UPDATE ON CORNEAL TRANSPLANTATION

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OBJECTIVES

• Types of corneal transplantation
• Donor Selection of corneal tissue
• Penetrating keratoplasty
• Anterior Lamellar Keratoplasty
• Endothelial Keratoplasty
CORNEAL TRANSPLANTATION

• Cornea: immunologic privilege, first successfully transplanted solid tissue (1905)

• In the USA, ~ 40,000 corneal transplantations vs. ~ 12,000 other solid-organ transplantations.
• **Penetrating keratoplasty** (PK or PKP): full-thickness, gold standard

• **Lamellar keratoplasty**: partial-thickness
  - Anterior lamellar keratoplasty (ALK):
    - Superficial ALK (SALK)
    - Hemi-automated lamellar keratoplasty (HALK)
    - Deep ALK (DALK)
  - Posterior lamellar keratoplasty or endothelial keratoplasty (EK)
    - Descemet stripping and endothelial keratoplasty (DSEK)
    - Descemet’s membrane endothelial keratoplasty (DMEK)

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**Distribution 2012**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corneal Grafts Total</td>
<td>68,681</td>
</tr>
<tr>
<td>Penetrating Keratoplasty</td>
<td>36,716</td>
</tr>
<tr>
<td>Anterior Lamellar Keratoplasty</td>
<td>1,855</td>
</tr>
<tr>
<td>Endothelial Keratoplasty</td>
<td>24,277</td>
</tr>
<tr>
<td>Keratolimbal Allograft</td>
<td>97</td>
</tr>
<tr>
<td>Keratoprosthesis (K-Pro)</td>
<td>263</td>
</tr>
<tr>
<td>Tectonic</td>
<td>-</td>
</tr>
</tbody>
</table>

53% 5% 35%
DONOR CORNEA CONSIDERATION

• Donor corneas: stored in Optisol-GS

• Exclusion criteria: unknown cause of death, systemic infections, CNS infection, leukemia, ocular hx (infection/inflammation, malignancy, prior refractive sx), Hep B/C, HIV, etc

• Certain considerations: endothelial cell density (ECD) >2000/mm², death-to-preservation time, donor age, tissue storage time
**PENETRATING KERATOPLASTY**

- **Indications:** any stromal or endothelial corneal pathology i.e. keratoconus, failed graft, post-cataract edema, corneal dystrophies/degenerations

- trephination of donor tissue, 0.25-0.50 mm larger
- trephination & excision of host cornea
- suture (interrupted, continuous, or combined)
PK COMPLICATIONS

• Intraoperative: lens/iris damage, poor graft/donor centration, iris/vitreous incarceration, damage to donor endothelium, hemorrhage

• Postoperative: wound leak, flat chamber, glaucoma, endophthalmitis, persistent epi defect, recurrent primary disease, epithelial ingrowth, primary graft failure, infected sutures, graft rejection, regular/irregular astigmatism (most common)
THE CORNEA DONOR STUDY (CDS)

• Designed as a prospective, double-masked, controlled trial to determine:
  • The role of donor age in long-term corneal graft survival
  • The effect of ABO blood type matching on corneal graft survival
  • The effect of donor age on long-term donor endothelial cell density

• Patient enrollment 2000-2002: 40 to 80 years old, and in “moderate-risk” corneal transplant categories, mostly endothelial diseases, Fuchs’ dystrophy 675 (61%), Pseudophakic/aphakic corneal edema 369 (34%)
Graft failure, defined as a re-graft or a cloudy cornea that was sufficiently opaque as to compromise vision for a minimum of 3 consecutive months.

<table>
<thead>
<tr>
<th>CDS 5-year result</th>
<th>Donor age (yr)</th>
<th>Graft survival</th>
<th>Median cell loss</th>
<th>Median ECD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donor age (yr)</td>
<td>12-65</td>
<td>66-75</td>
<td>69%</td>
<td>824 cells/mm²</td>
</tr>
<tr>
<td>Graft survival</td>
<td>86%</td>
<td>86%</td>
<td>75% *</td>
<td>654 cells/mm² *</td>
</tr>
<tr>
<td>Median cell loss</td>
<td>69%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median ECD</td>
<td>824 cells/mm²</td>
<td></td>
<td></td>
<td>654 cells/mm² *</td>
</tr>
</tbody>
</table>
When analyzed as a continuous variable, higher donor age was associated with lower graft success beyond first 5 years (P<0.001).

The 10-year success rate was relatively constant for donors aged 34 to 71 years (75%). The success rate was higher for 80 donors aged 12 to 33 years (96%) and lower for 130 donors aged 72 to 75 years (62%).

