PENETRATING KERATOPLASTY

PREOPERATIVE PLANNING AND INTRAOPERATIVE STEPS + MANAGEMENT OF COMPLICATIONS

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JAMES LEHMANN, MD

- Partner at Focal Point Vision
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- Volunteer Faculty Sightlife and ORBIS
- Financial Disclosures
  - RxSight, J and J, CorneaGen, Glaukos, Modernizing Medicine, Diamatrix
POLL QUESTIONS
I HAVE PERFORMED PENETRATING KERATOPLASTY . . .

1. Never
2. 1-20 cases
3. 21-50 cases
4. 51+ cases
WHICH OF THE FOLLOWING IS NOT A CONTRAINDICATION TO PENETRATING KERATOPLASTY?

1. Active Ocular Cicatricial Pemphigoid
2. Untreated exposure
3. Keratoconus with scar
4. Active Graft Vs. Host Disease
WHEN PERFORMING PENETRATING KERATOPLASTY, WHICH IS TRUE?

A. The donor trephination should be larger than the recipient.

B. The recipient trephination should be larger than the donor.
IF THE PATIENT HAS A CORNEAL SCAR AND MILD CATARACT...

1. The surgeon should perform a PK3

2. The surgeon should perform only a PK, then months later the cataract surgery

3. The surgeon should take out the cataract first, then months later, perform the PK

4. The surgeon should perform DMEK
LECTURE OBJECTIVES

▸ To understand parameters for donor cornea selection
▸ To understand preoperative planning for penetrating keratoplasty
▸ To learn about basic intraoperative steps for penetrating keratoplasty
▸ To learn about how to avoid and manage intraoperative complications
BACKGROUND

PATIENT SELECTION

DONOR CORNEA SELECTION

PREOPERATIVE PLANNING

SURGICAL TECHNIQUE

INTRAOPERATIVE COMPLICATIONS
ONE SIZE FITS ALL
TYPES OF CORNEAL TRANSPLANTS

PKP

DALK

DSAEK

DMEK

KPRO
EBAA TRENDS 2020

Domestic Surgery Use of U.S. Supplied Intermediate-Term Preserved Tissue

- PK
- EK
- ALK
- KLA
BACKGROUND

PATIENT SELECTION

DONOR CORNEA SELECTION

PREOPERATIVE PLANNING

SURGICAL TECHNIQUE

INTRAOPERATIVE COMPLICATIONS
# Indications for PK in Use

<table>
<thead>
<tr>
<th>Stromal or Full Thickness (non-endothelial) Disease</th>
<th>Surgical Diagnosis</th>
<th>PK</th>
<th>ALK</th>
<th>EK</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>B Keratoconus</td>
<td>5,463</td>
<td>88.2%</td>
<td>732</td>
<td>11.8%</td>
<td>--</td>
</tr>
<tr>
<td>E Other Degenerations of Dystrophies</td>
<td>1,164</td>
<td>93.0%</td>
<td>88</td>
<td>7.0%</td>
<td>--</td>
</tr>
<tr>
<td>F Post-refractive Surgery</td>
<td>70</td>
<td>94.6%</td>
<td>4</td>
<td>5.4%</td>
<td>--</td>
</tr>
<tr>
<td>G Microbial Changes</td>
<td>677</td>
<td>95.0%</td>
<td>36</td>
<td>5.0%</td>
<td>--</td>
</tr>
<tr>
<td>H Mechanical or Chemical Trauma</td>
<td>982</td>
<td>96.9%</td>
<td>31</td>
<td>3.1%</td>
<td>--</td>
</tr>
<tr>
<td>I Congenital Opacities</td>
<td>620</td>
<td>96.1%</td>
<td>25</td>
<td>3.9%</td>
<td>--</td>
</tr>
<tr>
<td>J Pterygium</td>
<td>10</td>
<td>76.9%</td>
<td>3</td>
<td>23.1%</td>
<td>--</td>
</tr>
<tr>
<td>K Non-infectious ulcerative keratitis or perforations</td>
<td>1,301</td>
<td>95.5%</td>
<td>62</td>
<td>4.5%</td>
<td>--</td>
</tr>
<tr>
<td>L Other causes of corneal dysfunction or distortion</td>
<td>2,346</td>
<td>92.5%</td>
<td>191</td>
<td>7.5%</td>
<td>--</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>12,633</strong></td>
<td><strong>91.5%</strong></td>
<td><strong>1,172</strong></td>
<td><strong>8.5%</strong></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>32.9% of PK</td>
<td>49.1% of ALK</td>
<td>0</td>
<td>0%</td>
<td>18.9% of grafts</td>
</tr>
</tbody>
</table>

