Ocular Surface Procedures in the Treatment Room

University of Toronto

Financial Disclosures

• Clara Chan, MD, FRCS, FACS: Consultant for Alcon, Allergan and Bausch & Lomb
• Neera Singal, MD, FRCS: no disclosures
• David Rootman, MD, FRCS: Consultant for AMO
• Allan Slomovic, MD, FRCS: Consultant for Alcon, Allergan, Bausch & Lomb
• Zach Ashkenazy, MD, Randall Ulate, MD, Mario Saldanha, MD, Mahmud Showail, MD, Armand Borovik, MD: no disclosures

• Off-label use of fibrin tissue glue, Anti-VEGF agents, and mitomycin C, will be mentioned in presentations

Corneal Tattooing

David Rootman, MD

When?

• To improve eye cosmetic appearance
• Reduce glare from large iridotomies
What do we need?

- Operating microscope
- Coloring agents
- Needle (21G)

Step by step

1) Topical anesthetic
2) Betadine prep, drape, lid speculum
3) Mix dye according to patient’s iris color.

Postoperative management

- Topical antibiotics and steroids (Tobradex qid) for 1 week.
- Bandage contact lens for 1 week
- Continue steroid topical drops for another 2-3 weeks

Results

Pocket Tattoo

David S. Rootman, MD, FRCSC
Professor, University of Toronto
Adjunct Professor, Ben Gurion University
Technique

- Vertical, corneal incision 50% depth
- Lamellar pocket
- Insertion of pigment on crescent knife blade

Femto-Tattoo

- Discussion
- Questions

Conjunctivochalasis

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What is conjunctivochalasis?

- Consider it “inferior SLK”
- Excess conjunctival folds between globe and lid margin
Why does it happen?
• Conjunctiva is no longer adherent to tenon’s capsule
• Absence of tenon’s capsule and conjunctiva does not adhere to sclera
  WITH
• Thinning and stretching of conjunctiva

Risk Factors
• Increased age
• Chronic ocular surface inflammation
  • Dry eye, blepharitis, allergic conjunctivitis
• Post-operative chemosis
• Post-traumatic chemosis

What problems does this cause?
• Irregular tear film
• Poor tear outflow mechanism
  • Hinders lid pump function
  • Mechanical blockage of puncta
• Recurrent subconjunctival hemorrhages

What do patients complain about?
• Asymptomatic to severe discomfort
  • “My eyelids feel stuck to my eye ball”
  • “I find it hard to blink”
  • “My eyes feel so tired”
  • FBS, tearing, discomfort, pain

When do I treat?
Symptomatic and signs of:
• “Effortful” blinking
• Positive “Rub test” or “Thumb test”
  • Apply gentle upward pressure to the eyeball through lower lid, ask the patient to look in different direction to replicate symptoms

Treatment options
First:
• Optimize dry eye, MGD, allergies
• Optimize lid abnormalities (ectropion)
Surgical Intervention:
• Cautery to shrink the excess conjunctival folds
• Conjunctival resection with amniotic membrane
• Conjunctival resection with suture closure
• “Paste-Pinch-Cut” with fibrin glue*

*Doss LR, Doss EL, Doss RP. Cornea 2012;31:999-62.
"Paste-Pinch-Cut"

- My preferred technique
- Fibrin glue provides hemostasis
- Much less inflammation
- Improved patient comfort
- Efficient procedure
- Faster recovery

Step by Step

1) Topical anesthetic
2) Betadine prep, drape, lid speculum
3) Weck cell pledgets soaked with topical anesthetic applied to inferior bulbar conjunctiva x 30 seconds
4) Draw up fibrinogen in 1 cc syringe with 25 gauge short needle and thrombin in another 1 cc syringe with 30 gauge short needle

