Indicazioni e Tecniche della Cheratoplastica Perforante

M. Ciancaglini
Paradigm Shifts in Corneal Transplantation

Donald TH Tan,1,4 FRCSED, FRCOphth, FAMS, Arundhati Anshu,2 FRCSED, Jodhibir S Mehta,2,4 FRCSED

**Fig. 1.** Schematic diagram depicting the various forms of lamellar keratoplasty procedures and the indications.

**Fig. 2.** Bar chart depicting shifting trends in corneal grafting procedures at SNEC over the past 3 years. In 2005, penetrating keratoplasty (PK) was the most commonly performed grafting procedure while in 2007, lamellar keratoplasty in the form of anterior lamellar keratoplasty (LK and ALTK) and descemet stripping endothelial keratoplasty (DSEK) was the most common procedure.
Deep Lamellar Keratoplasty (DLKP) is a challenging yet rewarding choice of surgery for keratoplasty patients who have a healthy endothelial cell count. Penetrating keratoplasty (PKP) in these patients is not only unnecessary, but places the graft at risk of endothelial rejection, which can occur in approximately 20% of cases. Keratoconus patients are perhaps those who benefit most from a successful DLKP procedure. Although the 5-year success rate of PKP in keratoconus is over 95% in most studies, an episode of endothelial rejection can be detrimental in these young patients who may require a second keratoplasty procedure with an inevitably worse prognosis.

Finally, there is also a need to establish the proper indications for DLKP. Keratoconus is certainly a good indication; however, cases with scarring of DM may affect visual outcome even if the procedure can be completed successfully. Hereditary dystrophies of the stroma are also candidates. However, we have experienced cases of macular dystrophy with continuous loss of endothelial cells after DLKP. Ocular surface diseases such as chemical and thermal burns are good indications once reconstruction of the epithelium is achieved, and residual opacification of the stroma requires treatment. DLKP is especially effective in such patients with vascularized corneas, and who are thus at high risk of endothelial rejection. Corneal

Although several techniques for DLKP are reported in the literature, each surgeon should choose the method that feels most comfortable. Although the long-term results of DLKP are awaited for definitive conclusions to be reached, the available data to date show that DLKP can indeed be the ideal choice of surgery for patients with healthy endothelium.
# 2008 Eye Banking Statistics Reported by U.S. Banks:
## Distribution of Tissues
### 77 U.S. Eye Banks Reporting

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</tr>
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<tbody>
<tr>
<td>Corneal Grafts Total</td>
<td>52,487</td>
<td>50,122</td>
<td>45,035</td>
<td>48,298</td>
<td>51,544</td>
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<tr>
<td>Penetrating Keratoplasty</td>
<td>32,524</td>
<td>34,806</td>
<td>38,064</td>
<td>45,821</td>
<td>51,544</td>
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<tr>
<td>Anterior (Lamellar) Keratoplasty</td>
<td>1,072</td>
<td>950</td>
<td>806</td>
<td>869</td>
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<tr>
<td>Endothelial Keratoplasty</td>
<td>17,468</td>
<td>14,159</td>
<td>6,027</td>
<td>1,429</td>
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<tr>
<td>Keratolimbal Allograft</td>
<td>173</td>
<td>207</td>
<td>138</td>
<td>179</td>
<td>-</td>
</tr>
<tr>
<td>Tectonic</td>
<td>1,250</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Sclera</td>
<td>5,374</td>
<td>4,698</td>
<td>4,018</td>
<td>3,886</td>
<td>5,323</td>
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<tr>
<td>Long-Term Preserved Corneas</td>
<td>989</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Research</td>
<td>13,730</td>
<td>13,824</td>
<td>11,845</td>
<td>14,332</td>
<td>15,780</td>
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<tr>
<td>Training</td>
<td>5,385</td>
<td>4,801</td>
<td>4,858</td>
<td>5,477</td>
<td>4,852</td>
</tr>
</tbody>
</table>
Infectious keratitis remains the most common indication for PKP in north China.
Corneal infections either active or healed are the most common indication for keratoplasty in northern India.

**Indications of Penetrating Keratoplasty in Northern India**

*Parul Sony, MD,* Namrata Sharma, MD, *Seema Sen, MD,* and Rasik B. Vajpayee, MS, FRCSEd*

