Laser Refractive Cataract Surgery

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History of Cataract Surgery

- Sushruta performed couching 800 BC
  • Sushruta Samhita (सुश्रुतसंहिता)
- Jaques Daviel invented ECCE 1747
- Sir Harold Ridley implanted first posterior chamber IOL 1950
- Charles Kelman introduced phacoemulsification in 1967
Charles Kelman, 1967

Charles Kelman, 1967
Phaco 1967 - What is next?

*Laser Refractive Cataract Surgery*

- using a femtosecond laser!
  - 2008: first surgery performed in Budapest by Zoltan Nagy using **Alcon LenSx** laser
  - 2009: **Alcon LenSx** first laser to receive FDA approval for cataract surgery

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My Personal Experience

- **Alcon LenSx** laser
- Surgery performed in Budapest, Hungary
- **Alcon LenSx** laser in Mannheim since 7-2011
OR Setup, Mannheim, Germany

OR Setup, Mannheim, Germany
Why Laser Refractive Cataract Surgery?

- Capsulorhexis
- Lens fragmentation / liquefaction
- Corneal incisions
- Astigmatism correction
CAPSULORHEXIS

Ideal Capsulorhexis

- Reproducible size and shape, well centered

Current Manual Capsulorhexis

<table>
<thead>
<tr>
<th>Too large</th>
<th>Too small</th>
<th>Irregular shape</th>
<th>Off center</th>
</tr>
</thead>
<tbody>
<tr>
<td>No capsule-IOL overlap</td>
<td>Phimosis</td>
<td>IOL tilt</td>
<td>IOL decentration</td>
</tr>
<tr>
<td>IOL tilt</td>
<td>Difficult phaco maneuver</td>
<td>IOL decentration</td>
<td>Edge catches visual axis</td>
</tr>
</tbody>
</table>
### Laser Capsulorhexis

**Capsulotomy Diameter Accuracy**

<table>
<thead>
<tr>
<th>Diameter Error (mm)</th>
<th>Laser (n=60)</th>
<th>Manual (n=60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.25</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>0.25</td>
<td>90</td>
<td>10</td>
</tr>
<tr>
<td>0.5</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>0.75</td>
<td>70</td>
<td>30</td>
</tr>
<tr>
<td>1.0</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>1.25</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>1.5</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>2.0</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>2.5</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>3.0</td>
<td>10</td>
<td>90</td>
</tr>
</tbody>
</table>

Only 10% of manual rhesis achieved diameter accuracy of +/- 0.25mm
**LenSx Laser Capsulorhexis**

Manual capsulorhexis  
LenSx laser capsulorhexis

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**Peer-Reviewed Literature**
First Paper on LRCS published 2009!

**Initial Clinical Evaluation of an Intraocular Femtosecond Laser in Cataract Surgery**

Nagy Z, Takacs A, Filkorn T, Sarayba M

*J Refract Surg* 2009; 25:1053-1060

- 8 procine eyes each group, 5-mm CCC using corneal mark
- CCC stretched with calipers, ratio calculated

**Laser CCC slightly stronger than manual**

- Laser CCC ratio 2.13 +/-0.03 (range, 2.07 – 2.17)
- Manual CCC ratio 1.98 +/-0.08 (range, 1.84 – 2.09)
Capsulotomy Shape and Diameter

  Femtosecond laser capsulotomy and manual CCC parameters and their effects on IOL centration
  *J Refract Surg* 2011; 27:558-563
- Laser CCC 20 eyes, Manual CCC 20 eyes; 1 year data
- Vertical and horizontal diameter an capsule overlap measured with Adobe Photoshop

**Circularity of CCC better after Laser CCC**
**Greater IOL / capsule overlap after Laser CCC**
Comparison of Intraocular Lens Decentration Parameters After Femtosecond and Manual Capsulotomies

Nagy Z, Kranitz K, Takacs A, Mihaltz K, Kovacs I, Knorz MC

Comparison of IOL decentration parameters after femtosecond and manual capsulotomies

J Refract Surg 2011; 27:564-569

Laser CCC 54 eyes, Manual CCC 57 eyes

Circularity and IOL decentration at 1 week (Adobe Photoshop)

Axial length and ACD with Lenstar LS 900 (Haag-Strait)

Circularity of CCC better after Laser CCC

Better IOL centration after Laser CCC
Internal Aberrations and Optical Quality After Femtosecond Laser Anterior Capsulotomy in Cataract Surgery


