Endothelial Keratoplasty Techniques
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DISCLOSURE
The speaker has a financial interest in the EK instruments which he designed.
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Endothelial Keratoplasty: Current technique, complications and clinical results
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Endothelial Keratoplasty (EK) is a form of corneal transplantation that replaces just the posterior diseased cornea, leaving the corneal surface relatively untouched.

Endothelial Keratoplasty: Multiple names and acronyms
- PLK: Posterior Lamellar Keratoplasty (Melles)
- DLEK: Deep Lamellar Endothelial Keratoplasty (Terry)
- DSEK: Descemets Stripping Endothelial Keratoplasty (Melles)
- DSAEK: Descemets Stripping with Automated Endothelial Keratoplasty (Garvey)
- DMEK: Descemets Membrane Endothelial Keratoplasty (Melles)
- DMAEK: Descemets Membrane Automated Endothelial Keratoplasty (Price)

The evolution of Endothelial Keratoplasty
- DLEK: Hand dissected donor placed in a hand resected bed
- DSAEK: Microkeratome donor placed on a smooth stripped surface
- DMEK: Stripped Descemet's placed on a smooth stripped surface
- DMAEK: A DMEK with peripheral stroma to improve adhesion and handling
Our Current experience with over 1,800 cases of EK surgery from March 2000 to April 2013 (Prospective IRB Study)

We developed and performed the first EK procedure in the U.S.:
- 275 cases of DLEK (9mm and 5 mm inc)
- 37 cases of DSEK
- Over 1,400 cases of DSAEK
- >90 cases DMEK

We have published over 100 peer-reviewed research papers, review articles, editorials, and book chapters on endothelial keratoplasty.

DSAEK: Pre-op Diagnosis

- Reason for transplant: First 725 DSAEK cases
  - 575 Fuchs (79%)
  - 110 PBK (15%)
  - 5 Other endothelial failure (.7%)
  - 24 failed PK (3%)
  - 6 ABK (.8%)
  - 5 ICE (.7%)

- Patients with comorbidity: 210 (29%)

Visual results: 6 months Fuchs’ Dystrophy Eyes

Visual Results (eyes with no retinal disease) (n=160)
- mean BSCVA 20/31 (range 20/15-60)
- 93% with vision 20/40 or better
- 13% with vision 20/20 or better


What happens over time with Vision after DSAEK?

Time-Point 2020 2025 2030
- 6 Months 15% 37% 69%
- 1 Year 18% 40% 78%
- 2 Years 33% 60% 83%
- 3 Years 44% 72% 91%


Major Problems with DSAEK surgery in the U.S. (recent surveys)
- Dislocation Rate of Donor from Recipient Bed: 15%
  - Wide range reported: 1% to 82%
- Primary (iatrogenic) Graft Failure Rate: 5%
  - Wide range reported: 0% to 29%
- Pupillary block glaucoma: 0.1% to 9.5%
- Eccentric Donor trephination: 0% to 10%

Devers Eye Institute

First 915 cases: same surgical technique
(2 experienced surgeons and 7 novice)
- Dislocation rate: 2.8% (26 out of 915)
- Primary graft failure rate: <0.5% (4 out of 915)
- Pupillary Block rate: <0.2% (1 out of 915)
- Eccentric Trephinations: <0.1% (1 out of 915)

Take home message: DSAEK using our standard technique has a very low risk profile.
Graft Dislocation Rate by Category

<table>
<thead>
<tr>
<th>Category</th>
<th>Graft Dislocation Rate (%)</th>
</tr>
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<tbody>
<tr>
<td>Control</td>
<td>2.5</td>
</tr>
<tr>
<td>All Complex</td>
<td>5.7</td>
</tr>
<tr>
<td>ACEOL</td>
<td>5</td>
</tr>
<tr>
<td>PGS</td>
<td>8.1</td>
</tr>
<tr>
<td>EK Under PK</td>
<td>5</td>
</tr>
</tbody>
</table>

