

# Endothelial Replacement Surgery

A comparison of deep lamellar endothelial keratoplasty and penetrating keratoplasty.

BY MARK A. TERRY, MD

The leading causes of visually significant endothelial dysfunction are Fuchs' endothelial dystrophy and pseudophakic bullous keratopathy. When the medical therapies of steroid drops to stimulate endothelial function and/or hypertonic saline and tear film evaporative actions are insufficient, endothelial replacement surgery is necessary for visual rehabilitation.

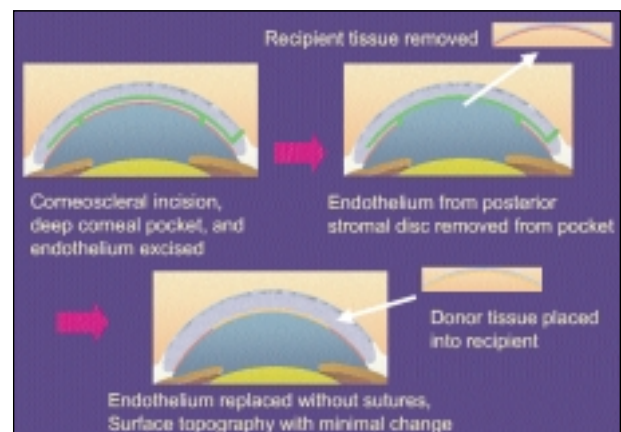
During the past century, the only option for endothelial transplantation has been full-thickness penetrating keratoplasty (PKP). Although this procedure can provide excellent stromal graft clarity, it is plagued by the inherent problems of vertical stromal wounds that heal poorly and require surface corneal sutures. The latter cause irregular astigmatism and contribute to vision-threatening situations such as ulceration, vascularization, and graft rejection.

In 1993, Ko et al<sup>1</sup> performed a technique of replacing the endothelium through a limbal incision. Their results in an animal model led to further development in 1998 by Melles et al,<sup>2,3</sup> who published their results on posterior lamellar keratoplasty in the first human surgeries. My colleagues and I modified the technique and instruments in our laboratory, and we treated the first US patients in 2000 under an Institutional Review Board-approved protocol.<sup>4-6</sup> We named this procedure *deep lamellar endothelial keratoplasty (DLEK)* and now have the largest, prospective clinical study of this procedure in the world.<sup>7-13</sup> The DLEK procedure appears to avoid the inherent problems of PKP by allowing endothelial replacement without the need for surface corneal incision or sutures and by maintaining the original, normal corneal topography.

## DLEK SURGICAL TECHNIQUE

Our original, small-incision DLEK technique was based on a single case report and then modified for convenience.<sup>14</sup> Although the DLEK procedure is still evolving, the basic procedure is schematically shown in Figure 1 and follows the outlined steps:

1. Using a temporal approach with a diamond knife, we create a 5-mm incision in the scleral limbus with a depth of 350 $\mu$ m.
2. We perform dissection with Devers Dissectors (Bausch & Lomb, Rochester, NY) of a total corneal lamellar pocket at a depth of approximately 80%.
3. With intrastromal scissors (Cindy Scissors; Bausch & Lomb), we resect an 8-mm-diameter disc of the posterior corneal stroma, Descemet's membrane, and endothelium.
4. We place the donor corneal-scleral cap onto an artificial anterior chamber. We cut a peripheral incision with a



(Courtesy of Ayad Farjo, MD)

Figure 1. The schematic diagram of a DLEK surgery.

diamond knife set to a depth of 350 $\mu$ m to achieve the minimal depth needed for the deep stromal plane. The Devers Dissectors are used to create a deep stromal pocket at the limbus; the tissue is dismantled and placed endothelial side up on a donor punch block. A trephine with the same 8-mm diameter as the recipient is used to punch out the donor posterior disc.

5. We place Healon (Advanced Medical Optics, Santa Ana, CA) onto the donor endothelium, fold the disc into a taco shape (endothelium inside), and grasp it with specially designed "Charlie" insertion forceps (Bausch & Lomb). We then insert the folded disc into the patient's anterior chamber.