Post-operatively

- Tobradex ointment and patch x 4 hours
- Tobradex and artificial tears qid x 1 week
- Tylenol PRN for pain
- Follow-up at 1 week
- Finish the Tobradex, then Maxidex 1 drop qid tapering 1 drop every 2 weeks
- Follow-up at 6 weeks post op

Questions
Discussion

Superficial Keratectomy

Neera Singal, MD, FRCSC
Director of Cornea, Kensington Eye Institute
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Department of Ophthalmology and Vision Sciences
Indications

- Anterior basement membrane dystrophy
- Salzmann's nodular degeneration

Indications

- In combination with other procedures
  - Band keratopathy
  - Pterygium Excision and conjunctival autograft

Prior to procedure

- Establish the diagnosis
- Informed consent
  - Explain postop course
  - Time off work

Instruments

- Topical anaesthetic
- Slit lamp/minor procedure room
- Speculum
- 12 forceps
- Beaver blade
- Bandage contact lens

Post Operative Instructions

- Bandage contact lens X 1 week
- Topical antibiotics and steroid qid X 1 week
- Oral analgesic
- FU 1 week and 1 month
Case

- 75 y.o. male referred for consideration of cataract surgery by the optometrist for declining vision

Case

- 20/80
- Salzmaan nodules
- Irregular astigmatism
- Mild NS

Corneal gluing

Dr Armand Borovik
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Department of Ophthalmology and Vision Sciences

Indications

- Corneal perforation < 3 mm
- Impending perforation
- Post trauma
Requirements

• Tetracaine
• Lid speculum (preferable)
• 15 blade
• Cyanoacrylate glue
• Weckcel
• Sterile cue tips
• Ointment e.g. tobradex or erythromycin
• Sterile drape
• Skin punch 3mm or 4mm

Technique 1

• Topical anesthetic
• Lid speculum ensuring no pressure on globe
• Debride necrotic tissue 2mm around perforation
• Prepare glue
• Cut disc of sterile drape with skin punch
• Apply ointment to cue tip
• Place drape on cue tip
• Apply small amount of glue to disc
• Dry perforation and surrounding area thoroughly
• Apply disc directly over the area of perforation
• BCL

Technique 2

• Topical anesthetic
• Lid speculum ensuring no pressure on globe
• Debride necrotic tissue 2mm around perforation
• Prepare glue
• Apply small amount of glue to back of Weckcel
• Dry perforation and surrounding area thoroughly
• Touch back of Weckcel to perforation
• Can build up layers as needed to seal
• BCL

Post gluing

• Reassess 1 hour post gluing to ensure AC deepening
• Treatment regimen based on underlying etiology
• Leave glue/BCL in place until "pushed out" by underlying healed stroma

Keys to success

• Dry the area to be glued thoroughly
• Don’t use too much glue
• Place a BCL
• Don’t glue the lashes!

Corneal Biopsy

Mario Saldaña, MD
University of Toronto
Department of Ophthalmology and Vision Sciences
Indications

• Infections
• Dystrophies
• Degenerations
• Manifestations of systemic diseases
• Drug-induced changes

Requirements

• Speculum
• 2-4 mm diameter punch (skin)
• 0.12 mm forceps
• Crescent blade

Technique – cut down

Split specimen in half:
1) ½ for pathology
2) ½ for microbiology
50-70% positive results on culture negative specimens

Post-operatively

• Tobradex ointment and patch x 4 hours
• Tobradex and artificial tears qid x 1 week
• Tylenol or Ibuprofen PRN for pain
• Follow-up at 1 week

Technique

Discussion

Questions
Conjunctival biopsy

Randall Ulate, MD
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Department of Ophthalmology and Vision Sciences

Types of conjunctival biopsy

• Excisional
• Incisional

Indications for Excisional Biopsy

Lesions that:
• Threaten vision
• Cause irritation
• Are related to systemic disease
• Possible malignancies

Indications for Incisional Biopsy

• OCP suspect
• Obtain sample to aid in diagnosis of a larger area of abnormality

Step by Step

1) Topical anesthetic
2) Betadine prep, drape, lid speculum
3) Mark area of conjunctiva to be biopsied
4) Weck cell pledges soaked with topical anesthetic (proparacaine or tetracaine) applied to area of conjunctiva x 30 seconds +/- subconjunctival injection of 2% lidocaine with epinephrine to balloon up the area

5) 0.12 forceps and westcott scissors used to excise conjunctiva
6) Place specimen onto piece of paper indicating orientation (blue paper from weck cell packaging)
7) Hemostasis with weck cells pressure +/- handheld cautery
8) Primary closure using 9-0 vicryl or fibrin glue
9) If large area, then use amniotic membrane
Amniotic Membrane Transplant for Persistent Epithelial Defect

Mahmood Showail MD, FRCSC
Clara Chan MD, FRCSC

Introduction – Amniotic Membrane

• It surrounds the developing fetus (inner most layer of the fetal membrane)
• Derived from fetal tissue
• It is a translucent structure that is located adjacent to amniotic fluid

Post-operatively

• Tobradex ointment and patch x 4 hours
• Tobradex and artificial tears qid x 1 week
• Tylenol PRN for pain
• Follow-up at 1 week
• Finish the Tobradex, then Maxidex 1 drop qid tapering
  1 drop every 1-2 weeks
• Follow-up again after 4-6 weeks

Discussion

Questions

Background

• Amniotic membrane transplant promotes ocular surface healing by suppressing inflammation, fibrosis and neovascularization of the cornea
• It consists of:
  – A single layer of cuboidal epithelial cells
  – Basement membrane
  – Avascular stroma
  (loosely attached to the Chorion)
• The stroma exhibits anti-inflammatory, anti-scarring and anti-angiogenic properties

Indications for AM Transplant

1. Non-healing epithelial defect
2. Neurotrophic ulcer (HSV, VZV)
3. Shield ulcer secondary to vernal keratoconjunctivitis
4. Chemical injuries
5. Stevens-Johnson syndrome
6. Limbal stem cell deficiency (combined with limbal stem cell transplant)
7. Morrow's ulcer
8. Bullous keratopathy
9. Pterygium surgery
10. Conjunctival reconstruction

Instruments and Disposables

- Corneal tray
- Sterile drape
- Speculum
- Alcaine 0.5% drops
- Weck cells
- Amniotic membrane tissue
- Vicryl or 10-0 Nylon sutures
- Tissue glue
- BCL

Procedure

Surgical pearls

- Don’t forget to debride the edges of the epithelial defect
- +/- Use tissue glue
- Tissue orientation:
  - Stromal side: sticky side
  - Basement membrane: non sticky
  - Stromal side down (Epithelium will integrate within the tissue) - Last longer
  - Basement membrane side down - It acts as a patch graft and epithelium will grow under - dissolve faster

Post op care

- Drops:
  - Prednisolone 1% gtt QID (taper q2 weeks)
  - Antibiotic gtt QID (1 week)

- Follow up schedule:
  - 1 week, 1 month, 3 months

Discussion

Questions
Avastin Treatment for the Management of Corneal Vascularization

Allan Slomovic MSc, MD, FRCS (C.), Owen and Marta Boris Endowed chair in Cornea and Stem Cell Research
Research Director, Cornea Service. University Health Network
President, Canadian Ophthalmological Society

DISCLOSURE

• Consultant for:
  1. Alcon Canada – Paid consultant
  2. Allergan – Advisory board
  3. Bausch and Lomb Canada – Paid consultant
  4. AMO – Research assistance

I have no financial interests that specifically pertain to my presentation

• The use of Anti-VEGF antibodies for the treatment of corneal neovascularization is currently an Off-Label use of this medication

1. What is Avastin?

• Avastin is the 1st specific angiogenesis inhibitor available in North America.
• Since it’s landmark study for the treatment of Macular Degeneration, Avastin has been used in Ophthalmology to treat no fewer than 51 different disease processes, all having in common pathological vascularization