Control  vs. All Complex  p = 0.259  vs. ACEOL  p = 0.405  vs. PGS  p = 0.03  vs. EK Under PK  p = 0.06

5 Dislocated DSAEK Grafts in eyes with h/o Glaucoma Filtration Surgery
HYPOTONY => DISLOCATION

- pt1-trab: bleb leak noted intraop (hypotony)
- pt2-trab: IOL exchange/dislocation
- pt3-trab: bleb leak/overfiltration by bleb with severe hypotony
- pt4-trab: no bubble in AC day 1 hypotony
- pt5-tube: severe hypotony, leaking bleb wound

Dislocation Rate (%)


Why do DLEK grafts stick with no air bubble support and DSAEK grafts fall off despite air bubble support?

...go to the laboratory first to answer questions, before testing ideas on patients...

Clinical Implications of Lab Results

- The smoother surface of DSEK recipient bed can provide better optics for vision but make dislocation rate much higher.
- The rougher surface of DLEK recipient bed allows attachment of the graft with NO air bubble support (ie: better adhesion) but may limit visual acuity by one line worse than DSEK

The gecko knows how to stick.

Tokay gecko demonstrating how good peripheral adherence allows a DSAEK graft to stick.

“Peripheral scraped stromal fibrils of recipient bed”

“Central smooth recipient bed”
Key points to avoiding complications in DSAEK surgery
- Use 5 mm scleral incision at limbus - good wound construction!
- Minimize trauma to donor at EVERY step of the surgery
- Do peripheral scraping of bed - NOT SUBTLE!
- Moderate the size of the pupil for what you need: 
  - Dilate pupil (without NSAIDS) for cataract surgery
  - Constrict pupil (with Miochol and stroking iris) for insertion of tissue
  - Dilate pupil (with standard drops) at end of case to prevent block
- To remove interface fluid: sweep cornea with dissected IOP off air leaves IOP at above 40 for 2 to 3 minutes then lower to normal for 7 to 8 minutes - total 10 min wait time
- Venting incisions are NOT necessary and can cause epithelial ingrowth and infections of interface!
- Close scleral wound with vicryl sutures: prevent hypotony
- Removes ALL air from eye, then replace with only a 5-6 mm air bubble...NEED to see patient 1 hour later after surgery.
- Patient SUPINE for 1 hour then as much as possible day of surgery - NO Pressure on Eye

Interface fluid centrally: Only where the recipient bed edges were scraped are holding the graft on.

Different meridians show the areas of attachment and also the access region for interface fluid.

1 year s/p DSAEK
- VA (without glasses) = 20/25
- Graft interface clear
- Endothelial Specular = 2500 cells/mm²

Interface fluid resolves without intervention

1 day post-DSAEK
UCVA=20/200

1 week post-DSAEK
UCVA=20/200

3 weeks post-DSAEK
UCVA=20/20

2 months post-DSAEK
+1.25 + 1.00 x 25 = 20/40
UCVA=20/20
Take Home Points

- Scraping can provide a physical adhesion of tissue to prevent dislocation until the endothelium “wakes up” to solidify adhesion.
- If tissue is attached but interface fluid…do NOT re-bubble…WAIT…tissue will attach without intervention.
- Only re-bubble if detachment is imminent or patient is impatient for vision.
- One exception to the rule…

Full Thickness Edge from Eccentric Trephination
Implanted Tissue Shows “Architectural Separation”
(Which will NOT resolve with observation and risks epithelial ingrowth of donor epithelium)

Take Home Point

- Use the Microscope for Trephination of the Donor Tissue to avoid Eccentric Trephination…even if you are a “pre-presbyope” you cannot reliably discern a tolerance of ¼ mm with the naked eye! (i.e. an 8.5 mm trephination in a 9.0 mm bed)
- In addition: If you do NOT use a microscope for trephination, you can get an eccentric trephination and NOT EVEN KNOW IT!