## Regraft

<table>
<thead>
<tr>
<th>Surgical Diagnosis</th>
<th>PK</th>
<th>ALK</th>
<th>EK</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>D Repeat Corneal Transplant</td>
<td>4,529</td>
<td>61.3%</td>
<td>38</td>
<td>0.5%</td>
</tr>
<tr>
<td></td>
<td>11.8% of PK</td>
<td>1.6% of ALK</td>
<td>8.8% of EK</td>
<td>10.1% of grafts</td>
</tr>
</tbody>
</table>
MOST COMMON INDICATIONS

- In US –
  - Keratoconus, Repeat Grafts, Perforations

- In India –
  - Therapeutic for Ulcers, then optical for redraft

  - Bullous Keratopathy, Therapeutic, Corneal Dystrophies
CONTRAINDICATIONS TO CORNEAL TRANSPLANTATION

- Uncontrolled Ocular Surface Disease
  - Severe KCS
- Stevens Johnson Syndrome
- Ocular Cicatrical Pemphigoid
- Limbal Stem Cell Deficiency
- Exposure
Fungal Keratitis
MORE CONTRAINDICATIONS...

- Active Infection
  - Unless Therapeutic PK
- Special Circumstance: HSV
  - Systemic anti-HSV meds – Valtrex
  - Quiet disease prior to surgery
- Uncontrolled Glaucoma
- Multiple Previous Rejections
- Inability to Care for PK
BACKGROUND

PATIENT SELECTION

DONOR CORNEA SELECTION

PREOPERATIVE PLANNING

SURGICAL TECHNIQUE

INTRAOPERATIVE COMPLICATIONS
DONOR CORNEA SELECTION

- Pertinent Stats
  - Age (15-65)
  - Date of Death
  - <12 days for use
  - D to P / Cooling
  - <20 hrs
  - Cell Count / Picture
  - 2500 cells/mm
  - Clear Zone
**DONOR CORNEA SELECTION — CORNEAL DONOR STUDY**

- MULTICENTER STUDY IN THE U.S.
- TRACKING 10 YEAR OUTCOMES OF PENETRATING KERATOPLASTY
  - PRIMARY OUTCOMES BASED ON DONOR AGE
  - COMPARING 12-65 YO VS 66-75 YO
- ALL CORNEAS MET EBAA CRITERIA FOR PK
  - >2300 CELL COUNT
  - DONOR AGES 12 TO 75
CORNEA DONOR STUDY — ENDOTHELIAL CELL LOSS AFTER PK

- 31% cell loss
- 44% cell loss

No Sig Diff
DONOR CORNEA SELECTION — DOES HLA MATCHING MATTER?

