When It’s Time For A New Cornea...

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Course description:
This 1-hour course will provide detailed information on the different types of corneal transplant surgery including candidacy, the surgical process (including videos), pre and post-operative care and complications. An overview of vision rehabilitation including contact lens fitting strategies will be discussed as well so an OD will feel more comfortable managing cornea transplant patients.

Course Objectives:
At the conclusion of this course the participant will be able to:
1. Discuss the role of optometric co-management in transplant procedures (pre-op and post-operative care).
2. Explain the basic surgical process for some popular transplant procedures (PKP, DALK, DSAEK, DMEK).
3. Identify appropriate candidates for corneal transplantation.
4. Recognize complications associated with transplant procedures and their management (i.e. when to treat and when to refer back to the surgeon).
5. Identify appropriate contact lens designs for post-transplant patients and describe some basic fitting principles used when assessing a post-transplant lens fit.

Outline

I. Different types of Corneal Transplants
   a. PKP (Penetrating Keratoplasty)
   b. DSAEK (Descemets Stripping Automated Endothelial Keratoplasty)
   c. DMEK (Descemet Membrane Endothelial Keratoplasty)
   d. DALK (Deep Anterior Lamellar Keratoplasty)
   e. Combined Procedures: Cataract Surgery with Corneal Transplantation

II. History of Corneal Transplants
   a. First successful corneal transplant in 1905 by Eduard Zirm
   b. Why is Corneal Transplantation so successful?
   c. The progression of Corneal Transplant Surgery

III. PKP (Penetrating Keratoplasty)
a. All five layers of the cornea replaced

b. Indications
   i. Optical: keratoconus, Fuch’s endothelial dystrophy, corneal opacities
      1. Reduced best corrected vision
      2. Intolerance to contact lens wear
   ii. Therapeutic: pseudophakic bullous keratopathy, corneal perforation, re-graft

c. Prognostic factors
   i. Abnormalities of the eyelids
   ii. OSD
   iii. Severe stromal vascularization
   iv. Active anterior segment inflammation
   v. Peripheral corneal thinning at proposed host-graft junction
   vi. Anterior synechiae
   vii. Uncontrolled glaucoma
   viii. Previous graft failures
   ix. Poor compliance

d. Pre-Surgical Care
   i. Patient education
      1. Vision may be worse or no better than before surgery for up to the first 6 months
         a. Suture removal
      2. Necessity of additional visual correction
         a. Approximately 50% of post-PK patients will benefit visually from contact lens wear (usually GP in nature)
      3. Over 50% of post-PK patients have 4D or more of corneal astigmatism
      4. Regular AND irregular astigmatism are common post-PK
      5. Dependence on eye drops (on occasion, some for the rest of their lives)
      6. Life long risk of rejection
      7. Future need for repeat transplant
   ii. Definition of success: better vision, less pain, successful spectacle or contact lens wear, less glare, quality of life improvement
   iii. Testing
      1. Detailed social history
         a. Helps predict whether the patient will be compliant with post-op regimen and will report quickly if problems arise
      2. Ocular health assessment
         a. Treat complicating factors
            i. Eyelids, dry eye/OSD, surface & intraocular inflammation, IOP, previous grafts
         b. Address limitations to visual outcome
i. Media opacities, uncontrolled glaucoma, amblyopia, macular abnormalities, retinal disease, optic nerve damage

d. Overview of surgical technique
   i. Trephination of recipient and donor corneas
   ii. Suture of donor cornea
      1. Interrupted, running, or combination sutures
   iii. Additional surgical techniques
      1. Femtosecond corneal button formation
      a. Corneal button patterns
      2. Can be combined with vitrectomy or cataract extraction