Summary of practical points regarding pre-cut tissue for DSAEK:
(Experience with COLD STORAGE OPTISOL only)

- My personal experience with it is with over 1,400 cases and it has worked as well as tissue cut on site.
- Request tissue that is at least 120 microns in thickness…thicker is easier, no detriment to vision.
- Do NOT trust any centering marks made by Eye Bank Technician…made with naked eye and can smudge in transit.
- Care must be taken in not getting an eccentric puncture…use the microscope to punch tissue!
- Ink Marks on stromal surface KILL endothelial cells! (and are not necessary)
- If you are compelled to use ink marks, use a “dry ink” method to mark the stroma, not the pen.

Anecdotal Evidence

What else do we know about DSAEK?
Most any case of endo failure can be treated successfully with DSAEK

DSAEK in CHED Eyes:
Long term follow-up

Pre-op: CHED in 7 y/o girl
Va cc = 20/200

Post-op at 3 years:
Va cc = 20/200

No Cataract, but recipient stroma is “frosty” from structural changes of chronic edema.
What has the literature taught us about donor tissue characteristics in DSAEK?

- **Li J, Goshe J, Davis-Boozer D.** Endothelial Keratoplasty: The relationship between donor tissue size and donor endothelial survival. Ophthalmology 2011; 118: 36-40

What has the literature taught us about donor tissue characteristics in DSAEK?

- **Common myths have been burst:**
  - Storage time doesn’t matter – 7 days is as good as one day (CBSF study may validate even longer storage times)
  - Cell count doesn’t matter – 2100 cell count is as good as 3,000 cell count
  - Age of donor doesn’t matter – 70 y/o tissue is as good as 21 y/o tissue
  - Size doesn’t matter – 8.0 mm graft is as good as 9.0 mm graft
  - Thickness doesn’t matter – 180 um graft as good as 100 um graft for vision (controversial)

What else do we know about DSAEK?

- **Use of cohesive viscoelastic (Healon) for DSAEK does NOT cause dislocations or cause the dislocation rate to increase.**
- **DSAEK with Phaco/BiOL should be done as a triple, NOT sequentially…no difference in complications rate or endothelial survival.**
- **Dislocation rates are still low (<3%) in complex cases such as PBK with filters, tubes, and under failed PK grafts…as long as hypotony is avoided.**
- **Donor tissue with RK scars, LASIK, surface scars can all be used safely for DSAEK…no difference in refractive results, complications or ECD.**
- **Fellows can do DSAEK during their fellowship just as well as their Attendings …as long as the same surgical technique is followed.**

References for Previous Slide

- **Terry MA, Shamie N, Chen ES, Phillips PM, Shah AK, Hoar KL, Friend DJ.** Descemet’s stripping automated endothelial keratoplasty (DSAEK) in eyes with previous trabeculectomy and tube shunt procedures. Ophthalmology 2009; 116: 401-6
- **Li J, Goshe J, Davis-Boozer D.** Endothelial Keratoplasty: The relationship between donor tissue size and donor endothelial survival. Ophthalmology 2011; 118: 36-40

Update on longer term Endothelial Survival in DSAEK

Devers Eye Institute
5 year DBAEK data:
M. Price retrospective study
Ophthalmology 2011
- N = 165
- 89% Fuchs
- Forceps insertion through 5 mm incision
- Kaplan Meir Survival:
  - 95% for Fuchs*, 76% for PBK
- Median Endo cell loss at 5 years:
  - 53% (range=7% to 89%) (n = 90)
Take Home Message:
ECD after DBAEK may be better than PK long term

What about incision size for
insertion of tissue?
Also: Does technique of
insertion of tissue matter?

