Internal Limb Lengthening in Congenital Shortening

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Disclosures

• Device Developers (JH, SS)
• Paid Consultant - Ellipse Technologies, Inc. (SS)
• Royalties Received (SS)
Intramedullary Lengthening World

The holy grail is an internal controllable lengthening device.
Intramedullary Lengthening World

congenital shortening

PRECICE®
Background - Precice

FDA approved 2011 (rod)

**Modular Device**
- Actuator (magnetic motor)
- Extension pieces
- Maximum stroke = 6.5 cm
- Diameters 10.7, 12.5 mm
Precice mechanism sketched on a napkin by the engineer-inventor, Scott Pool.

Long Term Project - 2009

**PRECICE™**
**Intramedullary Limb Lengthening System**

<table>
<thead>
<tr>
<th>Nail Approach</th>
<th>Drill Guide Configuration</th>
<th>Overall Length (mm)</th>
<th>10.7 mm</th>
<th>12.5 mm</th>
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</thead>
<tbody>
<tr>
<td>Retrograde Femur (10°)</td>
<td></td>
<td>230</td>
<td>ERA1-230</td>
<td>ERA2-230</td>
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<td>Antegrade Tibia (10°)</td>
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<td>ERC1-230</td>
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<td>Antegrade Femur (Trochanteric 5°)</td>
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</table>

**Locking Screws:**
- 5.0 mm (GREEN)
- 4.0 mm (BLUE)
Congenital Limb Lengthening

- Underlying acetabular dysplasia
- Congenital instability of joints
  - absent ACL / PCL of knee
- Presence of tight soft tissue
  - Rectus Femoris Tendon / TFL
  - Iliotibial Band
  - Fibular Anlage
  - Gastrocsoleus Complex
- Need for extensive lengthening
Congenital Limb Lengthening
“Must Do List”

- Correct acetabular dysplasia

- Reconstruction of knee ligaments
  - grossly unstable knee joints

- Prophylactic release- soft tissue
  - Rectus Femoris Tendon / TFL
  - Iliotibial Band
  - Fibular Anlage
  - Gastrocsoleus Complex

- ALWAYS bridge the unstable joint with Ex Fix
Thou shalt bridge all unstable joints with external fixation.

Thou shalt maintain knee motion with bracing as needed.
Baltimore Congenital Experience

- Total # rods = 76 rods
  - Congenital Shortening = 32 patients / 43 rods
  - 33 femurs / 10 tibias
- To date - 19 patients / 27 rods completed
- 11 females, 8 males
- Age = 16.5 years (range 9-27 years)
- 22 femur, 5 tibia
Etiology

PFFD/ Fib. Hemi 15
Achondroplasia 4
19
Results (PRELIMINARY)

- Length Gained= Average 5.0 cms (range 2.5-7.5 cms)
- 27/27 limbs completed lengthening
- 25/27 limbs completed healing (FWB)
- The electronic remote controller (ERC) demonstrated excellent accuracy and control
- Lengthening goal was achieved in all patients
## Range of Motion (knee)

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Average Pre-operative</th>
<th>Average Immediate Post-lengthening</th>
<th>Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee Extension</td>
<td>+1.7°</td>
<td>-1.6°</td>
<td>3.3°</td>
</tr>
<tr>
<td>Knee Flexion</td>
<td>123°</td>
<td>99°</td>
<td>24°</td>
</tr>
</tbody>
</table>
Range of Motion (hip)

All hips (with one exception) have regained pre-operative hip ROM
• 15 y.o. girl, CFD/fibular hemimelia

• LLD 4.0 cm femur
   LLD 3.5 cm tibia

• Valgus femur and tibia
Lengthening complete (40 mm femur, 35 mm tibia, 40 days)
No complications
6 months post-surgery
• Post- Precice Removal
(9 months post-insertion)
<table>
<thead>
<tr>
<th>Complications</th>
<th># Limbs Affected</th>
<th>How Resolved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Leg Swelling</td>
<td>1</td>
<td>Readmission to hospital for pain control</td>
</tr>
<tr>
<td>Rotatory Knee Subluxation</td>
<td>1</td>
<td>Ligament reconstruction/soft tissue release</td>
</tr>
<tr>
<td>Locking Screw Pain</td>
<td>1</td>
<td>Screw revision, then removal</td>
</tr>
<tr>
<td>Delayed Healing</td>
<td>2</td>
<td>Stem cell injection (1) RIA bone graft (1)</td>
</tr>
<tr>
<td>Failure to lengthen/preconsolidation</td>
<td>1</td>
<td>Exchange rod/re-osteotomy</td>
</tr>
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## Complications

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<tr>
<td>Hip Subluxation</td>
<td>1</td>
<td>Articulated Ex Fix with Hip distraction and subsequent synthetic ligament reconstruction</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7</strong></td>
<td><strong>All resolved</strong></td>
</tr>
</tbody>
</table>
Retrograde Femur

- 16 y.o. female, CFD
- LLD = 6.5 cms
- Retrograde femur
- Lengthening and valgus correction
Rotatory subluxation (after 2.5 cm)
Solution: PCL extra-articular reconstruction

Lengthening after PCL reconstruction

6 weeks post-lengthening

6 months post-lengthening
Complications: Avoidance Strategies

- Perform necessary preparatory surgery
  - correct acetabular dysplasia
  - reconstruct knee ligaments
  - release offending soft tissues
    - rectus femoris, TFL, ITB, fibular anlage, gastrocsoleus
- Regimen and adequate physical therapy
- Close follow up during distraction phase (q 2 wk)
- Functional bracing - especially night-time
Bracing Strategies

• Pre-operative sizing and construction
  - made prophylactically for patients with joint instability

• HKAFO / KAFO
  - for hip, knee, or ankle

• Custom Knee or Ankle device
  - CKD - custom knee device
  - CAD - custom ankle device
Custom Knee (CKD) and Ankle (CAD) Devices

- Custom made hinged knee/ankle brace
  - provides a slow stretch over time
  - worn intermittently during the day
  - worn full time at night
- Prevents or treats joint contractures
Conclusions: Precice IM Lengthening

• Can be performed safely and effectively in patients with congenital shortening

• Frequent f/u and regimented physical therapy are imperative

• Static or dynamic bracing should be employed especially at night

• Preparatory surgery must be addressed for safe lengthening
THE END
Typical Post-op Patient Management

- Hospital stay 2-4 days
- Begin lengthening 5-7 days after surgery
- 5 days/week PT (while lengthening)
- X-rays every 1-2 weeks
- Weightbearing up to 50 lbs.

Typical Lengthening Rate
- Femur (1 mm/day)
- Tibia (.75 mm/day)
Patient Management

• Once lengthening is complete, f/u q.4 weeks

• Can reduce to PT 3x/week if ROM and muscle strength indicate

• Increased to full weightbearing when 3/4 cortices healed

• Rod removal suggested @ 12-18 months
BILATERAL FEMUR

15 y.o. boy, achondroplasia

Plan:
- 6.5 cm femur lengthening
- 6.5 cm tibia lengthening and varus correction
15 y.o. Achondroplasia
Despite acute lengthening of 1.0 cms, patient healed w/o complication

*10 day Latency period before lengthening

Total Length Gain = 14 cm

7 months post-surgery
15 y.o. Achondroplasia