f. Advantages/Disadvantages

g. Post-Surgical Co-Management
   i. Medications and typical follow up
      1. Post-Op Day #1
         a. Topical steroids (PF or lotemax QID, durezol QID-BID)
         b. Topical fluroquinolone QID
         c. Artificial tears QID
         d. Eye shield QHS
         e. Restrictions
      2. Post-Op Day #7
         a. Stop antibiotic if fully epithelialized
         b. Continue steroid QID
      3. First 3-4 months
         a. Topical steroids TID-QID
      4. Next 6 months
         a. Taper topical steroid to no less than QD for the 1st year
   ii. Selective suture removal
      1. Indications
         a. Decrease early post-op astigmatism
         b. Increased regular corneal topography
         c. Better visual acuity in early post-op period
         d. Quicker visual rehab - aids in CL fitting
      2. Selection process
         a. Refractive and topography driven
         b. Case: topographical shift following suture removal
      3. Follow up care
   iii. Immediate post-op complications
      1. Wound leak
      2. Delayed re-epithelialization
      3. Flat chamber/iris incarceration in wound
      4. Endophathalmitis
5. Glaucoma - watch for loss of folds in Descemet's membrane
6. Primary donor failure

iv. Long-term complications
1. Glaucoma
2. Recurrence of primary disease – bacterial, fungal, viral and amebic keratitis, + stromal dystrophies can recur in a graft
3. Microbial keratitis
   a. Infectious crystalline keratopathy (ICK)
4. Suture-related problems
   a. Broken suture...what to do?
5. Wound dehiscence
6. Late endothelial failure
7. Graft failure
8. Refractive error, astigmatism, anisometropia
9. Corneal graft rejection - early vs late
   a. Incidence greatest in 1st year
   b. Host immunologic reaction to graft
      i. May ultimately lead to graft failure
         1. Most common cause of failure!
   c. Symptoms:
      i. Decrease in VA
      ii. Redness
      iii. Pain
      iv. Irritation
      v. Photophobia
   d. Signs:
      i. AC reaction
      ii. Keratic precipitates
      iii. Stromal edema
      iv. Circumlimbal injection
   e. Types:
      i. Epithelial
         1. Epithelial rejection line
         2. Occurs in 10% of all rejection cases
         3. Seen early in post-op period (1-13 mo)
         4. May lead to endothelial rejection
      ii. Stromal
         1. Subepithelial infiltrates (like those seen in EKC)
         2. May lead to endothelial rejection if goes untreated
      iii. Endothelial
         1. Most common & most serious form
         2. Clinical signs
a. Endothelial KPs, Khodadoust line, AC reaction, corneal edema

f. Treatment:
   i. Topical steroids – treat aggressively!
      1. Pred q1hr for 1 week then reduced depending on response
      2. Monitor IOP carefully

h. Life expectancy of PK
   i. 33% ECD loss by the surgery itself
   ii. Decompensation proceeds at a more rapid pace than normal corneas
   iii. After 15 years average ECD = 800 cells/mm2
   iv. Life expectancy of 15-25 yrs

i. Where are we going?
   i. PK + Refractive Surgery (PRK/LASIK)

j. Case Examples

IV. DMEK (Descemet Membrane Endothelial Keratoplasty)
a. Even more selective than DSAEK, only the isolated Descemet's membrane and endothelium from the donor cornea are transplanted

b. Indications
   i. Fuchs endothelial dystrophy
   ii. Uncomplicated cases of pseudophakic bullous keratopathy
   iii. Posterior polymorphous dystrophy
   iv. Endothelial decompensation

c. Contraindications
   i. Aphakia
   ii. Previously failed grafts
   iii. Glaucoma cases with setons or drainage blebs
   iv. Patient's with ACIOLs
   v. Peripheral anterior synechiae
   vi. Iris abnormalities (aniridia)
   vii. Significant stromal disease

d. Pre-Surgical Care
   i. Patient Education
      1. Visual acuity will be poor especially for the first week until air bubble resolution
      2. Due to greater complexity with DMEK than DSAEK – may require re-bubbling or repeat surgery
         a. “DMEK graft does not seal well around the edges”
      3. Must avoid higher elevations (mountains, flying) for at least the 1st month (or until air bubble has completely dissipated)
   
   ii. Testing
1. Confirm presence of endothelial dysfunction: SLE, pachymetry, specular microscopy, anterior segment OCT
2. Inferior Laser Peripheral Iridotomy – to avoid acute post-op glaucoma

e. Overview of surgical technique
  i. DMEK – graft consists of an isolated endothelium-Descemet membrane layer
  ii. DSAEK – graft consists of donor endothelium, Descemet membrane AND posterior stroma