‣ SOLID ORGAN TRANSPLANTS
  ‣ HLA MATCHING

‣ COLLABORATIVE CORNEAL TRANSPLANT STUDY (CCTS) 1985
  ‣ HIGH RISK CORNEAL TRANSPLANT RECIPIENTS
    ‣ VASCULARIZATION, PRIOR SURGERY, ETC...
  ‣ NO BENEFIT @ 3 YEARS FOR HLA MATCHING
  ‣ MILD BENEFIT FOR ABO COMPATIBILITY MATCHING
DONOR CORNEA SOLUTIONS

- SHORT TERM STORAGE (0-48 HOURS)
  - 4°C MOIST CHAMBER
  - M-K MEDIUM

- INTERMEDIATE TERM STORAGE (0-14 DAYS)
  - K-SOL, CSM, DEXSOL, OPTISOL, CORNISOL MEDIA
    - CONTAIN CHONDROITIN SULFATE
    - AMPHOTERICIN
  - EUSOL-C
  - LIFE4C°

- LONG TERM STORAGE (> 14 DAYS)
  - CRYOPRESERVATION
  - ORGAN CULTURE AT 34°C
SEROLOGIC TESTING

- **HEPATITIS**
  - HBC, HBSAG, CCV
    - 2 documented transmission (0 since 1986 HBsag)

- **HIV-1 & HIV-2**
  - No cases of documented transmission

- **RPR, CONFIRMATION WITH FTA-ABS/MHA-TP IF (+)**
  - No cases of documented transmission

- **NOT REQUIRED: HTLV, EBV, CMV, CHAGAS, WEST NILE**
DONOR CORNEA SCREENING

CONTRAINDICATIONS

HEPATITIS

<table>
<thead>
<tr>
<th>Contraindications for Transplant*</th>
<th>2014</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive or Reactive Test for Communicable Disease Agent or Disease</td>
<td>10,161</td>
<td>30.8%</td>
</tr>
<tr>
<td>Anti-HIV-1/2</td>
<td>185</td>
<td>0.6%</td>
</tr>
<tr>
<td>HIV-1 Nucleic Acid Test Positive</td>
<td>70</td>
<td>0.2%</td>
</tr>
<tr>
<td>Anti-HCV</td>
<td>1,889</td>
<td>5.7%</td>
</tr>
<tr>
<td>Hepatitis C Nucleic Acid Test Positive</td>
<td>709</td>
<td>2.2%</td>
</tr>
<tr>
<td>Hepatitis B Surface Antigen (HBsAg) Positive</td>
<td>1,130</td>
<td>3.4%</td>
</tr>
<tr>
<td>Hepatitis B Core (HBCAb) Positive</td>
<td>4,889</td>
<td>14.8%</td>
</tr>
<tr>
<td>Hepatitis B Nucleic Acid Test Positive</td>
<td>379</td>
<td>1.1%</td>
</tr>
<tr>
<td>Syphilis Positive</td>
<td>390</td>
<td>1.2%</td>
</tr>
<tr>
<td>HTLV Antibody (HTLV I/II Ab)</td>
<td>206</td>
<td>0.6%</td>
</tr>
<tr>
<td>West Nile Virus Nucleic Acid Test Positive</td>
<td>4</td>
<td>0.01%</td>
</tr>
<tr>
<td>Other Positive Serology</td>
<td>342</td>
<td>1.0%</td>
</tr>
<tr>
<td>Other Communicable Disease Testing Issue</td>
<td>423</td>
<td>1.3%</td>
</tr>
<tr>
<td>Medical Record or Autopsy Findings</td>
<td>7,313</td>
<td>22.2%</td>
</tr>
<tr>
<td>Dementia</td>
<td>733</td>
<td>2.2%</td>
</tr>
<tr>
<td>Sepsis</td>
<td>3,510</td>
<td>10.6%</td>
</tr>
<tr>
<td>Sepsis - (determined by positive blood cultures)</td>
<td>1,067</td>
<td>3.2%</td>
</tr>
<tr>
<td>Sepsis - (determined by other indicators)</td>
<td>2,443</td>
<td>7.4%</td>
</tr>
<tr>
<td>Plasma Dilution</td>
<td>445</td>
<td>1.4%</td>
</tr>
<tr>
<td>Unknown Cause of Death</td>
<td>388</td>
<td>1.2%</td>
</tr>
<tr>
<td>Medical Record or Autopsy Findings: Other</td>
<td>2,237</td>
<td>6.8%</td>
</tr>
<tr>
<td>Medical/Social Interview</td>
<td>2,331</td>
<td>7.1%</td>
</tr>
<tr>
<td>Travel Questions</td>
<td>379</td>
<td>1.1%</td>
</tr>
<tr>
<td>Dementia / Neurological Issues</td>
<td>139</td>
<td>0.4%</td>
</tr>
<tr>
<td>Medical/Social Interview: Other</td>
<td>1,813</td>
<td>5.5%</td>
</tr>
<tr>
<td>Body Exam</td>
<td>235</td>
<td>0.7%</td>
</tr>
<tr>
<td>Total eyes/corneas intended for transplant but not released for transplant</td>
<td>32,958</td>
<td>32,456</td>
</tr>
</tbody>
</table>