<table>
<thead>
<tr>
<th>CDS 10-year result</th>
<th>12-65</th>
<th>66-75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donor age (yr)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graft survival</td>
<td>77%</td>
<td>71%</td>
</tr>
<tr>
<td>Median cell loss</td>
<td>76%</td>
<td>79% *</td>
</tr>
<tr>
<td>Median ECD</td>
<td>628 cells/mm²</td>
<td>550 cells/mm²</td>
</tr>
</tbody>
</table>

* Indicates statistical significance.
Anterior Lamellar Keratoplasty (ALK)

- Indicated in corneal conditions where the endothelium is still functional, such as ectatic disorders, superficial scars, and various dystrophies.
  - Superficial ALK (SALK): pathology limited to anterior third
  - Hemi-automated lamellar keratoplasty (HALK): 50% thickness
  - Deep ALK (DALK): deeper stroma
- Dissections were achieved freehand or automated by a microkeratome or femtosecond laser

- Stroma-to-stroma interfaces, as in SALK, can degrade visual acuity over time
- Stroma-to-DM interfaces, as in DALK, provide higher quality vision
- HALK: donor cornea prepared with microkeratome, recipient cornea prepared freehand
ANTERIOR LAMELLAR KERATOPLASTY (ALK)

• Advantages: Extraocular procedure resulting in a low risk of many complications, including transplant rejection and failure. Less topical steroid use than PK or EK. Early suture removal safe.

• Disadvantages: Usually more technically demanding than PK. Fails unless host endothelium is healthy. Regular and irregular astigmatism the same as for PK.

• Most common intraocular complication is Descemet’s perforation and conversion to PK.
### Endothelial Cell Loss and Visual Outcome of Deep Anterior Lamellar Keratoplasty versus Penetrating Keratoplasty: A Randomized Multicenter Clinical Trial

Yanny Y. Y. Cheng, MD, Nienke Visser, MD, Jan S. Schouten, MD, PhD, Robert-Jan Wijdh, MD, Elisabeth Pels, PhD, Hugo van Cleynenbreugel, MD, Catharina A. Eggink, MD, PhD, Michel J. W. Zaal, MD, PhD, Wilhelmina J. Rijneveld, MD, Rudy M. M. A. Nuijts, MD, PhD

Ophthalmology Volume 118, Number 2, February 2011

<table>
<thead>
<tr>
<th>12-mo</th>
<th>DALK (28)</th>
<th>PK (28)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCVA logMAR</td>
<td>0.39 (20/50)</td>
<td>0.31 (20/40)</td>
</tr>
<tr>
<td>Endothelial loss</td>
<td>12.9%</td>
<td>27.7% *</td>
</tr>
<tr>
<td>Spherical equivalent</td>
<td>-2.02</td>
<td>-2.30</td>
</tr>
<tr>
<td>Endothelial rejection</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

(Micro)perforation of the Descemet’s membrane occurred in 32% of the DALK eyes, and 18% of the patients required conversion to PK
Endothelial Keratoplasty (EK)

- Indicated in endothelial dysfunctions such as pseudophakic/phakic bullous keratopathy, Fuch’s dystrophy, Posterior Polymorphous dystrophy, and Iridocorneal Endothelial syndrome
- DSEK/DSAEK: DM & endo with a thin layer of posterior stroma
- DMEK/DMAEK: only DM & endo, no stroma; 748 DMEK performed in 2012
- “A” stands for “automated”: using keratome to dissect
- Eye banks now provide pre-cut tissue for DSAEK and DMEK

- Descemet stripping and endothelial keratoplasty (DSEK)
- Descemet stripping automated endothelial keratoplasty (DSAEK)
- Descemet’s membrane endothelial keratoplasty (DMEK)
- Descemet’s membrane automated endothelial keratoplasty (DMAEK)
ENDOTHELIAL KERATOPLASTY (EK)
ENDOTHELIAL KERATOPLASTY (EK)

- Advantages: No induced astigmatism resulting in early visual recovery and better visual outcomes. Fewer suture and wound related complications. Lower risk of other complications.

- Disadvantages: Suboptimum visual result unless corneal stroma is relatively free of opacity; reduced vision due to interface opacity or transplant folds in some cases.

- Complications: Detachment in 5–30% of cases. Can be re-attached by re-injecting air. Possible pupil block following air tamponade.
DSAEK VS DMEK

- Potential advantages of DMEK: faster visual rehabilitation, better visual outcomes, and lower rejection rates.
<table>
<thead>
<tr>
<th>PK</th>
<th>ALK</th>
<th>EK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can be used for any indication</td>
<td>Minimal requirement for donor material</td>
<td>Better globe integrity</td>
</tr>
<tr>
<td>Potentially best optical result</td>
<td>Extraocular procedure</td>
<td>Fewer wound cx</td>
</tr>
<tr>
<td>Relatively undemanding technique</td>
<td>Low risk of rejection</td>
<td>Faster recovery</td>
</tr>
<tr>
<td></td>
<td>Less topical steroid use</td>
<td>No suture-related issues</td>
</tr>
<tr>
<td></td>
<td>Early suture removal safe</td>
<td>Less post-op astigmatism</td>
</tr>
</tbody>
</table>

| Higher rejection rate                                              | Graft-host interface limit VA                               | Graft-host interface limit VA                                       |
| Many complications                                                 | Astigmatism similar to PK                                    | Rejection rate similar to PK                                        |
| Astigmatism common                                                 | Dependent on endo quality                                   | Dependent on epi/stroma quality                                   |
|                                                                   | Technically more difficulty                                  | Long term survival unknown                                         |
FUTURE DIRECTIONS

• Descemetorhexis Without Endothelial Keratoplasty (DWEK)
• Rho Kinase Inhibitors
REFERENCES:


