1 Femtosecond Cataract Surgery: Correction of Astigmatism and Complex Cases
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3 Femtosecond Laser Utility in Cataract Surgery
   • Precision Incision
     – Main Incision
     – Paracentesis
     – Capsulotomy
     – Nucleus Disassembly/Chopping
     – Arcuate Incisions for correction of astigmatism

4 Main Incision
   • Triplanar
     – This type of incision cannot be made manually
   • Self-sealing
     – Stronger?

5 Astigmatism Correction
   • Arcuate Incisions in the corneal periphery in the (+) AXIS of astigmatism
     – Term: Peripheral Corneal relaxing incisions
       • PCRI
     – Concept: controlled wound gape

6 Who is a candidate?
   • Generally >.75 D, < 1.50 D of cylinder
     > than 1.25-1.50, consider Toric IOL
     Unless combining astigmatism correction with multifocal IOL
     < .75 consider on axis incision
       2.4 mm incision can correct about .3 diopters

7 Generally in combination with other surgeries
   • Cataract
• Post-lasik enhancement
• PKP?

8 Post-op Target
• < 0.5 Diopters of astigmatism
  – Optical bench testing data on degradation of image for multifocal lens
    • Scott McRae, MD

9 Pre-op testing
• Refraction
• Concept of Coupling
  • Sphere is reduced about ½ of the cylinder
  • Applies to Incisions
• K-readings
• Topography
  • Ideally; should be within 10 degrees of each other
  • Tomography: Posterior Corneal Elevation?
    • Pachymetry
      • Not needed
      • OCT real-time corneal thickness measurement

10 Consent issues
• Pain
• Bleeding (minimal)
• INFECTION
• PERFORATION (RARE)
• LOSS OF VISION
• LASER RELATED CONSENT
  – Under/overcorrection

11 Dry Eye/Keratitis Risk
• Especially against the rule astigmatism
• Corneal innervation at 3 and 9 is interrupted
  – More important as arc length approaches 90 degrees

12 Factors Affecting Astigmatism Correction
• Depth of Cut: must approach 90%
• Length of Cut (Degrees)
• Age: elasticity and biomechanical corneal factors
• Optical Zone: closer to the visual axis, the more effect
  – Too close: can induce irregular astigmatism or glare
– Try to avoid OZ smaller than 7.00 mm

13 Surgical plan
• Base on nomogram
• Nomogram specifies:
  • For a given correction and age of patient, how many degrees should the incision subtend at the given optical zone?
  • Donnenfeld = Starting point
    – Applies to DIAMOND KNIFE INCISIONS at DEPTH of 600 microns and at LIMBUS

14 Nomogram for PKP?
  Nomogram DOES NOT apply to the following:
  – Post lasik LRI
  – Post PKP AK

15 Topography or Surgical Plan
• Bring to OR
• Tape to microscope in surgeon’s orientation
  – If you are sitting at 12, then turn topo upside down so you can visualize proper incision axis placement
  – Operate on + cylinder axis !!
    • Most common error is operating on wrong/incorrect axis

16 Mark
• Mark 180 with overlap of cornea
  – Must be able to see marks after docking
  – Note helpful landmarks in chart
    • Iris nevi, pingeucula, BV, etc.
  – Best way to mark?
    • Sitting up (Cyclotorsion)
    • At slit lamp
    • Landmarks may be helpful

17 Instrumentation
• Solid blade lid speculum
–Keeps lashes out of the way
–Lieberman or wire OK
–Unlike LRI- Do not need Mendez degree marker or fixation device

Docking= Key
• Look for good exposure
  • Lieberman Speculum
  • Same amount of scleral show above and below limbus
• No tilt
  • Avoid chin elevation or tuck
  • Nose straight up and down if possible
• Similar considerations for LASIK/INTRALASE

Avoid:
• Do not adjust X-Y on cornea; try to center patient interface as cornea approached
• Multiple Docks = Chemosis = Poor suction
• Watch for loss of suction or loose conjunctiva

Post Laser: Check the incision
• Length and depth OK?
• Check
  • Look for perforation
  • Avoid placing a Wekcel sponge into the incision if possible (debris)
• If perforation identified
  • AC stable?
  • Microperf versus macro perf?
  • Prophylactic oral antibiotics?
  • Be prepared to suture
    • Always have 10-0 nylon and needle holder, colbri and scissors available as well as BSS to reform AC if necessary

Observations
• Donnenfeld nomogram does not work well for femtosecond arcuate incisions

What have we learned?
• Incisions with the femtosecond laser are not like diamond knife “LRI’s”
  – LRI’s are at different distance from central cornea depending on the corneal diameter
  – Rather consider these incisions as an arcuate keratotomy incision with precise OZ of 9.0 mm PCRI
    • Centered on pupil, not limbus
      – Limbal incisions are a variable distance from the optical center

**Nomogram suggestions**
• Previous Nomogram: Significant Undercorrection
• Current methods:
  – 100% of Donnenfeld nomogram
    • Incisions are now (LONGER)
  – Optical Zone 8.5 mm
    • CLOSER = more effect
    • Leaves room for 8.0 mm OZ PRK
  – Depth: 87% (DEEPER)
    • Perforations at 90%?