2. VEGF plays a major role in Corneal angiogenesis and vascular permeability by causing a signaling cascade in endothelial cells

INDICATIONS:

Regression of corneal vascularization +/- lipid deposition

• Best results: localized areas of vascularization (2 - 3 clock hours) +/- lipid deposition eg HSK, HZK, Post-infectious Keratitis

• Worst Results:
  1. Widespread corneal vascularization (Corneal graft rejection), LSCD, Stromal scarring
  2. We also showed that it was not effective in causing regression of corneal vessels in recurrent pterygia

Science 19:983, 1983
Subconjunctival Bevacizumab Injection for Corneal Neovascularization

Cornea 2008 Feb; 27 (2) 142-7

- Subconjunctival injection of 2.5 mg/0.1 ml bevacizumab was performed at the limbus, adjacent to where the pathologic blood vessels growing into the cornea.

- The average number of Avastin injections per eye was (Rg 1 – 4).

Patient 1 - positive reaction (HSK):

Pre-avastin

1 week post 4th Avastin injection
Decrease: extent, density and proportion of vascularized cornea
Note: significant, but not complete regression of B.V.

Patient 2 - positive reaction (Failed PKP post HSK):

Pre-avastin

1 week post 2nd Avastin injection
Note: significant, but not complete regression of B.V.

Patient 4 - no reaction:

Pre-avastin

Post-avastin 1 week post 3rd avastin injection

- Centricity of vessels (the distance the new vessels extended from the limbus towards the visual axis) did not respond to the Sub Conjunctival Avastin injection.

- Maybe the peri-limbal application of the drug, did not reach the more central part of the vessels.
Increase the local drug concentration in pathologic vessels situated farther from the limbus

- Eyes were anesthetized with topical proparacaine hydrochloride drops
- 0.05 ml (1.25 mg) given intrastromally toward the distal end of the pathologic blood vessels
- 0.05 ml (1.25 mg) given subconjunctivally near the limbus adjacent to the pathologic blood vessels
- Average of 1.7 injections (range 1-3 injections per patient)
- Vessels partially regressed in all patients
- Vessels returned as early as 2 months (range 2-18 months)
- No adverse effects – Minimal pain/discomfort

Patient 3 (unknown keratitis)

PRE-INJECTION BCVA = 20/60
1 week after 1st injection (total of 3 injections) BCVA = 20/50
Reduction of vascularity, but no change in corneal scar

Patient 10 (herpes zoster keratitis)

PRE-INJECTION BCVA = 20/25
4 mos after 1st and only injection BCVA = 20/25
Reduced lipid, reduced vessel caliber and reduced centricity

Patient 9 (neurotrophic keratopathy)

PRE-INJECTION BCVA 20/200
4 mos after 1st and only injection BCVA = 20/70
Significant reduction in vascularity, lipid deposition and centricity
**3 SURGICAL PEARLS**

1. Intracorneal and subconjunctival Avastin is beneficial in regressing corneal vascularization and lipid deposition

2. **Best results**: localized areas of vascularization (2-3 clock hours) + lipid deposition e.g., HSK, HZK, Post-infectious Keratitis

3. Based on the evidence, our current regimen for regressing corneal vascularization consists of 3 injections (subcon and intrastromal) separated by 4-6 weeks and then PRN injections.