*(Cornea 2005;24:989–991)*

**TABLE 1. Indications for Penetrating Keratoplasty in Northern India**

<table>
<thead>
<tr>
<th>Category</th>
<th>No.</th>
<th>%</th>
<th>Subcategory</th>
<th>No.</th>
<th>%</th>
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<tbody>
<tr>
<td>Corneal scarring</td>
<td>769</td>
<td>38.03</td>
<td>Healed keratitis</td>
<td>401</td>
<td>19.83</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Trauma</td>
<td>338</td>
<td>16.71</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>SJ syndrome</td>
<td>6</td>
<td>0.29</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Others</td>
<td>24</td>
<td>1.18</td>
</tr>
<tr>
<td>Acute infective keratitis</td>
<td>574</td>
<td>28.38</td>
<td>PBK</td>
<td>125</td>
<td>6.18</td>
</tr>
<tr>
<td>Bullous keratopathy</td>
<td>272</td>
<td>13.45</td>
<td>ABK</td>
<td>147</td>
<td>7.27</td>
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<tr>
<td>Failed graft</td>
<td>234</td>
<td>11.5</td>
<td>CHED</td>
<td>39</td>
<td>1.92</td>
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<tr>
<td>Corneal dystrophy</td>
<td>78</td>
<td>3.85</td>
<td>Macular dystrophy</td>
<td>15</td>
<td>0.74</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fuchs dystrophy</td>
<td>15</td>
<td>0.74</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Others</td>
<td>9</td>
<td>0.45</td>
</tr>
<tr>
<td>Keratoconus</td>
<td>48</td>
<td>2.37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degeneration</td>
<td>13</td>
<td>0.64</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>34</td>
<td>1.68</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

ABK, aphakic bullous keratopathy; PBK, pseudophakic bullous keratopathy; CHED, congenital hereditary endothelial dystrophy; SJ, Stevens-Johnson.

**period from June 1997 to November 2003**

N: 2022 penetrating keratoplasties
Major shifts in corneal transplantation procedures in north China: 5316 eyes over 12 years.

Xie L, Qi F, Gao H, Wang T, Shi W, Zhao J


4346 patients (5316 eyes)

LKPs and PKPs were performed on 1558 eyes (29.3%) and 3758 eyes (70.7%), respectively

Between 1996 and 2007

<table>
<thead>
<tr>
<th>LKP</th>
<th>PKP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996-8 chemical burns, keratoconus and corneal dermoid</td>
<td>viral keratitis, suppurative keratitis and corneal scarring</td>
</tr>
<tr>
<td>2005-7 suppurative keratitis, keratoconus and viral keratitis</td>
<td>suppurative keratitis, viral keratitis and bullous keratopathy</td>
</tr>
</tbody>
</table>

The ratio of LKP to PKP operations tended to increase
The Impact of Corneal Allograft Rejection on the Long-Term Outcome of Corneal Transplantation

DOUGLAS J. COSTER, FRACO, AND KERYN A. WILLIAMS, PhD

(Am J Ophthalmol 2005;140:)

**RESULTS:** Corneal graft outcome is not improving with era. The sequelae of inflammation, whether occurring before corneal transplantation or subsequently, exert a profound influence by predisposing the graft to rejection.

**CONCLUSIONS:** Corneal allograft rejection remains a major cause of graft failure. High-level evidence to vindicate the use of a particular approach or treatment to prevent or treat corneal graft rejection is lacking. In the
Indications to penetrating surgery

Curvature
- Keratoconus
- Corneal ectasia:
  - Pellucid
  - Terrien
- Keratoglobus

Transparency
- Endothelial failure
  - Pseudofachia
  - Afachia
- Regraft
- Stromal dystrophies
- Primary endotheliopathy
  - Fuchs dystrophy
  - S Chandler
  - Endothelial dystrophies.
- Infectious scar
- Congenital opacities

Acute pathology
- Perforazioni infettive
- Perforazioni infiammatorie
  - Artrite reumatoide
  - Granulomatosi
  - Ulcera di Mooren
  - Vasculiti sistemiche
  - S. Sjogren
- Perforazioni traumatiche

From Krachmer J.H. et al. “Cornea” Elsevier Ed. 2005
When to consider A PK

✓ In presence of an absolute indication:
  - Corneal perforation
  - Descemet’s rupture
  - “a chaud” keratoplasty
  - AC reconstructive surgery.

✓ In presence of intraoperative complication
  - macro-perforation of Descemet M. in DALK
  - Need for conversion in DSAEK

✓ When new technologies may improve final results of a penetrating procedure (femtosecond)
Posterior imaging in non-transparent corneas may help in PK selection.
Acute corneal hydrops in Kkonus due to DM rupture
PK with cauterization for acute hydrops
Keratoconus with DM scarring
PK with apex cauterization in Kkonus with DM scarring
Severe corneal infection in OGVHD

Corneal abscess due to Candida Albicans + Stenotrophomonas Maltophilia in immuno-suppressed one-eyed patient (GVHD)

Urgent therapeutical procedure in the lack of efficent antibiotic therapy
Extensive corneal melting with large perforation

In presence of acute melting with perforation, PK needs to be performed in emergency, Often free hand, due to difficulties in effective trephination
PK in Descemetocele with peripheral thinning
After AMT reconstruction for deep infectious ulcer
DALK attempt and conversion to PK
FSL PKs benefit from wound configuration
Not achievable in standard mechanical trephination PK