6. Next, we unfold the disc in the recipient anterior chamber, position it with the use of an air bubble, and replace this bubble with BSS at the end of the procedure, as the donor disc of tissue adheres to itself. The edges of the recipient rim are carefully positioned posterior to the donor disc edges using the specially designed "Nick-Pick" forceps (Bausch & Lomb). This step is essential to avoiding postoperative dehiscence of the graft.

7. We close the scleral wound with two or three interrupted nylon sutures.

The DLEK procedure does have a significant early learning curve, even for experienced PKP surgeons. It appears that the skill set for DLEK is closer to anterior lamellar keratoplasty surgery than to PKP surgery. Therefore, I highly recommend extensive practice with cadaver eyes or other surgical models in the laboratory before performing surgery on patients. Once mastered, the DLEK procedure can be combined during the same sitting with ocular surgeries such as phacoemulsification, IOL exchange, iridoplasty, and vitrectomy.

## RESULTS

We had completed 160 cases of DLEK surgery as of November 15, 2004 (36 initial cases with a 9-mm, superior, scleral-access incision and 124 cases using a 5-mm temporal scleral access incision). All cases were treated under the auspices of an Institutional Review Board-approved, prospective clinical protocol with a special consent form for this new surgery. We have now analyzed the first 90 consecutive patients to reach the 6-month postoperative protocol visits in order to determine how well the DLEK procedure preserves the normal corneal topography to allow faster and better visual rehabilitation. We can compare the results of our prospective study of DLEK to the results published in the literature of PKP.<sup>15-21</sup>

At 6 months, the average amount of astigmatism after DLEK surgery was 1.63  $\pm$  0.97D in our 9-mm incision series (n=36) and 1.17  $\pm$  0.71D in our 5-mm incision series (n=54). The results in our small-incision group

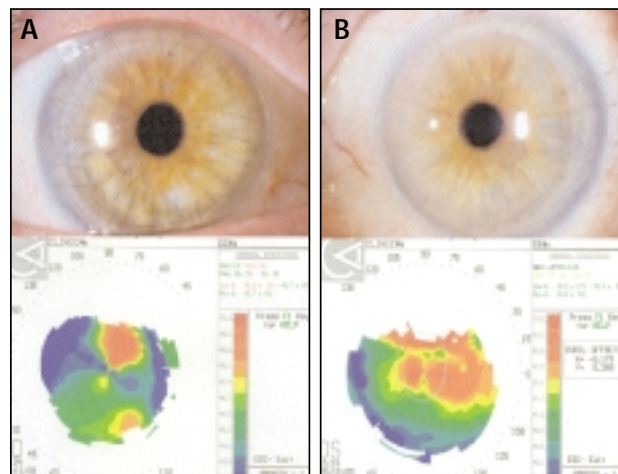


Figure 2. Pictured is a patient with a PKP graft in his right eye (A) and a DLEK graft in his left eye (B). The PKP graft is 24 months out from surgery, and the eye has a refraction of -4.25 + 4.75 X 70 and vision of 20/40. Of importance is the irregularity of the topographic map. At 1 month postoperatively, the eye with the DLEK graft achieved a refraction of -1.00 + 1.50 X 170 and vision of 20/25. Noteworthy is the regularity of the topography map. As the author expected, the patient prefers the vision of his eye with the DLEK graft.

represented an average change of only 0.13D from the preoperative level of refractive astigmatism. In contrast, after standard PKP surgery, the average astigmatism is often reported to be between 4.00 and 6.00D.<sup>15</sup> One group of highly experienced PKP surgeons reported that 42% of patients had 5.00D or more of corneal astigmatism following PKP.<sup>16</sup> The average spherical equivalent 6 months after DLEK was -0.45  $\pm$  1.47D and -0.41  $\pm$  1.30D in our 9- and 5-mm incision series, respectively. These amounts compare well to the spherical equivalents reported after PKP; they can range between -6.75 and +7.25D.<sup>17</sup>

