Nomogram Development of Femtosecond Laser Arcuate Incisions for ReLACS

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Relevant Financial Disclosures

• Abbott Medical Optics A
• Optimedica Corporation R
• Surgisite Boston, LLC A, R
• Wavetec Visions A, R

Why use a femtosecond laser for incisions?

- Manual LRI variability:
  - Positioning (axis, centration)
  - Architecture (angulation, depth)

- Laser Cataract Surgery offers:
  - Reproducible cut positioning and quality
  - Micron level consistent depth precision
  - Intrastromal incision option
  - Integration w/ capsulotomy, fragmentation

What are the results of Manual LRIs?

- 100 eyes w K Cyl > 0.5 D WTR and 0.75 D ATR
  - Avg correction of 60% WTR/ATR; 23% Oblique
  - 50% overcorrections (7/14) were oblique
  - Conclusion: Oblique incision axis placement suboptimal.
**Placing a Precise Incision: Parameter Planning with Arcuate Incisions**

Axis range: 0 - 360 degree
Optical zone: 2 mm – 11 mm
Length: 10 - 120 degrees

**Validated Depth Accuracy**

Significance:
- HIGH correlation to optical microscopy
- HIGHLY accurate automated surface fits

**Precision Data - Arcuate incisions (N=14):**
- OPTICAL ZONE: Within 0.83 ± 0.66 % of intended
- AXIS: Within 0.22 ± 0.20 degrees of intended
- LENGTH: Within 0.22 ± 0.29 degrees of intended

Study and images by Prof. Burkhard Dick, MD. University Eye Clinic. Bochum, Germany
Basic Procedure: Placing Incisions

1. Align suction ring with corneal marks
2. Set axis, optical zone, centration and length
3. Confirm depth on 3D OCT cross section

Built in Cyclorotation Compensation-some systems

Process:
1. Align suction ring with corneal marks
2. System recognizes marks on suction ring and automatically adjusts axis of incisions

FS Laser Creates New Flexibility

Side Cut Angle: 90°
Side Cut Angle: 120°

Patients and Methods

- n = 49 eyes/mean age 67 + 10 yrs (38-84)
- Donnenfeld nomogram x 2/3 (www.lricalculator.com)
- Image guided FS laser using liquid immersion PI
- Ant penetrating incisions/80% depth by OCT
- 9.0 mm OZ centered on limbus/Incisions opened in OR
- Compared Preop Corneal (AK) w PO Refractive Astig
- Results analyzed w Alpins Assort Vector analysis software

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Results

<table>
<thead>
<tr>
<th></th>
<th>Preop Corneal Cyl</th>
<th>Postop Refractive Cyl</th>
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<tbody>
<tr>
<td>Mean ± SD</td>
<td>1.05 ± 0.57</td>
<td>0.63 ± 0.44</td>
</tr>
<tr>
<td>Range</td>
<td>0.5 to 4.0</td>
<td>0.0 to 2.25</td>
</tr>
</tbody>
</table>

N = 49

Preop Corneal Cyl minus Postop Refractive Cyl (D)

| Mean ± SD | 0.42 ± 0.50 |
| Range     | -0.50 to 1.75 |

P < 0.0001 (Paired Student’s t Test)

Results

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<td>0.0 to 1.63</td>
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</tbody>
</table>

N = 49

Preop Corneal Cyl minus Postop Corneal Cyl (D)

| Mean ± SD | 0.33 ± 0.55 |
| Range     | -0.55 to 2.37 |

P < 0.001

Alpins Assort Software

- Vector analysis
- TIA = Target Induced Astigmatism
- SIA = Surgically Induced Astigmatism
- CI = Correction index = SIA/TIA
- ME = Magnitude of error = SIA - TIA

= 49 eyes
1-2 months postoperative

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*Gills manual LRI = 23% 0.5 D or less
Alpins Assort Correction Index = SIA/TIA = 0.84

Mean achieved correction = 91% of intended

Alpins Assort WTR CI

Mean achieved correction = 64% of intended

Magnitude of Error (ME) analysis

• No eye overcorrected by > 1 D
• Overcorrection $> 0.5$ D & $< 1$ D $3/49 = 6$
• All significant over-corrections began as WTR astigmatism
ReLACS Spherical Equivalent Attempted vs Achieved

\[ y = 1.0164x + 0.0612 \]
\[ R^2 = 0.6327 \]

Achieved Spherical Equivalent Refraction (D)
Attempted Spherical Equivalent Refraction (D)

43/49 eyes = 88% + 0.5 D of target MRSE

LRIs during ReLACS

Conclusions

• Effective for low to moderate regular anterior corneal astigmatism – complement toric IOL use. No significant coupling.

• This nomogram specific to ANT PENETRATING incisions w laser system, parameters discussed herein.

• Role of posterior corneal astigmatism is important: Significant UNDER correction in ATR cases (25% of sample size).

• Recommend 70% WTR, 110% ATR Donnenfeld nomogram. Ongoing analysis will allow further refinement.

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