**How Does Our Study Compare with Other Research?**

- 67 Studies on Avastin treatment for Corneal Vascularization in humans (N=45) and laboratory animals (N=22)
  - Topical (1-25 mg)
  - Subconjunctival (1.25-5 mg)
  - Intracorneal (1.25-2.5 mg)

- All studies have shown a beneficial effect of Avastin in reducing Corneal Vascularization

**Tarsorraphy**

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Department of Ophthalmology and Vision Sciences

**Indications**

- Exposure keratitis
- Persistent epithelial defects
- Prophylaxis in corneal surgery:
  - Limbal stem cell deficiency
  - Boston type 1 Keratoprosthesis
  - Neurotrophic corneas undergoing corneal grafts
  - Severe dry eye (rheumatoid arthritis, Sjogren’s, GVHD patients)

**Types**

- Temporary
  - Mechanical
  - Pharmacological
- Permanent
Requirements

1) 2% lidocaine + epinephrine, 30G needle
2) Double-armed 5/6-0 nylon (or silk but more inflammatory)
3) Needle driver, toothed forceps, Kelly clamp/Snap, Westcott scissors, blade (for permanent)
4) 2 silicone tubes

Technique

Double Bolster for easy review

- 2 Bolsters are used to increase stability
- The end stitch is tied and held under tape
- Allows for easier reopening and closure
- Best for cases where frequent assessment is needed

Gundersen Flap

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Department of Ophthalmology and Vision Sciences
Indications
- Chronic sterile epithelial and stromal ulcerations
- Stromal herpes simplex virus keratitis
- Chemical and thermal burns
- Keratoconjunctivitis sicca
- Postinfectious ulcers
- Neurotrophic keratopathy
- Closed but unstable corneal wounds
- Painful bullous keratopathy in a patient who is not a good candidate for PK
- A phthisical eye being prepared for a prosthetic shell

Requirements
- Anesthetic eye drops
- Betadine wash
- 2% lignocaine with 1:100,000 epinephrine on 30g needle
- Marking pen
- Lid speculum
- Blunt tip Westcotts scissors
- Forceps (we prefer a Fechtner forceps for handling conjunctiva if available)
- 5/0 silk
- 8/0 vicryl
- Tissue glue (optional)
- BCL (optional)
- Antibiotic drops

Technique
- Topical anesthetic
- Betadine wash
- Lid speculum
- 5/0 silk superior corneal stay suture
- Retract as far as possible inferiorly
- Mark superiorly conj as posterior as possible
- Infiltrate conjunctiva in its entirety
- Create superior flap carefully ensuring no tenons or buttonholes
- 360 peritomy

Post-operatively
- Patch until the following morning then
- Tobradex drops qid until bottle finished
- Follow-up at 1 week and 1 month

Keys to success
- Complete removal of the corneal epithelium and necrotic tissue
- Creation of a mobile, thin conjunctival flap that contains minimal Tenon capsule
- Absence of any conjunctival buttonholes
- Absence of any traction on the flap at its margins that may lead to flap retraction
Chemical Chelation of Band Keratopathy

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Department of Ophthalmology and
Vision Sciences

Chemical Chelation

- Band keratopathy
  - Subepithelial Calcium deposition
  - Causes:
    - Idiopathic, Silicone oil, Inflammation, Phthisis, systemic

Chemical Chelation

- Treatment of Band Keratopathy
  - Indications
    - Pain
    - Epithelial defects
    - DVA
    - Cosmesis

Chemical Chelation

- EDTA
- Weck cell
- Lid Speculum
- Blade
- 0.12 forceps
- BSS
- BCL
Anterior Stromal Puncture
Clara Chan MD
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Recurrent corneal erosion syndrome
- Loose adhesion between corneal epithelium and underlying basement membrane
- Repeat episodes of dislodgment of corneal epithelium
- Primary or secondary

Symptoms and signs
- Pain, photophobia, tearing, redness and decreased vision
- Classically when the patient is awakened from sleep

Non-surgical treatments
- Topical lubricating drops
- Hypertonic saline and ointments
- Inhibitors of MMP’s
- Topical gels
- Corticosteroids
- Autologous serum drops

Surgical intervention
- Superficial keratectomy without a diamond burr
- Anterior stromal puncture
- Phototherapeutic keratectomy (PTK)
Anterior Stromal Puncture

What do we need?