Higher-order aberrations and optical quality after femtosecond laser anterior capsulotomy in cataract surgery

J Refract Surg 2011; 27:711-716

48 eyes Laser CCC, 51 eyes Manual CCC;

OPD-Scan (Nidek) performed at 6 months

Significantly lower tilt and coma after Laser CCC

Significantly higher MTF and Strehl ratio after Laser CCC
CAPSULOTOMY STUDY FINDINGS

Fewer Higher Order Aberrations and Better Quality of Vision with LenSx® Laser compared to Manual Group

<table>
<thead>
<tr>
<th></th>
<th>Manual</th>
<th>Femtosecond</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal Tilt</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vertical</td>
<td>0.27±0.57</td>
<td>-0.05±0.36</td>
<td>0.006</td>
</tr>
<tr>
<td>horizontal</td>
<td>0.15±0.59</td>
<td>0.16±0.63</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td><strong>Internal Coma</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vertical</td>
<td>0.10±0.15</td>
<td>0.003±0.11</td>
<td>0.006</td>
</tr>
<tr>
<td>horizontal</td>
<td>0.03±0.18</td>
<td>0.06±0.11</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td><strong>Ocular Tilt</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vertical</td>
<td>0.09±0.44</td>
<td>-0.08±0.35</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>horizontal</td>
<td>0.10±0.49</td>
<td>0.16±0.39</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td><strong>Ocular Coma</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vertical</td>
<td>0.04±0.19</td>
<td>-0.02±0.16</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>horizontal</td>
<td>-0.01±0.16</td>
<td>0.02±0.14</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

Significantly Smaller

LENS FRAGMENTATION / LIQUEFACTION
Liquefy and Chop Pattern

**Liquefy**
- Used for softer lenses (to Grade 2)
- Number of cylinders customizable

**Chop**
- Generally used for harder lenses (grade 3, 4+)
- Number of cuts customizable

Hybrid Technique
Hybrid Pattern

- Combination of liquefaction and chop patterns
- Efficient for all cataract grades
- Rapid lens removal with minimal phaco required
- Preferred pattern for surgeons going forward

Phaco vs LenSx Laser

- 43% reduction
- 51% reduction
Phaco vs LenSx Laser

- 28% lower endothelial cell loss in Laser group compared to Phaco group (one month postop)
LenSx Laser Corneal Incision

PostOp OCT image of LenSx 2-plane corneal incision

Laser Incisions

Laser incisions are more architecturally reproducible and have greater self-sealing properties

Percentage of Eyes Requiring Stromal Hydration

- Laser Two-Plane Incision (n=42)
- Manual Two-Plane Incision (n=33)
ASTIGMATISM CORRECTION

Treatment of Pre-Existing Astigmatism

Figure 55: Frequency of Surgical Treatments for Astigmatism

Source: Market Scope Q1:2011 Survey of Cataract Surgeons

“Cataract and refractive surgeons report that between 5 and 30% of their patients require LASIK, LRI or some other secondary enhancement procedure in order to improve their visual outcomes.” 2011 Market Scope Global IOL report.
Manual Arcuate Incision

Traditional, handheld Diamond Knife

- Manually executed by “tracing” corneal marks
- Inconsistent depth control
- Poorly predictable

LenSx Laser Arcuate Incisions

Image-guided with 3D visualization

- 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
  - Every Time
LenSx® Laser Arcuate Incision

• Square edge
• Uniform depth (no ripples)
• Precise, reproducible
  – Arc shape
  – Arc length
  – Diameter

Courtesy Dr. Eric Donnenfeld
Double-Angle Plot

Pre OP (n=14)
- Keratometric Centroid: +0.08D @ 17° ± 0.59D, ρ = 1.82

Post OP (n=14)
- Refractive Centroid: +0.26D x 178° ± 0.23D, ρ = 0.45

MARKET POTENTIAL
Issues to Consider

- Can the market support another premium technology?
- Do we need a laser to improve our clinical performance?
- Will our patients understand and embrace the technology?

Global Cataract Market

[Bar chart showing global cataract surgery forecast from 2007 to 2014.]

Data: Market Scope 2009 Report
How we market LRCS

Welcome to the Future!

Laser Refractive Cataract Surgery

A combination of premium technologies
A premium opportunity for surgeons and patients
Conclusions

- Laser Refractive Cataract Surgery increases safety and efficacy of cataract removal
- Laser fragmentation requires less phaco power and preserves endothelial cells
- Laser CCC improves IOL centration
- Laser-created incisions correct astigmatism