Terry MA, Saad HA, Shaniti N, Chen ES, Friend DJ, Holiman JB, Neugr C.
Endothelial Keratoplasty. The influence of insertion techniques and incision size

Incision size
% loss-6 mon % loss-12 mon
3.2 mm (n=103) 40% 44%
5.0 mm (n=64) 27% 31%

p< 0.001 p< 0.001

Maneuver-Induced Endo. Damage
5mm incision size: 8% +/- 3% Damage
Versus
3mm incision size: 28% +/- 13% Damage

Acute Endothelial Damage from Insertion:
Incision size matters, method is less important

Smaller incisions cause more
endothelial damage: Clinical data
- Price, Gorovoy et al: Cornea 2010; 29:523-7
Incision Size: 3mm vs 5mm

<table>
<thead>
<tr>
<th>Technique</th>
<th>Primary Graft Failure Rate</th>
<th>Dislocation Rate</th>
<th>Endothelial Cell Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 mm Incision Forceps n = 105 (Foster, Vasan, Walter Cornea 2011)</td>
<td>5%</td>
<td>28%</td>
<td>44% (n=52)</td>
</tr>
<tr>
<td>5 mm Incision Forceps n = 225 (Terry et al Ophthalmology 2009)</td>
<td>0%</td>
<td>2%</td>
<td>29%</td>
</tr>
</tbody>
</table>

Take Home Message
REGARDLESS OF TECHNIQUE
Because the wound compresses the tissue during insertion:
- Small incision (<5mm) = Big Damage
- Larger incision (>5mm) = Small Damage

Endothelial Keratoplasty Complications
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Primary Graft Failure: Attached but still edematous (upside down graft)
Pt referred to Devers after 3 prior DSAEK grafts failed

How to avoid unrecognized upside down grafts?
- Use a technique where the graft unfolds SLOWLY so you can watch for upside-down movement
  OR
- Place a “dry-ink” mark on peripheral stroma to show “correct side up”
  (do NOT use ink pen directly on tissue)

How to avoid PGF?
- Minimize endothelial trauma at every step of the procedure
  OR
- Use an insertion incision that is 5 mm or larger in length to minimize tissue compression
  OR
- Use an insertion device to deliver the tissue to the AC without compression from the wound

Stoeger C, Hellman, J, Davis-Boozer O, Terry, MA. The endothelial safety of using a gentian violet dry ink “S” stamp for pre-cut corneal tissue. Cornea 2012 (in press)
Graft Rejection

Graft Rejection: Mild/Chronic

Severe/Acute

Mild/Chronic

Severe/Acute: Khoudahoust Line

Our Published rejection rate = 7.3%
(Li JY, Terry MA, Grahn J et al: Ophthalmology 2012)

When do rejections occur?
When steroids stopped (12-18 months)

Late Endothelial Failure

Late Endothelial Failure

DSAEK Replacement Graft:
BSCVA at 18 days post-op=20/50

Other complications of DSAEK:
Intraoperative Complications
- Blood in the interface
- Iris tears
- Graft flipping upside down, ejection from eye, etc.
**Blood in interface**
- Insignificant if blood is mild or peripheral: haze resolves
- Can cause significant visual loss from interface haze if severe

**Iris tears during surgery**
Referred with: iris disinsertion, retained nucleus, and dislocated graft

**Post-operative Complications of DSAEK**
- Dislocation of Graft
- Interface Fluid: transient and permanent
- De-centration of graft
- Interface opacities: epithelial downgrowth, architectural haze
- Surface infectious keratitis: with and without melting
- Herpes Simplex keratitis
- Endophthalmitis
- Trauma after DSAEK

**Dislocation of graft**
Obviously need re-injection of air

**Interface fluid resolves without intervention**
- 1 day post-DSAEK
  UCVA=20/200
- 1 week post-DSAEK
  UCVA=20/200
- 3 weeks post-DSAEK
  UCVA=20/100
- 2 months post-DSAEK
  +1.25 + 1.00 x 25 = 20/40
  UCVA=20/60

**Edge wrinkles and separation with edema: Ultra-thin grafts**
**Take Home Points**

- Scraping can provide a physical adhesion of tissue to prevent dislocation until the endothelium "wakes up" to solidify adhesion.
- Edge separations are more common with "ultra-thin" tissue due to easier formation of wrinkles.
- If tissue is attached but interface fluid...do NOT re-bubble...WAIT...tissue will attach without intervention.
- Only re-bubble if detachment is imminent or patient is impatient for vision.