- Anesthetic eye drops
- Short (5/8 inch) 25 Gauge needle
- 1 ml syringe
- Lid speculum
- Antibiotic drops
- BCL

Surgical Technique

- 25 gauge short bent needle
- 5%-10% stromal depth
- Punctures less than 1 mm apart
- No need for special equipment
- No chemicals are used
- Epithelium remains relatively intact - less discomfort

Performing the procedure with fluorescein staining and under cobalt blue light allowed the surgeon to determine that adequate treatment was complete as bubbles could be visualized.
Post-operatively

- BCL: at least 6 weeks *
- Tobradex (Tobramycin 0.3%/Dexamethasone 0.1%) QID until follow-up at 1 week and then tapered over 1 month
- Continue lubrication drops 4 times daily or more as needed (preservative-free drops) and use ointment at night if BCL falls out


Potential risks

- Corneal perforation
- Corneal scarring
- Changes in refractive power
- Topographic irregularities

Questions

Discussion

Pterygium Surgery with Sutured Conjunctival Autografts

David S. Rootman, MD, FRCSC
Professor, University of Toronto

Why Sutures When We Can Glue?

- More secure fixation of autograft
- Less likely to dislocate
- Stretches out a smaller autograft
- Long track record
- No bovine or foreign blood products
- Less messy
- Good suturing practice
- Less expensive

Disadvantages of Sutures

- Takes longer
- More difficult
- Sutures irritate patient
- More likelihood of bleeding
- May have to remove sutures
Seven Principles of Procedure

1. Smooth partial keratectomy
2. Release of Tenon’s capsule constriction
3. Thin autograft
4. Alignment of graft
5. Secure suturing of graft
6. Bandage contact lens

Keratectomy

- As described by Richard Abbott
- 7-0 Silk fixation suture
- Inject under pterygium with 1% xylocaine epi
- Angled cut at anterior edge of pterygium
- Smooth dissection in anterior stroma
- Removal of all scar tissue on cornea
- Similar to making a phaco scleral tunnel

Release of Tenon’s Capsule

- Do not over dissect
- Release medial rectus on both sides
- Allow conjunctiva to slide back to caruncle
- Mark extent of excision
- Minimal removal of conjunctiva
- Stay away from caruncle

Autograft harvesting

- Measure area of resection
- Pull eye downward
- Use Gentian violet to mark area
- Central mark to help orientation
- Rhomboidal shape, wider at posterior edge
- Make graft as thin as possible
Measure autograft

Alignment of Graft
- Slide conjunctiva on cornea, Tenon up
- Appose limbal cells to limbus at site of excision
- Secure with 10-0 monofilament vicryl
- Turn graft over after secured at limbus

Suturing of Autograft
- Secure in all four corners with scleral bite
- Avoid medial rectus to minimize bleeding
- Close nasal conjunctiva to conjunctiva of graft, no scleral bite here
- Close edge to edge superiorly and inferiorly
- No exposed Tenon capsule, prevents granuloma
- Do not advise running suture

Bandage Contact lens
- Apply at end of procedure
- More comfort for patient
- No patch needed
- Leave on for 2 weeks
- Lessens chance of Dellen
- Steroids for 6 weeks qid or until eye white

Conclusions
- Pterygium excision with conjunctival flap is a good procedure with low complication rates
- Using sutures is a good alternative compared with tissue glue
Pterygium Excision and Conjunctival Autograft Utilizing Fibrin Sealant

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Pterygium

- Epidemiology
  - male > female
  - 20-40 age group
  - nasal > temporal
- Genetic predisposition
- Environmental risk factors

Indications for Excision

- Symptomatic (FBS, redness)
- Affecting vision (WTR astigmatism)
- Special consideration in patients undergoing cataract surgery

Conjunctival autograft + Fibrin Sealant

- Tisseel VH
  - Baxter
  - Human component only
- Evicel
  - Ethicon
  - Human component only

Transmission of parovirus B19, hepatitis or human immunodeficiency virus from fibrin glue use during surgery continues to be a theoretic risk despite viral inactivation techniques.

