Acute Deformity Correction and Lengthening with a Magnetic Intramedullary Lengthening Nail

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Disclosures

• No external support funded this study.
• Dr. Standard is a consultant for NuVasive.
• Dr. Conway is a consultant for Biomet, DePuy, and Cerament.
• Dr. Herzenberg is a consultant for Orthofix, Orthopediatrics, Smith Nephew, and NuVasive.
Background

- *simultaneous* deformity correction and lengthening can be done with external fixators.

- IM telescopic nails have gained popularity for lengthening, but can they also simultaneously correct deformity?
PRECICE intramedullary lengthening system

- Available since 2011
- Powered by rotating magnets
- Able to compress and distract
## Lengthening Nails and Deformity Correction: Literature Review

<table>
<thead>
<tr>
<th>Author</th>
<th>Nail</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Küçükkaya (2015)</td>
<td>Fitbone</td>
<td>9/25 (36%)</td>
</tr>
<tr>
<td>AL-Sayyad (2012)</td>
<td>Fitbone</td>
<td>3/14 (21%)</td>
</tr>
<tr>
<td>Thaller (2014)</td>
<td>Phenix</td>
<td>3/10 (30%)</td>
</tr>
<tr>
<td>Kenawey (2011)</td>
<td>ISKD</td>
<td>28/57 (37%)</td>
</tr>
<tr>
<td><strong>Current study</strong></td>
<td><strong>PRECICE</strong></td>
<td><strong>29/29 (100%)</strong></td>
</tr>
</tbody>
</table>
Methods

• Retrospective IRB approved study
• January 2012 – August 2015
• Exclusion criteria:
  - Lengthening without simultaneous acute deformity correction
  - Def. correction planned at time of nail removal
  - Skeletally immature patients with guided growth plates
Patients

- 25 patients (10 males / 15 females)
- 29 segments (18 femurs / 11 tibias)
- Mean age = 17 years (8 - 49 years)
- Mean goal of lengthening = 4.7 cm (1 - 8 cm)
- Mean angular deformity (16/29) = 7° (4° - 11°)
- Mean rotational deformity (12/29) = 18° (10° - 45°)
- Angular + rotational deformity = 1/29
LLRS AIM Index (CORR 2013)
Complexity

- **Moderate (25%)**:  
  - Ø4 (femur)  
  - Ø3 (tibia)

- **Mild (75%)**:  
  - Ø14 (femur)  
  - Ø8 (tibia)
## Etiologies

<table>
<thead>
<tr>
<th>Etiology</th>
<th>Number of segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFD/FH</td>
<td>14</td>
</tr>
<tr>
<td>Achondroplasia</td>
<td>5</td>
</tr>
<tr>
<td>Post traumatic limb shortening</td>
<td>3</td>
</tr>
<tr>
<td>Skeletal Dysplasia</td>
<td>3</td>
</tr>
<tr>
<td>LLD/Clubfoot</td>
<td>2</td>
</tr>
<tr>
<td>Marfan syndrome</td>
<td>1</td>
</tr>
<tr>
<td>Perthes disease</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>29</strong></td>
</tr>
</tbody>
</table>
Fixator assisted nailing (FAN)
Rotational control with pins and spirit level
Femur Results

Frontal plane

Sagittal plane

LDFA

Degrees

Pre

Post

Normal values

Varus

Valgus

Procurvatum

PDFA

Degrees

Pre

Post

Normal values
Tibia Results

Frontal plane

Sagittal plane

MPTA

Degrees

Pre

Post

Normal values

Valgus

PPTA

Degrees

Pre

Post

Normal values

Procurvatum
# Limb Lengthening Results

<table>
<thead>
<tr>
<th></th>
<th>Femurs (18 segments)</th>
<th>Tibias (11 segments)</th>
<th>p - value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of segments achieved desired lengthening</td>
<td>16/18 (89%)</td>
<td>11/11 (100%)</td>
<td>-</td>
</tr>
<tr>
<td>Consolidation Index (CI)</td>
<td>37 days/cm (17 – 65 days/cm)</td>
<td>52 days/cm (24 -108 days/cm)</td>
<td>0.08</td>
</tr>
<tr>
<td>Distraction Index</td>
<td>0.7 mm/day (0.4 to 0.9 mm/day)</td>
<td>0.6 mm/day (0.4 to 1.2 mm/day)</td>
<td>0.39</td>
</tr>
<tr>
<td>Complications</td>
<td>8/18 (44.4%)</td>
<td>4/11 (36.4%)</td>
<td>0.67</td>
</tr>
<tr>
<td>Implant related complications</td>
<td>6.9% (2 rod failures)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
20-year-old female with right CFD, LLD of 4.5 cm, 11° distal femur valgus

Immediate post-operative

After complete distraction
After healing

LDFA 79°

90°
## Complications

<table>
<thead>
<tr>
<th>Complications</th>
<th>Femurs (18 segments)</th>
<th>Tibias (11 segments)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delayed Union</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Subluxation</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Nerve Compression</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Loss of rod fixation</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Rod Failure</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
13-year-old female (history of clubfoot) with left tibial shortening 3 cm and 20°ITT

Pre-op

After complete distraction

Non-union anterior lateral tibia

Bone graft, nail dynamization
Complete healing 10 months after index surgery
In our study

• Acute deformity correction plus lengthening gave similar healing index to pure lengthening.

• Acute deformity correction plus lengthening gave similar complication rates to pure lengthening.

• Using FAN, blocking screws, and torsional control pins, we achieved excellent accuracy of correction.
Conclusion

• The PRECICE IM lengthening system allows both lengthening as well as acute angular, rotational, or combined deformity correction, within limits.
• Accurate pre-operative planning, FAN techniques, and blocking screws are the keys to achieve these results.