) to cut the anterior corneal disc, and the residual posterior stroma and endothelium are trephined to the same size. The donor is transplanted and sutured on the recipient bed.(some surgeons do not find it necessary to suture the posterior lamella). The anterior flap is then repositioned and sutured.

The use of a hinged corneal flap could improve the post operative reapposition (as in LASIK), and also creates a smoother corneal surface, thus reducing the occurrence f postoperative astigmatism. The host epithelium and stroma are preserved and may reduce the risk of rejection episodes.

Excimer laser-assisted keratophakia for keratoconus:

From the donor eye, a free corneal flap of 9.0-mm diameter was created using a micro keratome. A second free layer was cut with an approximate thickness of 250 um +_ 35 um and punched, with a 7.25 or 7.5 mm trephine. In the host cornea, a 9.0 mm hinged flap was made with the microkeratome, and the stromal button was positioned underneath the recipient flap. Care was taken to leave a final corneal thickness of at least 500 um. The flap was then sutured with interrupted 10/0 monofilament nylon sutures. Sutures were removed at three months after surgery when the refraction stabilized by the end of 6th postoperative month in all cases, PRK or LASIK can be performed to treat the residual refractive error. This sandwich technique increases the thickness but minimally changes the refractive error of the cornea in keratoconus cases, but prepares the cornea for refractive laser surgery to be performed safely and effectively in these patients.

Manual anterior and posterior lamellar keratoplasty

Air dissection of Descemet's membrane in deep anterior lamellar keratoplasty

Stromal interface opacification is mainly responsible for the inferior visual results in lamellar keratoplasty . Placing the interface at the natural cleavage plane in front the Descemet's membrane provides visual results comparable to those in penetrating keratoplasty. Different methods have been tried to expose the Descemet's membrane but all the methods employed so far are unreliable, time consuming and perforation rates are high (more than 35%).

Intrastromal air injection to opacify the cornea for easy identification for Descemet's membrane has been used. How ever perforation rate is still undesirable in this technique.

A fairly safe, consistent and rapid way of baring Descemet's membrane is the "big bubble technique of air injection" . After a partial trephination, a 27 G bent needle, with the bevel down, is inserted deep (90%) into the corneal stroma. Air is forced into the pre-Descemet's plane creating a large bubble between the stroma and the Descemet's membrane. After anterior keratectomy the cavity of the bubble is entered with a sharp 15° knife . A 0.25 mm round wire spatula is inserted into the plane and the overlying stroma is split with a sharp knife creating a large surgical descemetocele. The residual stromal is removed with colibri forceps and a blunt Vannas scissors to expose the Descemet's membrane in the entire area . Descemet's membrane and the endothelium is stripped off from the donor button and sutured *in situ* with 10/0 nylon running suture.

Viscodissection of Descemet's membrane in deep anterior lamellar keratoplasty

To create an optical interface at the posterior corneal surface, the anterior chamber may be completely filled with air. The air-to-endothelium interface can then be used as a reference plane for dissection depth during; surgery, *ie,* the depth at which a dissection is made can be monitored continuously during the surgery. Using this technique, a deep stromal dissection can be made without the need for removing the stroma layer for layer, making the surgery quicker and minimizing the risk perforation .

To achieve a deep dissection depth, a set of spatulas may be used. Using these instruments, a 95% dissection depth can be obtained with a perforation ratio of less than 10%. As an alternative, a visco elastic may be used to split Descemet's membrane from the posterior stroma. Using the same optical interface as a reference plane, a needle attached to a syringe filled with visco elastic may be inserted into the central cornea. When needle has reached the appropriate depth, the visco elastic may be injected just anterior to Descemet's membrane, creating a pocket filled with visco elastic between Descemet's membrane and the posterior stroma.

Although visco dissection of Descemet's membrane can be performed quicker than with the spatulas, a disadvantage is the higher perforation rate. When viscoelasticinjected into the cornea to enlarge the pocket, a rupture of Descemet's membrane can occurred. For this reason, spatula dissection is preferred, since the technique is much more controlled.

Posterior lamellar keratoplasty through a self sealing tunnel incision

In this technique, a superior 9mm scleral incision is made 1mm away and concentric to the limbus. A crescent blade is used to dissect into the cornea at a depth of 75-85% to create a lamellar pocket. A lamellar dissector (Dever's dissector) is used to extend to the lamellar plane over the entire cornea. A special trephine (Terry Trephine) is introduced in to the lamellar plane to initiate a posterior stromal cut. Once the anterior chamber is entered, a pair of highly curved scissors (Cindy scissors) is used to complete the trephine cut for 360°. Donor corneoscleral tissue is mounted on an artificial anterior chamber and partial thickness trephination is performed followed by lamellar dissection to remove 80% of the stromal tissue. Following this, donor tissue is mounted endothelial side up on a standard donor punch trephine block. A trephine of the same size as Terry trephpine is used to punch the donor posterior stromal lenticule. This lenticule is then placed onto a sodium hyaluronate coated insertion spatula (Ousley spatula). The recipient anterior chamber is filled with air, followed by insertion of the donor lenticule into the lamellar interface. Once in the correct position, the spatula is gently removed leaving the stromal surface of the done tissue self adherent to the host stromal bed supported by the air bubble in the anterior chamber. The scleral incision is then closed using interrupted 10-0 nylon sutures. At the end of surgery the air bubble can be removed and replaced with balanced salt solution (BSS).