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**Decentration of the Graft: to fix or not to fix**

1 week post-op: Graft decentered superior nasally with edema inf-temp

Patient GH

Patient EF

Three years after decentered graft healed: Clear but cell count 420 cells/mm

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**Interface opacities: epithelial ingrowth**

- Main Causes: Venting incisions and Eccentric trephination of grafts.

Photos courtesy of Drs. Mike Straiko and Larissa Fabre: (All cases were referred to them)

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**Interface opacities:**

- Main Cause: Too much viscoelastic placed on donor prior to insertion – spills into interface during unfolding or delivery.

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**Severe interface haze but Va=20/30**

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**Infection after DSAEK:**

- Infectious keratitis: bacterial, HSV
- Endophthalmitis: fungus/yeast (Candida) most commonly reported
Venting Incisions: Not necessary -- Can Cause Problems -- (epithelial downgrowth and infections)

HSV after DSAEK

Ruptured globe after DSAEK

Summary

Endothelial Keratoplasty: Surgery in complex and combined cases

What about more common complex EK cases?

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DSAEK in Eyes with Anterior Chamber IOL

PBK with ACIOL
- 83 yo c/o gradual blurring of vision over 2 years and onset of severe pain
  - closed loop ACIOL x 25 years
  - large sector iridectomy
  - vision of 20/30 until 2 years ago
- BCVA: HM
- pachy: 935
- bullous corneal edema, well positioned, stable ACIOL

PBK with ACIOL: should the lens be exchanged?
- retain ACIOL if....
  - stable, well positioned lens
  - prolonged good vision with ACIOL
  - delayed endothelial failure
  - sufficient anterior chamber depth
  - elderly patient
  - surgeon has a healthy heart

DSAEK with retained ACIOL
- preop BCVA: HM
- pachy 935
- 1 week postop
  - BCVA 20/40
- 3 months postop
  - BCVA 20/30

DLEK performed, no air bubble at end of surgery
- Post-op Va = 20/25 at 5 years out
- Post-op ECD = 1626 cells/mm² at 5 years out
- Pt seen 2012 at 10 years out: Va same – ECD down to 600 but with clear graft

DSAEK with retained ACIOL: surgical tips
- evaluate air management early
- thorough vitrectomy critical
- Constrict pupil with Miochol and close large P.I.
  for better air bubble management
- Insert graft eccentrically, protecting endothelium
- inserting folded graft puts stroma against IOL,
  protecting graft endothelium
- may need to modify the unfolding, pushing IOL
  posteriorly while injecting fluid or air to unfold
- ok to choose smaller graft to make unfolding easier
- Remove most of air behind iris at end of case
**DSAEK in Failed PK Eyes**

- Choose PK eyes with prior successful spectacle or contact lens wear
- Do pre-operative assessment of posterior surface and edges of failed PK
- Use same size or undersized grafts
- Strip Descemet’s and scrape recipient periphery as usual, but AVOID posterior edge of graft
- Dislocation rate same as Fuchs’ eyes when using standard technique

**Results**

Straitko, Terry, Shamie et al: EK under PK (AJO 2010)

- N = 17 cases of EK under PK
- Primary Graft Failures: 0%
- Dislocations: 5.9% (1 out of 17)
  - This one dislocation occurred in the pt with aniridia, glaucoma tube, and severe scleral thinning with wound leak and hypotony on first day post-op.
  - (Donor graft re-attached with one re-bubble and gluing limbal wound closed.)
- PK wound dehiscence: 0%
- Pupillary Block: 0%
- All corneas clear at last follow-up visit (all > 6 months out)