**Other considerations**
• There is a mismatch between post op keratometric and refractive astigmatism
  – UCVA and refraction are often better than keratometric astigmatism would suggest
  – Unclear exactly why
  – Removal of lens removes lenticular astigmatism?
  – Posterior corneal astigmatism?

**Therefore**
DO NOT OPEN INCISIONS IMMEDIATELY
• Incisions can be opened to enhance refractive effect
• Wait 1-2 weeks
• Open with Sinsky hook, topical 5% betadine, topical proparacaine in exam room
• Unlike diamond knife incisions; femtosecond laser incision can be adjusted (opened) post-op
26 Case Example

• 67 yr old female

  • Pre-op cyl
    –IOL Master: 1.39 @ 80
    –Topography: 1.03 @ 94

  • Pre-op refraction:
    -1.50 sph (20/30)

27 Case Example

• Femtosecond laser cataract surgery with intraoperative AK

  • 85% DONO, 85% depth, O.Z. 9mm

  • Targeted correction of 1.39 D keratometric astigmatism

  • Arcuates left unopened intraoperatively

28 Case Example

• Post-op week 2:
  -IOL Master: 0.9 D @ 94
  -MRx: pl sph (20/20)

  • HAPPY PATIENT

  • Arcuates left unopened

29 Case Example

• 72 year old male with NSC
• -0.75 +1.25 X 040 20/40
  –K readings: 43.75@65/42.75
• LENSX Correction of astigmatism
  –2 arcuate cuts
Post op Case Example 1
• 1 month out
  – Plano +0.25 X 040
  – K readings 43.25 @ 41/ 43.00
  – Incisions left unopen

Case Example 2
• -18.00 + 3.00 X 098
  – K readings: 48.25 @ 062/ 46.25
  – Target: -1.50
• Underwent LENSX with arcuate incisions
  – Goal: Correct 2 D at about 90 degrees
  – Incisions fully opened

Post op Refraction
• +0.75 + 0.25 X 021 = 20/25

Case Example 3
• -1.00 + 1.50 x 135
• K readings: 44.50 @ 116/43.50
  – Underwent Cataract surgery with LENSX

Post Op Example 3
• Incisions initially unopened
  – Paired 30 degree arcs
• Post op refraction at 1 week
  – -1.00 + 0.75 X 152
  – Incisions opened at slit lamp
    • At 2 months: -1.00 + 1.50 X 145
    • -1.00 + 1.00 X 150 (Autorefract)
      • 43.64 @ 110/43.02

POST PKP ASTIGMATISM
• Case report:
  • 14 diopters of cylinder topography
• LENSX AK
  – Paired 70 degree arc
  – 85% depth
  – 6.75 mm OZ

Conclusions
• The femtosecond laser is capable of making extremely
Femtosecond laser is capable of making extremely precise incisions in terms of shape and depth.
- These incisions are fundamentally different than diamond knife incisions.
- Femtosecond incisions create a potential space that can be opened post-op.

Femtosecond LASER ASSIST: PXE and Loose Zonules
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The author has no financial interest in the material presented.

Clinical History
- 70 year old male with history of pseudoexfoliation
- Obvious phacodenisis on slit lamp exam
- Plan: Femtosecond laser incisions, capsulotomy, and nucleus division followed by phacoemulsification

Factors predisposing to zonular weakness
- Systemic problems
  - Marfan's syndrome
  - Pseudoexfoliation syndrome
- Trauma

Strategies to Address Zonular dehiscence
- Low stress capsulotomy
  - Minimize tangential and centripetal forces if possible
- Low flow phacoemulsification
  - Try to decrease turbulence
- Minimize force used to crack/divide nucleus
- Judicious use of CTR/support rings

Surgical Pearls
- Femtosecond laser allows for capsulotomy and nuclear quadrant division to be performed with minimal zonular stress.
• Iris hooks are used to support the capsule throughout the procedure
• Placement of CTR stabilizes bag and may prevent late dislocation
• Lens support relies on sulcus haptic position and optic capture

42 Conclusions
• The femtosecond laser may have utility in complex cataract cases

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