*Percentages read from this table should be read as “of the tissue not released for transplant”
DONOR EVALUATION

- DONOR
  - REVIEW OF MEDICAL AND SOCIAL HISTORY
  - SEROLOGIC TESTING

- DONOR CORNEA
  - SLIT LAMP EXAMINATION
    - Exposure, Infiltrate, Clear Zone
  - SPECULAR MICROSCOPY
DONOR SPECULAR MICROSCOPY
PRESURGICAL PLANNING

- Anesthesia
- Lens Management
- Failed PK
  - PK
    - Repeat trephination
    - Dissection
  - DSEK/DMEK
  - Boston Keratoprosthesis
ANESTHESIA FOR PENETRATING KERATOPLASTY

- **Goals**
  - Anesthesia
  - Akinesia

- **Types**
  - Local
    - Retrobulbar
  - General
    - Block at end of case, too.
SELECTING ANESTHESIA FOR PK

- Patient factors
  - Ability to lay still during procedure
    - Age
    - Mental status

- Ocular factors
  - Need to perform additional intraocular procedures “open-sky”
    - Cataract extraction
    - Scleral-fixated intraocular lens
  - Risk for suprachoroidal hemorrhage?
SELECTING ANESTHESIA FOR PK

- Possible complications of retrobulbar anesthesia
  - Globe perforation
  - Intravascular injection
  - Retrobulbar hemorrhage
  - Direct trauma to the optic nerve
  - Puncture of optic nerve sheath with injection into subarachnoid space
PRESURGICAL PLANNING

› Anesthesia

› Lens Management

› Failed PK
  › PK
    › Repeat trephination
    › Dissection
  › DSEK/DMEK
  › Boston Keratoprosthesis
LENS MANAGEMENT SCENARIOS IN PK

- MILD TO MODERATE CATARACT
- DENSE TO MATURE CATARACT
- DISLOCATED IOL
- POORLY FIT ACIOL OR UGH SYNDROME
- APHAKIA
**MILD TO MODERATE CATARACT**

- Most common scenario
- Leave cataract alone
- Return 6-9 M post PK
  - After suture mgmt.
ASTIGMATISM MANAGEMENT AFTER PK

Post Op 4M
ASTIGMATISM MANAGEMENT AFTER PK

Post Op 5M
ASTIGMATISM MANAGEMENT AFTER PK

Post Op 6M
Manjunath Natarajan, India

What are the advantages and disadvantages of continuous and interrupted sutures?
DENSE TO MATURE CATARACT

- Remove!
- Use K’s 45/45
- I like Alcon PMMA CZ70BD
- Use Flieringa ring!
- Open Sky ECCE
USE A FLEETING RING IF PT APHAKIC AT ANY POINT IN PROCEDURE!
QUESTION FROM THE AUDIENCE 2020 —

» Bayanda Mbambisa, South Africa

» What is the advantage of using a Flieringa Ring?
DISLOCATED OR POORLY FITTING IOL
DISLOCATED OR POORLY FITTING IOL