f. Post-Surgical Management
  i. Medications and typical follow up care
    1. Post-Op Day #1
       a. Take note of graft position and % of air bubble
       b. Patient remains supine for 48-72hrs
       c. Drops the same as PK
    2. Post-Op Day #2 or 3
       a. Take note of graft position and % of air bubble
          i. If early detachment noted:
             1. DSAEK – if central detachment consider re-bubble
             2. DMEK – if ≤30% peripheral detachment and center is clear & attached then monitor
    3. Post-Op Day #7
       a. If fully epithelialized then remove BCL and stop antibiotic drop
       b. Take note of any detachments – consider re-bubble
    4. 1 month Post-Op
       a. Check manifest refraction and corneal topography
       b. Suture removal if DMEK case
    5. 3 month Post-Op
       a. Check manifest refraction and corneal topography
       b. Suture removal if DSAEK case
       c. Continue steroids for at least 3-4 months QID before starting to taper
    6. 6 month, 1 year

7. Visual Rehabilitation
   a. Endothelial keratoplasty does NOT significantly alter corneal topography = gas permeable lenses are NOT required for BCVA
      i. Case: post-DSAEK patient wearing soft toric CLs
   b. DSAEK – refraction is generally stable ≥ 6 months post-op
   c. DMEK – refraction is generally stable at 3 months post-op
g. Complications
   i. Graft detachment
   ii. Graft failure = persistent corneal edema
   iii. Damage to donor tissue during preparation
   iv. Pupillary block
   v. Secondary Glaucoma
   vi. Graft rejection

h. Advantages/Disadvantages
   i. Partial transplant (DSAEK and DMEK) vs. PK
      1. Less traumatic surgery
         a. Less anesthesia (topical vs general)
      2. Preserved ocular integrity
         a. Wound strength/globe stability (3-4mm incision vs 360 degree circumferential incision) = risk of traumatic globe rupture eliminated
      3. Faster visual recovery
      4. Few sutures:
         a. Less astigmatism/ametropia
         b. Predictable post-op keratometry & refraction = more accurate IOL power estimation when combined with cataract surgery
            i. Hyperopic shift
               1. Spherical equiv of +0.50 to +1.12D expected with DSAEK
               2. Spherical equiv of +0.33D expected with DMEK
      5. Less risk of rejection
      6. Less long-term dependence on steroids
      7. Fewer office visits
      8. Less waiting time between eyes
   ii. Disadvantages
      1. Non-adhesion of graft
         a. Minimum donor graft age of 40 recommended
         b. Re-injection of air bubble
      2. Optical degradation from donor-host interface
      3. More manipulation of donor cornea = potentially higher perioperative endo cell loss (>PK)
      4. Graft dislocation
         a. DSAEK: detachments are complete and can be treated with re-bubbling; delayed rebubbling does NOT provide for worse outcome
         b. DMEK: detachments are peripherally, can be observed but at 6 wks post-op the tissue scroll is fibrotic and not amenable to re-bubbling
      5. Pupillary block
      6. Scarred stroma untreatable
7. Surgeon experience dependent/Time consuming surgical procedure
   i. Advantages/Disadvantages of DMEK vs. DSAEK
      i. Advantages
         1. Less endothelial cell loss long-term
            a. DMEK = 39%
            b. DSAEK = 53%
         2. Improved BCVA
            a. < 20% of DSAEK patients achieve 20/20 BSCVA vs. ≥50% of DMEK patients (Guerra FP et al, Opth 2011)
         3. Improved quality of vision (less HOAs)
            a. DSAEK donor graft contains ~ 100um of posterior corneal stroma
         4. Faster visual recovery
         5. Improved refractive outcome
            a. DMEK donor consists of 15um and is optically neutral
         6. Lower risk of rejection - less antigenic tissue is transplanted with DMEK
         7. Near normal anatomical corneal restoration
      ii. Disadvantages
         1. Steep learning curve = slow acceptance among surgeons
         2. Prone to early dislocation and failure
   j. Case examples (ie patient with DSAEK in one eye and DMEK in other)