In their series Terry and colleagues have shown favourable results with DLEK procedure at 6 and 12 months follow up. The best corrected visual acuity varied between 20/30 and 20/70. The corneal surface maintained regular and smoothe corneal surface on corneal topography. The average change in corneal power was –0.4 + 1.17 diopters (D), the average astigmatism was 2.28 + 1.03D and the average endothelial count was 2290 + 372 cells/mm^2.

With experience deeper dissections are being used, so that only 5 to 10% of the posterior recipient cornea needs to be excised.

With the deeper dissections, the need for the intrastromal trephine was eliminated, since perforation occurred within the first turn of the trephine, and mostly scissors were used to excise the tissue. With the need for the trephine gone, there was no need anymore for a 9.0 mm incision. Hence, the technique was adjusted to perform the dissection through a self-sealing 5.0 mm incision as in early phacoemulsification. In the latter technique the donor tissue is folded as a 'taco' filled with visco elastic, inserted into the anterior chamber, and unfolded and positioned against the posterior stroma using air .

With the small incision technique, a useful visual acuity (>20/40) can be obtained within the first month, and the induced astigmatism is less than one diopter . Endothelial cell counts seemed to be lower with the small incision technique compared with the initial technique. However, with the small incision technique a larger diameter donor button (8.5-9.0 mm) can be transplanted, so that the absolute number of endothelial cells may still be sufficient. A major advantage of the procedure is that the number of postoperative examinations is greatly reduced, since the need for selective suture removal, contact lens fitting, etc., is eliminated.

Transplantation of Descemet's membrane

The feasibility of the surgical technique as well as the clinical results may improve with deeper dissections, *ie,* the deeper the dissection, the less tissue has to be removed, the easier the technique, the less the risk of interface haze, and the better the visual outcome. Transplantation of the endothelium alone may not be effective in most cases of Fuchs' dystrophy, characterized by visually disturbing Descemet's membrane abnormalities, the Hassle-Henle warts. The most rational procedure may therefore be the transplantation of Descemet's membrane carrying the endothelium of the same donor.

This newest version of posterior lamellar keratoplasty has been termed Descements stripping automated endothelial keratoplasty (DSAEK). It is also known as DXEK (Descemetorhexis and endothelial keratoplasty). Primary advantage of DSAEK compared to other posterior graft procedures are the speed and degree of visual recovery. Vision usually recovers in one to three months.

For DSAEK the surgery basically is reduced to two steps. First the excision of the recipient Descemet's membrane, *ie,* creating a Descemetorhexis, and second the implantation of a donor Descemet's membrane into the anterior chamber and positioning of the tissue against the recipient posterior stroma. The performance of a Descemetorhexis is a quick and easy maneuver. For this proper donor tissue preparation is essential, for this the donor cornea must have sufficiently large scleral rim to allow fixation with an artificial anterior chamber. Corneoscleral button of 16mm diameter is recommended. The posterior lamellar donor button should comprise endothelium, Descemet's membrane and 100-200 um of stromal tissue. A thin donor botton is difficult to manipulate and too thick a button may compromise the optical quality. Lamellar dissection of the donor cornea is performed with an automated microkeratome. The system comes with 300um head. It is advisable to have 350-400um head available since corneal thickness of donor corneas is variable. Once the donor cornea is dissected then it is transferred to a cutting block, punched with a trephine having endothelial side up. A 9mm trephine provides more endothelial cells as well as better centering during surgery. The insertion of donor button in recipient eye is same as in posterior lamellar keratoplasty through a self sealing tunnel incision.

DLEK (Deep lamellar endothelial keratoplasty) is a new procedure and is currently in evolution.

Any procedure that replace endothelium ideally should accomplish the following.

1. a smooth surface topography without significant change in astigmatism
2. a highly predictable corneal power
3. healthy donor endothelium that resolves edema
4. tectonically stable globe, safe from injury and infection
1. an optically pure cornea

The most common and vexing problem encountered after Penetrating Keratoplasty is the topographic changes induced by surface corneal sutures, high or irregular astigmatism or both can persist some times even years after all sutures have been removed. Surface corneal sutures in Penetrating Keratoplasty can threaten the vision and graft in other ways such as suture related infections which can lead to devastating wound dehiscence and even endophthalmitis. They also lead to vascularisation which predisposes to graft rejection. Elimination of surface corneal sutures reduces the potential postoperative problems and follow up visits.

The small incision technique of DLEK is intellectually appealing the visual results, topographic results and importantly the endothelial cell survival with this technique in a series of patients needs to be studied. The best corrected visual acuity reported in these patients is 20/25 and not 20/20, optical irregularities of the interface likely contribute to this dearth of 20/20 results after DLEK surgery and further work towards optimizing the interface needs to be done.

Unique to DLEK surgery is the fact that after the transplanted endothelium clears the overlying edema of the recipient tissue, the preoperative bullae are deflated, leaving redundant epithelial tissue in folds on the surface, in most cases this redundant epithelium is gradually replaced by normal turnover of the epithelial surface. In some cases, long standing bullae may leave redundant tissue which persists and causes irregular astigmatism. In such cases, scraping the central 6mm diameter epithelium and placing a Bandage Contact Lens results in a smooth corneal surface.

Patients with endothelial decompensation from the fuch's dystrophy or pseudophakic bullous keratopathy with no significant anterior corneal scarring are suitable candidates for DLEK. The chance of endothelial rejection as with Penetrating Keratoplasty is present for DLEK as well. The specific technique of DLEK continues to be modified and the results crically analyzed. Once the procedure is made fully practical and uniform, then a large , prospective, randomized clinical trial comparing DLEK to PK and other forms of selective endothelial transplantation will be needed to fully establish the best standard of care for endothelial replacement surgery.

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