- IOL Exchange
- Sutured IOL
  - CZ70BD
  - Akreos
- Gore-tex suture
- Or Combined Yamane
APHAKIA — ESSENTIALLY THE SAME

- 45/45 Ks
- Sutured IOL
  - CZ70BD
  - Akreos
- Gore-tex suture
- Combined Yamane
PRESURGICAL PLANNING

- Anesthesia
- Lens Management
- Failed PK
  - PK
    - Repeat trephination – significant scarring or small graft
    - Dissection – recently done, same size
  - DSEK/DMEK
  - Boston KPRO
FAILED PK? REPEAT PK OR DMEK/DSEK?

- Questions: Vision? Glasses/Contacts worked?
  - Best Corrected Va prior to graft failure
  - Spectacle or contact lens-correction
    - Ability to tolerate RGP

- Anatomic factors
  - Amount and regularity of astigmatism
  - Corneal edema, scarring, vascularization
  - Lens status
Good Previous Vision, Graft Failure, K Edema, Minimal Scarring or Vascularization

DMEK or DSEK
BACKGROUND
PATIENT SELECTION
DONOR CORNEA SELECTION
PREOPERATIVE PLANNING
SURGICAL TECHNIQUE
INTRAOPERATIVE COMPLICATIONS
SURGICAL TECHNIQUE

‣ Recipient Eye Preparation
‣ Donor Prep
‣ Host Corneal Trephination
‣ **Special Issues
  ‣ Temporary Keratoprosthesis
  ‣ Cataract Extraction
‣ Donor Cornea Suturing
RECIPIENT EYE PREPARATION

- Flieringa ring
  - Young or Cataract or Aphakic
- Measure Corneal Diameter
- Mark Corneal Center
- Determine Donor Size
  - Standard 8.25 → 8.00
- Mark for Suture
FLIERINGA RING
MEASURING, CENTERING, AND MARKING
HOST CORNEAL TREPHINATION
USE OF TEMPORARY KERATOPROSTHESIS

- Optic
  - 8.2 mm
- Trephine diameter
  - 8.25 mm or bigger
OPEN SKY CATARACT EXTRACTION
REMOVAL OF PS AND OPEN SKY ECCE
DONOR CORNEA SUTURING

A
B
C
BACKGROUND

PATIENT SELECTION

DONOR CORNEA SELECTION

PREOPERATIVE PLANNING

SURGICAL TECHNIQUE

INTRAOPERATIVE COMPLICATIONS
INTRAOPERATIVE COMPLICATIONS

- Scleral Perforation
- Improper Trephination
- Bleeding
- Misalignment
- Iris/Lens Damage
- Torn Capsule
- Expulsive Choroidal Hemorrhage
ANESTHESIA IS YOUR FRIEND

- Retrobulbar
- General Anesthesia
- Body Habitus
- Patient Demeanor
- Previous Surgeries
- Difficulty/Length of Case
HOW TO AVOID SCLERAL PERFORATION

▸ Use Spatulated Needle
▸ Episceral Pass
▸ Rotate Eye for Comfort
▸ How to Fix it?

Figure 1. A clinical photograph of the superonasal scleral lesion with microcystic conjunctiva over it.
HOW TO AVOID IMPROPER TREPHINATION

- Once the Donor is Cut...It is too Late.
- Confirm Trephine Sizes
- Cut Donor First
- What Happens if Donor too Small?
  - Hyperopia, Glaucoma, Leak
- Too Big
  - Steep Ks, Myopia, Exposure
MATERIALS FOR TREPHINATION

- Vacuum Trephines
- Donor Bigger than Host
- .25 to .5 mm Bigger
HOW TO AVOID MISALIGNMENT

- Marking Recipient
- Centering Donor
- Suture Technique/Tension
HOW TO TREAT BLEEDING