Femtosecond Laser Shaped Penetrating Keratoplasty:
One-year Results Utilizing a Top-hat Configuration

Am J Ophthalmol 2008;
FRANCIS W. PRICE, JR AND MARIANNE O. PRICE

Results of Penetrating Keratoplasty
Performed with a Femtosecond Laser Zigzag Incision Initial Report

Marjan Farid, MD, Matthew Kim, MD, Roger F. Steinert, MD

FIGURE 1. Illustration of the femtosecond laser-shaped penetrating keratoplasty (PK) “top-hat” graft configuration.
Orientation Teeth in Nonmechanical Femtosecond Laser Corneal Trephination for Penetrating Keratoplasty

Am J Ophthalmol 2008;

LEONARDO MASTROPASQUA, MARIO NUBILE, MANUELA LANZINI, ROBERTA CALIENNO, AND ORIANA TRUBIANI

Complex geometry in FSL keratoplasty
### TABLE. Patient Diagnoses, Operative Details, and Outcomes Following Femtosecond Laser-Assisted Penetrating Keratoplasty

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Diagnosis</th>
<th>Preoperative BCVA</th>
<th>Suture Type</th>
<th>Donor Diameter (Projected/Chord Length)</th>
<th>Recipient Diameter (Projected/Chord Length)</th>
<th>Three-month BCVA</th>
<th>Refraction Three Months</th>
<th>Best Vision Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BK (trauma)</td>
<td>CF 1 m</td>
<td>16 interrupted</td>
<td>7.75</td>
<td>7.75</td>
<td>20/80</td>
<td>+3.00/−4.00×50</td>
<td>20/80</td>
</tr>
<tr>
<td>2</td>
<td>BK (laser PK)</td>
<td>CF 2 m</td>
<td>Double continuous 8 bite</td>
<td>7.75</td>
<td>7.5</td>
<td>20/30</td>
<td>+4.00/−1.50×55</td>
<td>20/30</td>
</tr>
<tr>
<td>3</td>
<td>Failed graft (PK for keratoconus)</td>
<td>CF 2 m</td>
<td>Double continuous 8 bite</td>
<td>8.25</td>
<td>8.00</td>
<td>20/70</td>
<td>+3.75/−1.50×160</td>
<td>20/70</td>
</tr>
<tr>
<td>4</td>
<td>BK (Fuch’s dystrophy)</td>
<td>HM</td>
<td>16 interrupted</td>
<td>8.25</td>
<td>7.75</td>
<td>CF 2 m</td>
<td>+3.00/−3.50×30</td>
<td>CF 2 m</td>
</tr>
<tr>
<td>5</td>
<td>Failed graft</td>
<td>20/400</td>
<td>Double continuous 8 bite</td>
<td>8.50</td>
<td>8.00</td>
<td>20/30</td>
<td>−2.75/−1.00×45</td>
<td>20/30</td>
</tr>
<tr>
<td>6</td>
<td>Pseudophakic BK</td>
<td>CF 3 m</td>
<td>16 interrupted</td>
<td>8.80</td>
<td>8.45</td>
<td>CF 2 m</td>
<td>+3.00/−5.50×60</td>
<td>20/400</td>
</tr>
<tr>
<td>7</td>
<td>Herpetic corneal scarring</td>
<td>CF 1 m</td>
<td>16 interrupted</td>
<td>7.75</td>
<td>7.50</td>
<td>20/40</td>
<td>+2.00/−0.50×180</td>
<td>20/20</td>
</tr>
<tr>
<td>8</td>
<td>Pseudophakic BK</td>
<td>CF 2 m</td>
<td>Double continuous 8 bite</td>
<td>8.50</td>
<td>8.25</td>
<td>20/80</td>
<td>−0.75/−2.75×160</td>
<td>20/80</td>
</tr>
</tbody>
</table>

BK = bullous keratopathy; BCVA = best-corrected visual acuity; CF = counting fingers; HM = hand motions; PI = peripheral iridotomy; PK = penetrating keratoplasty.

*Poor BCVA because of diabetic macular edema.

*Poor BCVA because of epithelial membrane with macular striae.
PENETRATING KERATOPLASTY
90° Visumax FSL full thickness trephination for PK

Donor button preparation in AAC
With 90° angled cut a 7.1 mm diameter is achieved on the endothelial side, while 8.1 mm on the surface.
$90^\circ$ Visumax FSL full thickness trephination for PK

Recipient preparation (full thickness corneal scar)

0.1 mm undersized - 7.0 mm diameter is achieved on the endothelial side, while 8.0 mm on the surface
Lamellar surgery has a worldwide strong trend of increase and will represent the majority of keratoplasty in developed countries.

However, standardization of DALK and DSEK procedures are still needed, and PK is the reference gold standard for comparison of efficacy.

**PK still represents the most used keratoplasty procedure in the treatment of corneal pathologies and has to be routine in the skill of the corneal surgeons.**