Update on Femtosecond Laser Cataract Surgery

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Disclosure
I am a consultant for:
- Acufocus
- Allergan
- Alcon
- AMD
- Aquesys
- Bausch & Lomb
- CRST
- Elensa
- Glaukos
- Kala
- L multifocal
- LenSx
- Matt Pharmaceuticals
- Merck

Effectiveness of Modern Cataract Surgery

- Safety
  - Endothelial cell loss
  - Vitreous loss
  - CME
  - Endophthalmitis
  - Retinal detachment
- Efficacy and Accuracy
  - Distance Correction Predictability
  - Biomometry/Keratometry
  - Astigmatism Correction
  - Effective Power of IOL

<table>
<thead>
<tr>
<th>Condition</th>
<th>Incidence</th>
<th>Vision Threatening</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior capsular opacity</td>
<td>0.5%</td>
<td>None</td>
<td>0.0%</td>
</tr>
<tr>
<td>Cystoid macular edema (standard)</td>
<td>0.3%</td>
<td>None</td>
<td>0.0%</td>
</tr>
<tr>
<td>Cortical cataract</td>
<td>0.3%</td>
<td>None</td>
<td>0.0%</td>
</tr>
<tr>
<td>Posterior capsular opacity</td>
<td>1.5%</td>
<td>None</td>
<td>0.0%</td>
</tr>
<tr>
<td>Neovascularization</td>
<td>0.1%</td>
<td>None</td>
<td>0.0%</td>
</tr>
<tr>
<td>Intraocular infection</td>
<td>0.1%</td>
<td>None</td>
<td>0.0%</td>
</tr>
<tr>
<td>Endothelial cell loss</td>
<td>0.1%</td>
<td>None</td>
<td>0.0%</td>
</tr>
<tr>
<td>MAC</td>
<td>0.1%</td>
<td>None</td>
<td>0.0%</td>
</tr>
<tr>
<td>Woundokus</td>
<td>0.1%</td>
<td>None</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Pereira et al. JCRS. 2006 Oct;32(10):1661-66

Femtosecond Cataract Literature Growing

Published Papers on Lenticular or Cataract Surgery Applications for Femtosecond Lasers

Surgical Systems

LenSx®

LensAR™

Catalys™

Victus™
Femtosecond Laser Guided by 3D Imaging

- Key to success is accurate real-time imaging
- Image cornea, iris, lens

Image Guidance Modalities by System

- LISA: Ablative Model. Can visualize multiple views including side view, capsule bag, topographic view, lens, side view, cornea
- Catalys (Abbott): 3D Full Volume OCT; Automated and user adjustable 3D surface identification and treatment customization

Image Guidance Modalities by System

Simple template-based software

Laser Cataract Surgery – 4 Indications and Associated Clinical Benefits

- Capsulotomy - up to 10x more precise
- Lens Fragmentation - ability to soften lens, and reduce ultrasound energy
- Arcuate Incisions for astigmatism correction - more precise control, option for intrastromal incisions
- Cataract Incisions - 3D architecture for better sealability and reproducibility

Manual vs Femtosecond Capsulotomy

Manual Capsulorhexis | Laser Capsulotomy
Potential Implications of an Improved Capsulotomy

- The size, shape, and positioning of the capsulorhexis is a key determinant for effective lens position
- A 0.5mm axial plane deviation from intended ELP results in 1D of refractive error

Precise capsulotomy with optimized location
More accurate & repeatable capsule healing
Better IOL performance
Better visual outcomes

Manual Laser

Improved Architecture Cataract Incisions

- Fully Customizable and adjustable
- Refractive incisions are no longer an art form. They are a science.
- Place Desired Incisions:
  - EXACT Size
  - EXACT Place
  - EXACT Depth

Challenges-Limbal Relaxing Incisions

- Variable and unpredictable treatment and response
  - Imprecise depth, length, angulation and position of incision
  - “LRIs are an art form not a science”

Capsulorhexis- Centration?

Center over the dilated pupil?
Center over the nondilated pupil?
Center over the visual axis?