V. DALK (Deep Anterior Lamellar Keratoplasty)
   a. All tissue anterior to Descemet's membrane is transplanted leaving the healthy endothelium intact
   b. Indications
      i. Pathology of the anterior cornea (epithelium, Bowman's layer, and stroma)
         1. Tectonic: to restore normal corneal thickness by using tailor-made lamellar corneal patches to match the defect on the patient
            a. Descemetocoele
            b. Pellucid Marginal Degeneration
            c. Advanced Terrien’s marginal degeneration
            d. Sterile Mooren’s ulcer & other forms of peripheral corneal melts related to autoimmune disorders
         2. Optical: to enhance vision
            a. Ectatic disorders
            b. Corneal opacification (due to trauma, infections, chemical insults, dystrophies/degenerations)
      c. Contraindications
         i. Endothelial dysfunction
         ii. Deep scars involving Descemet's membrane
d. Pre-Surgical Care
   i. Patient Education
      1. Warn patient about possible conversion to penetrating keratoplasty
      2. Similar to that of full thickness PK
   ii. Testing
      1. Check and monitor endothelial function: SLE, pachymetry, specular microscopy, anterior segment OCT
      2. Assessment of corneal scarring - must assess depth: SLE, anterior segment OCT

e. Overview of surgical technique
   i. Anwar “Big Bubble” technique

f. Post-Surgical Management
   i. Medications and typical follow up schedule
      1. Similar to that of PK
      2. Steroids can often be tapered sooner & sutures can be removed earlier
         a. Steroid drops are tapered starting at 3 mo post-op by one drop every month, QD dosing continued until end of 1st year
   ii. Complications
      1. Intraoperative complications
         a. Perforation and rupture of Descemet's membrane (10-30%)
      2. Postoperative complications
         a. Persistent epithelial defects (≈PK)
         b. Pseudoanterior chamber/Double anterior chambers
         c. Pupillary block and fixed dilated pupil (Urrets-Zavalia syndrome)
         d. Interface wrinkling
         e. Suture-related problems
         f. Graft rejection reaction (<PK) - NO ENDOTHELIAL REJECTION!
         g. Infectious keratitis
         h. Glaucoma (<PK)
   iii. Visual Rehabilitation – similar to that of PK

g. Advantages/Disadvantages vs. PK
   i. Advantages
      1. Lower risk
         a. Less traumatic surgery
         b. Less post-op complications because there’s no entry into the anterior chamber
            i. Avoids risks of glaucoma, cataract, RD, CME, expulsive hemorrhage, and endophthalmitis
      2. Preserved ocular integrity
      3. Faster recovery → Earlier suture removal
4. Reduced risk of allograft rejection  
   a. No risk of endothelial rejection!
5. Minor loss of endothelial cell density → Increased graft survival rate
6. Less long-term dependence on steroids
7. Stronger tectonically than PK

ii. Disadvantages
1. High amounts/irregular astigmatism (DALK≈PK)
2. Interface haze by limit final BCVA
3. Contact lens use necessary for max BCVA
4. Technically more difficult & time consuming for the surgeon
   a. Surgical complexity often requires conversion to PK

iii. Clinical Outcomes
1. Visual acuity: DALK≈PK
2. Refractive outcome: post-op myopic and astigmatic refractive errors similar between DALK & PK
3. Graft survival: most ECD loss (11.1%) occurs within 6 mo post-op and reaches physiologic rate of 1-2%/yr after, should persist indefinitely in an uneventful recovery

h. Case Examples (e.g. DALK patient with Descemet’s detachment)

VI. Combined Procedure Cataract Surgery with Corneal Transplantation
a. Indications
b. Advantages
   i. Convenience-avoid duplicate follow up appointments
   ii. Decreased risk- single anesthesia
   iii. Similar post-operative medication
c. Disadvantage
   i. Residual refractive error greater in simultaneous procedure vs separate procedures
   ii. Post cataract BCVA may be acceptable and corneal transplant unnecessary
d. Case Examples (ie patient with Fuch’s after cataract surgery with longer recovery but good final BCVA vs patient with simultaneous procedure)