**EK post trab: surgical tips**

- Use standard technique of Healon, etc
- watch for over-filtering blebs extending temporally – change entrance wound location as needed
- avoid over pressurizing the eye and popping bleb
- consider closing large surgical P.I.s
- OK to leave eye full of air with working bleb
- hypotony is your enemy
- Have filters with IOP below 6 mm revised BEFORE EK to prevent hypotony problems

**5 Dislocated DSAEK Grafts in eyes with h/o Glaucoma Filtration Surgery**

HYPOTONY => => DISLOCATION

- pt1-trab: bleb leak noted intraop (hypotony)
- pt2-trab: IOL exchange/dislocation day 5
- pt3-trab: bleb leak/overfiltration by bleb with severe hypotony
- pt4-both: no bubble in AC day 1 hypotony
- pt5-tube: severe hypotony, leaking bleb wound
Repeat EK for failed DLEK or DSAEK grafts:

**Precautions**

- **Standard DSAEK technique except for:**
  - **FIRST:** cut edges of old graft with a reverse cystitome to prevent tearing recipient Descemet's all the way to the angle.
  - **SECOND:** sweep interface with spatula.
  - **Third:** remove graft carefully.

  - **Re-scrape periphery of recipient bed**

  - **For failed DLEK:** make diameter of replacement DSAEK, \( \frac{1}{4} \) mm smaller size.

  - **For failed DSAEK:** Make diameter of replacement DSAEK same size or larger.

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**Summary**

- even in complex cases, surgical technique can remain mostly consistent.
- respect the endothelium at every stage of the procedure.
- hypotony is your enemy.
- if at all possible, for corneal endothelial disease, EK needs to be first line of surgical treatment.

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**DSAEK: New Insertion Techniques**

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**What has the literature taught us about DSAEK inserters?**

- **Insertion Devices: complications and ECD loss**
  - **NCI:** (Terry)
    - Dislocation: 2%
    - ECD loss: 33%
  - **Busin Glide:** (Busin)
    - Dislocation: 7%
    - ECD loss: 21% - 47%
  - **EndoSerter:** (Walter)
    - Dislocation: 5.7%
    - ECD loss: 28%
  - **EndoGlide:** (Tan)
    - Dislocation: 1.4%
    - ECD loss: 13% - 26%
  - **Forceps:** (Phillips) (Terry)
    - Dislocation: 1% to 2% (Published Series)
    - ECD loss: 17% to 28%

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**Summary**

- The new insertion devices currently have only preliminary data on less than 75 eyes in each series.
  - **Complications:**
    - Dislocation rates are low (1.6% to 5.7%) and comparable to forceps insertion by experienced surgeons. (1% to 2%)
    - PGF rates are low (0% to 1.0%), similar to forceps (0% to <1%) by experienced surgeons.
Summary

Endothelial Cell Loss

- ECD loss at 6 months has limited data on only a very small number of eyes (Tan=22, Terry=47, Walter=38)
- The ECD loss so far with inserters (13% to 28%) seems comparable to that of the Forceps (17% to 28%) and the Busin glide or Rosenwasser shovel (22%) with far larger number of eyes for analysis with these established, reusable instruments

What has the literature taught us about DSAEK inserters?

- Primary graft failure rate has been reduced in the hands of investigators
- Range of clinical Endo loss at 6-12 months between 13% (Tan EndoGlide) and 28% (EndoSerter) and not significantly different than recent large forceps series
- May be easier for some surgeons to use than forceps or other manual insertions
- Added cost of devices (about $150 per case) is main downside

Conclusions

- The decision to use new insertion devices for DSAEK surgery should be based on the individual surgeon’s satisfaction with his/her current results using his/her current technique.
- Surgeons proficient with forceps may not need to switch to insertion devices, while surgeons with high complication rates with forceps may find inserters easier and safer.
- The economic disadvantage of new insertion devices (nearly $200/case) should be weighed against the time commitment required for proficiency in established forceps and glide techniques…both of which can yield comparable results as insertion devices.
- Longer term data with higher numbers of eyes is required before the assumption of better results with inserters can be validated or disproven.