No documented cases of viral transmission have occurred from the use of sealants.
**Tisseel VH 2ml**

**Components**

- **Blue vials:**
  - Sealer Protein Concentrate: freeze dried (Fibrinogen)
  - Apoptosis
- **Black vials:**
  - Thrombin 500 IU
  - Calcium Chloride

**Preheat**

Reconstitute

**Heat Stir and Draw up**

Optional Syringe
DO NOT

- Use for more than 4 hours once reconstituted,
- Store in freezer,
- Heat above 37 degrees,
- Cool or freeze solutions after reconstitution, or
- Use solutions which are cloudy

Postoperative instructions

- Patch X 24 hours
- Instruct them to take the patch off in the morning
- Tobradex ointment qid X 1 week, then Predforte 1% qid
- F/U 1 week, 1 month, 2 months, 3 months

Case

- 71 year old man referred for consideration of a Toric IOL with cataract surgery
- Vision o.d 20/80 +2ns, significant nasal pterygium
Summary

- Advantages
  - Shorter surgical time
  - Less postoperative pain
  - Less postoperative inflammation
  - Possible lower recurrence rate

- Disadvantages
  - Cost
  - Theoretical risk of transmission of BB pathogens

Fibrin sealants are easy to use, simplify surgery and result in better immediate post operative outcomes.

Discussion

Questions

Collagen Crosslinking in Keratoconus

Mario Saldanha

Traditional treatment

- Wait until progresses to visual impairment and then intervene:
  - Spectacles
  - Contact lenses
    - Soft
    - RGP
    - Piggyback
  - Surgery

CXL – revolutionized treatment

- Prevents progression of KC
- CXL is not new
  - First studies took place in Europe
  - Over 13 year experience
- Approved by Health Canada since 2008

CXL

- Strengthens cornea by increasing crosslinking
Standard

• The most accepted - Dresden protocol.


Dresden Protocol

1. The central 7-9mm of the corneal epithelium is debrided.

2. Ultrasound pachymetry (to ensure 400 um).

3. 0.1% iso-osmolar riboflavin in 20% dextran solution is instilled on the corneal surface every 2-3 minutes for 30 minutes.

4. Silt lamp - ensure saturation
5. a sponge ring to protect stem cells.

6. UVA light - photoactivate the riboflavin-imbibed stroma.

7. Irradiation commences for 30 minutes with continued riboflavin instillation every 3 minutes.

8. Alternating applications of balanced saline solution (BSS) and topical anesthetic.

9. Corneal pachymetry is measured at 10, 20, and 30 minutes after riboflavin drops have started - greater than 400 microns.

10. If Pachymetry below 400 microns - hypotonic riboflavin drops

11. Broad-spectrum antibiotic such as moxifloxacin is instilled and a bandage contact lens

Post-op

• Similar to PRK

• BCL for comfort until healing (4-7 days)

• Topical antibiotics, preservative free lubricants and steroid drops

• Opioids and analgesics for pain

• Dexamethasone four times daily for 2-4 weeks, tapering to twice daily for 2-4 weeks depending on the presence or absence of any haze
Follow-up

- Patients are followed up at 1 day, 4-7 days for BCL removal,
- 1 month to monitor for haze, 3 months, 6 months, and 1 year.
- Thereafter, patients are seen every 6 to 12 months to monitor for progression.
- Serial manifest refraction and topography with their optometrist or ophthalmologist.

Results

- CXL halts progression of keratoconus
  - Longest follow-up to date 6 years*
  - Does not return the cornea to its normal state
- Some patients have an improvement in vision
- Flattening effect 3-40 up to 4 years later


Discussion

Questions

THANK YOU FOR ATTENDING