The early donor endothelial cell density after replacement surgery is one predictive factor of long-term graft survival. After 9-mm DLEK surgery, the average endothelial cell count at 6 months was 2,218  $\pm$  505 cells/mm<sup>2</sup>, representing only a 22% cell loss from preoperative donor counts. After the 5-mm incision DLEK, despite folding and unfolding of the graft, the average cell count at 6 months was 2,114  $\pm$  422 cells/mm<sup>2</sup>, representing a 24% cell loss from donor preoperative measurements. One year after PKP, the cell count has been reported as 1,958  $\pm$  718 cells/mm<sup>2</sup>, which represents a 34% cell loss from preoperative donor counts.<sup>18</sup>

The improvement in vision after DLEK surgery may be rapid, and the quality of vision is subjectively improved by the normalization of the corneal topography. The average visual acuity after DLEK surgery at 6 months was 20/40-2

(range, 20/20 to 20/200) with no patients seeing worse than 20/200. More than 65% of our small-incision DLEK patients saw 20/40 or better at 6 months. Although we did not perform contrast sensitivity testing in this study, level of 20/40 or better vision has allowed our DLEK patients to comfortably drive at night. The quality of vision after DLEK appears to be better than after PKP due to the normal topography and absence of irregular astigmatism. In addition, no DLEK patient required the use of a contact lens, LASIK, or relaxing incisions in order to achieve his best vision, as is commonly found following PKP surgery. The average age of our DLEK patients was 75 years, and many had pre-existing retinal macular disease (age-related macular degeneration or old cystoid macular degeneration) prior to undergoing surgery. This history probably accounts for the range of vision we encountered with two patients: each had 20/200 vision and crystal clear corneas but poor macular function. The younger patients in our series seem to have better final vision than the older patients, again demonstrating that a younger macula will see better than an older macula after any form of corneal transplantation, including DLEK. Finally, all of the patients in our series are aware that, at any time after DLEK surgery, if they are not happy with their vision, they always have the option of replacing the DLEK cornea with a full-thickness corneal transplant. After 5 years and 160 patients, no DLEK patient has chosen that option. Most impressively, in the subset of patients in our series who have undergone PKP in one eye and DLEK in their fellow eye, all but one prefer the vision of the DLEK eye, and all of the patients have chosen to keep the DLEK cornea rather than replace it with a PKP surgery.

In contrast to DLEK, the average visual acuity after standard PKP for Fuchs' dystrophy disease is 20/40+ (range, 20/20 to no light perception), with fully 18% of patients seeing worse than 20/200.<sup>19</sup> These data highlight the fact that, although more patients can attain vision of 20/20 following PKP versus DLEK surgery, more patients experience a severe loss of vision after PKP versus DLEK surgery. Finally, the visual acuity after PKP can fluctuate with extended wound healing. Topography and vision after PKP are never considered fully stable until all of the corneal sutures have been removed, sometimes years after the original surgery.

None of our 160 DLEK patients has lost his vision or his eye due to infection or trauma, whereas 6% of PKP patients suffer severe visual loss from such complications.<sup>20,21</sup> Finally, of the 16 patients in our series who underwent PKP in one eye and DLEK in the other, all but one preferred the vision in their DLEK eye, even when the Snellen visual acuity was one line better in their PKP eye (Figure 2).

## CONCLUSION

The introduction of DLEK surgery advances the notion of customized keratoplasty, whereby only the dis-

eased portion of the corneal tissue is replaced, leaving the healthy portion of the cornea intact for better quality of vision and a more stable eye.<sup>22</sup> As the technique of DLEK continues to evolve, we look forward to even greater advantages for this unique form of endothelial replacement surgery. Although case reports and anecdotal experience with a new technique are initially intriguing, only rigorous analysis of objective data can reveal its true advantages or disadvantages. Therefore, any major technical changes to the DLEK procedure (eg, femtosecond laser dissections, Descemet's stripping technique) must be well supported by solid, prospective data and balanced by well-documented risks before being fully embraced by the corneal transplant surgeon. ■

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