Summary of EK Techniques Talk

- The current forceps technique that we use with DSAEK surgery yields a very low dislocation rate in the hands of novice and experienced surgeons alike.
- Central Endothelial cell density (with our technique) appears to be relatively stable over the first 5 years after DSAEK, and seems better than PK, but even longer term data is needed.
- DSAEK surgery should be done with 5mm or larger wounds to prevent endothelial damage – Regardless of what technique of insertion is used.
- Newer insertion devices (such as injectors) which avoid wound compression should help reduce endothelial damage and improve long term cell counts, but so far the data doesn’t allow that.
- Strict adherence to an established DSAEK technique will yield a near 0% rate of PGF and a dislocation rate of less than 2% with good vision within weeks and 91% 20/30 or better (44% 20/20 or better) over time.

Deep Anterior Lamellar Keratoplasty (DALK): A Safer Technique

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Disclosure

- No financial interest in this presentation
- Other non-relevant disclosures
  - Bausch and Lomb Surgical
  - Optovue
  - Alcon
  - Fischer Surgical
  - Katena
Main indications for DALK
(any corneal disease with healthy endothelium)
- Corneal scars with healthy endothelium
- Herpes Simplex scarring
- Herpes Zoster scarring
- Ectasia following Lasik surgery
- Ectasia following RK surgery
- Atopic Disease
- Down’s Syndrome patients
- Deeply vascularized corneas

DALK complications
- Intra-operative: perforation of Descemet’s membrane during resection of recipient stroma: Incidence between 2% and 30%
- Post-operative: All same problems with sutures and astigmatism as PK
- Post-operative: stronger resistance to rupture of wound than PK
- May be more “reactive” to relaxing incisions than PK

Tips for Avoiding Conversion to PK
- Avoid cases with prior Descemet’s membrane breaks (Hydrops, 100% scarring, etc)
- Avoid over-inflation and bursting of Big Bubble
- After Big Bubble, keep eye extremely soft by frequent milking of the paracentesis site
- Use Healon liberally to maintain pre-Descemet’s space
- Use blunt tipped scissors (Cindy Scissors) for resection
- Try to avoid urge to resect very last fibers of peripheral posterior stroma – “The enemy of good is better”

Other Surgical Tips
- Get pachymetry map pre-operatively to determine thinnest area for trephination depth estimation and cap resection considerations
- Mark the recipient rim with marking pen BEFORE injection Big Bubble – helps with visualization of edge for resection if stroma of rim whitens diffusely
- If not sure Big Bubble is there: inject small amount of air into AC through paracentesis site – if Big Bubble present, air goes to peripheral area of chamber; if Big Bubble absent, air goes to central area of chamber.
- Use same size graft for keratoconus pts and moderate myopia eyes and use 0.25 mm oversize grafts for others
- Suture graft in place with preferred method, but be care to suture tighter than with standard PK
- Suture and Tuck edges of donor under recipient rim to avoid edge lift

What to do if you have a perforation
- Stop cursing immediately
- Assess the extent of the perforation: Central? Peripheral? Extending?
- Place air bubble into AC to close defect
- Carefully complete dissection, recognizing that only the central area needs to be near baring of Descemet’s
- Inject further air and position pt to allow coverage of perforation site by bubble
- Dilate pupil
- What if perforation is noted until next day? (eg: a suture needle pass perforation)…..Place full bubble and P.I.

Summary
- Lamellar corneal transplantation allows the selective replacement of only the diseased portion of the cornea, leaving the healthy corneal tissues behind.
- Lamellar techniques (EK and DALK) should be learned by every transplant surgeon wishing to offer their patients safer surgery with faster visual rehabilitation.