VII. OD Responsibilities
a. The Ultimate Challenge
   i. Long history of poor vision
   ii. Expectations
   iii. Excessive post-op astigmatism
   iv. Misdirected hostility
   v. Increased chair time
b. Graft Preservation – need to monitor these patients closely
   i. Catching rejection and treating early & aggressively
   ii. Monitoring IOP and treating to avoid steroid induced glaucoma
   iii. Neurotrophic features
1. Why are anterior grafts neurotrophic?
   a. Elimination of neural reflex between the cornea, lid and lacrimal apparatus
   b. Pre-existing neurotrophic states secondary to prior herpetic eye disease – a relatively common indication for anterior graft

2. Treatment of neurotrophic grafts
   a. Artificial tears
   b. Restasis/Xiidra
   c. Bandage soft CL
   d. Tarsorrhaphy
   e. Autologous serum
   f. Amniotic Membrane

iv. Infection
   1. Why do anterior grafts have increased risk of infection
      a. Use of corticosteroids
      b. Recurrence of virus in graft
      c. Use of contact lenses

   c. Visual Rehabilitation After Keratoplasty
      i. Glasses
         1. Warn patient of multiple remakes on glasses
         2. Topography can serve as an auto-refractor
         3. Suture removal will result in change to refractive error/astigmatism
         4. Utilizing trial frame
      ii. Contact Lens Fitting After Keratoplasty
         1. Reasons
            a. Therapeutic (bandage contact lens)
               i. Persistent epithelial defects/delayed re-epithelialization
               ii. Seal wound leaks or cover dehiscence
               iii. Protect against protruding sutures until removal
            b. Optical
               i. Correction of irregular astigmatism
               ii. Correction of high regular astigmatism
               iii. Anisometropia
               iv. Secondary aniseikonia
                  1. Rule of thumb: apply 1.5% magnification per diopter of disparity between the two eyes, if ≥ 5% then this would induce aniseikonia symptoms = CLs recommended
v. Simple ametropia – patient desires to be free from spectacles

2. Considerations
   a. How soon after surgery can patient be fit?
      i. Patient/surgeon dependent
      ii. As early as 3-6 months
      iii. Ideally 12-18 months
   b. Patient complaints
      i. Halos, glare, flare, poor night vision
      ii. Decreased vision, blurry vision
      iii. Anisometropia
   c. Physical Exam
      i. Pupil Size (bright and dim illumination)
      ii. Impingement on visual axis
      iii. Donor graft size
      iv. Overall graft shape:
         prolate/proud/oblate/sunken/tilted/eccentric
      v. Refractive status
   d. Lens Options
      i. Disposable or custom soft lenses
      ii. Corneal GP designs
         1. spherical or aspheric
         2. fitting strategies
            a. larger OADs – need to cover host/graft junction
            b. get good central fit first, then adjust periphery
            c. use pre-op Ks, fellow eye Ks or topo
            d. post-op central steep K + 3D
            e. Ks at point 3-4mm sup or temporal to visual axis
            f. Mid-K
      iii. Piggybacking – centration, comfort, protection
      iv. Hybrids – coverage, centration, comfort
      v. Sclerals
   e. Fitting Strategies
      i. Maintain corneal health and integrity
         1. Monitor endothelial cell count & pachymetry
         2. Choose a lens material that provides a high Dk
         3. Avoid excessive bearing over sutures/incisions
ii. Qualification of successful CL fit
   1. Acceptable vision
   2. Acceptable comfort
   3. Acceptable post-wear biomicroscopy

iii. Role of Reverse Geometry Theory
   1. Lens where the central optic zone has a flatter radius of curvature than the adjacent areas, creating a more oblate shape.
   2. Why use it?
      a. Stark topo changes (post-RK, post-PKP)
      b. Closely mimic corneal shape, limit clearance
      c. Improve fit, comfort, vision, centration

f. Follow-up care
   i. How often should you be seeing these patients?
   ii. Patient education
      1. Always watch for signs/symptoms of rejection
      2. Always watch for symptoms of broken suture
   iii. Ocular health assessment
      1. Corneal staining
      2. Monitor IOP
      3. Refraction