Challenges-Limbal Relaxing Incisions

- The incisions may be a science but the response remains unpredictable
  - Variable response in incision due to:
    - Age
    - Corneal diameter/curvature
    - Pachymetry
    - Corneal biomechanics
    - IOP

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Femtosecond Laser Arc Incisions are Adjustable

- Full effect of the incision is not achieved until the incision is manually opened
  - Intraoperatively or postop
- Titrate response to laser by adjusting
  - Line separation
  - Spot separation
  - Energy
  - Angulation of incision

Intrastromal Ablations for Astigmatism

- Less effective than full thickness incisions
  - Smaller optical zones
- Bowman’s membrane remains intact
  - Less pain
  - Reduced loss of corneal sensation
  - Less dry eye
  - Greater wound stability
  - No need for antibiotics

Laser Assisted Lens Fragmentation

- Increased ease of nucleus disassembly & phaco can lead to the following benefits:
  - Reduction in phaco energy and time
  - Reduce corneal trauma and endothelial cell loss
  - Reduce risk of capsular tears
  - Increase ability to use I/A alone
  - Faster visual recovery

Starting Laser Nomogram

<table>
<thead>
<tr>
<th>Dosente Field Nomogram for Limbal</th>
<th>Nomogram for 9 mm Arc Incisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50 D 1 Incision, 1.5 Clock Hours (60 Deg. Each)</td>
<td>1 Incision, 1 Clock Hours (30 Deg. Each)</td>
</tr>
<tr>
<td>0.75 D 2 Incisions, 1 Clock Hour (30 Deg. Each)</td>
<td>2 Incisions, 2/3 Clock Hour (20 Deg. Each)</td>
</tr>
<tr>
<td>1.00 D 2 Incisions, 2 Clock Hours (60 Deg. Each)</td>
<td>2 Incisions, 1 1/3 Clock Hours (40 Deg. Each)</td>
</tr>
<tr>
<td>1.00 D 2 Incision, 3 Clock Hours (90 Deg. Each)</td>
<td>2 Incision, 2 Clock Hours (60 Deg. Each)</td>
</tr>
</tbody>
</table>

*Use 5 degrees more for against-the-rule astigmatism
*Use 5 degrees more for younger patients
*Use 5 degrees less for older patients

Conclusions

- LRIs and arcuate incisions are now playing an increasingly important role in refractive cataract surgery
- Manual LRIs can be performed in the office
- Femtosecond arcuate incisions may now be made at the time of cataract surgery with increased precision and safety
- Intrastromal arcuate incisions will play an important role in astigmatism management

Reduced Phaco Energy and Endothelial Loss

- 46% reduction in phaco power
- 28% decrease in endothelial loss following laser cataract surgery vs. manual

Source: Gass, Royal Hawaiian Eye Meeting Presentation, January 2011.
Lens fragmentation drives excellent outcomes

Complete softening of the cataract that enables a fluidics-driven lens removal, providing a gentle procedure with minimal trauma to the eye

- Can segment and completely soften the nucleus with minimal gas generation
- Fragmentation volume maximized
- User-adjustable grid spacing (100-2000 microns)
- Fast and easy cortical removal
- Minimal corneal edema and inflammation postoperatively

Optimized Grid Softening Reduces EPT 86%

Advantages of Laser Cataract Surgery

Complicated Eyes

- Dense nuclear cataracts
- Shallow anterior chambers
- Weak zonules
- Fuchs’ corneal dystrophy
Complications

Sub Conjunctival Hemorrhage
- More likely in older patients
- Suction pressure dependent
- Time dependent
- Vasoconstrictors may be helpful

Pupil Constriction
- Maximal preop dilation
- Preop NSAID to help maintain dilation
- 10% Neo for poorly dilating pupils
- Avoid lasering capsule within 0.5 mm of iris
- Perform lens removal within 1 hour of femtosecond laser
- Intracameral epinephrine preservative free (1:5,000) if pupil constricts

Incomplete Capsulotomy
- Newer software decreases this risk
- Evaluate CCC edge and use cystatome or forceps to confirm completion
- Do not hydrodissect until confirmed complete or a radial tear may develop
- If incomplete, complete with forcep or cystatome

Capsular Block Syndrome
- More likely due to:
  - Perfectly round capsulotomy
    - No specific point for fluid to escape
  - “Fluffed-up” cortex at capsulotomy edge blocks fluid egress
  - Bubbles in capsular bag already creates intralenticular pressure
  - Avoid excessive hydrodissection

Conclusion
Femtosecond Cataract Surgery
- Novel technology provides image-guided laser cataract surgery.
- Computer-controlled and laser accurate incisions
  - Intrastromal incisions and self sealing wounds
- Precise capsulotomies which can be optimized for improved refractive results
- Reduced phacoemulsion time and energy
- New IOL designs will be coming