- Vascularized Cornea
- May not be Possible to Avoid
- 360 Peritomy
- Cautery
HOW TO AVOID DAMAGE TO IRIS

- During Trephination
  - Fill A/C with Viscoelastic
- Removing ACIOL
  - Cut / Don’t Pull
- Breaking PAS / Adhesions
  - Cut / Don’t Pull
- Pupillary Membrane
  - Cut
- Repairing Iris
  - Prolene Suture Mattress or Single Bites
HOW TO AVOID TRAUMA TO THE LENS

- During Trephination
  - Viscoelastic
  - Preoperative Pilocarpine
- During Iris Repair
  - Lift Iris While Passing Needle
- If Capsule Damaged…
  - Need IOL Calcs
  - ECCE
AVOID CAPSULAR RUPTURE

- Open Sky ECCE
  - Efficient, Fast
- Large Rhexis
  - Can-opener/Slash/CCC
  - Gentle Pressure
- Sulcus IOL, Rigid
- Cortex Removal
  - Weck vs. I/A
HOW TO CLEAN UP CAPSULAR RUPTURE

▸ Flieringa Ring Is Helpful
▸ Anterior Vitrectomy
  ▸ Kenalog
▸ IOL Placement
▸ Miosis
▸ PI
SUPRACHOROIDAL HEMORRHAGE

- Preoperative factors
  - Previous suprachoroidal hemorrhage
  - High myopia
  - Previous ocular surgery
  - History of ocular trauma
  - Glaucoma
    - Increased intraocular pressure
RISK FACTORS FOR SUPRACHOROIDAL HEMORRHAGE

- Systemic factors
  - Advanced age
  - Systemic vascular disease
    - Arterial hypertension
    - CAD
    - Arteriosclerosis
  - DM
  - Anticoagulation
RISK FACTORS FOR SUPRACHOROIDAL HEMORRHAGE

- Intraoperative Factors
  - Vitreous loss
  - Sudden ocular decompression
  - Contraction of extraocular muscles
  - Prolonged intraoperative hypotony
  - Scleral manipulation in eyes that have undergone a second surgery
  - Extensive use of cryotherapy and photocoagulation with the trans scleral mode
RISK FACTORS FOR SUPRACHOROIDAL HEMORRHAGE

- Systemic Intraoperative Factors
  - Elevated intraoperative pulse rate
  - Valsalva maneuver
    - Several cases of expulsive hemorrhage have been reported when keratoplasty was performed under general anaesthesia and were directly related to the patient's "bucking" on the endotracheal tube.

ACUTE MANAGEMENT OF SUPRACHOROIDAL HEMORRHAGE

- Immediate closure of the eye
  - Cobo keratoprosthesis (or thumb)
  - Patient or donor cornea
- Reduction of intraocular pressure
  - Intravenous diuretics
    - Acetazolamide (500 mg)
      - Onset 5-10 minutes
      - Duration of action 2 hours
    - Mannitol 20% (0.5 to 2 g/kg)
      - Onset 30-60 minutes
      - Duration of action 6 hours
POLL QUESTIONS
WHICH OF THE FOLLOWING IS NOT A CONTRAINDICATION TO PENETRATING KERATOPLASTY?

1. Active Ocular Cicatrical Pemphigoid
2. Untreated exposure
3. Keratoconus with scar
4. Active Graft Vs. Host Disease
WHEN PERFORMING PENETRATING KERATOPLASTY, WHICH IS TRUE?

A. The donor trephination should be larger than the recipient.

B. The recipient trephination should be larger than the donor.
IF THE PATIENT HAS A CORNEAL SCAR AND MILD CATARACT . . .

1. The surgeon should perform a PK3

2. The surgeon should perform only a PK, then months later the cataract surgery

3. The surgeon should take out the cataract first, then months later, perform the PK

4. The surgeon should perform DMEK
Thank You!

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