Equalization of Limb Length Discrepancy using Growth Arrest vs Intramedullary Lengthening

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Introduction

• Limb length discrepancy (LLD) in children can be related to post-traumatic, congenital or developmental causes.

• Surgical treatment options in the growing child include:
  1. Epiphysiodesis (growth arrest)
  2. Lengthening
## Comparison between Permanent Epiphysiodesis and Limb Lengthening

<table>
<thead>
<tr>
<th></th>
<th>Epiphysiodesis</th>
<th>Limb Lengthening</th>
</tr>
</thead>
<tbody>
<tr>
<td>O.R. time and hospital stay</td>
<td>less</td>
<td>more</td>
</tr>
<tr>
<td>Complications</td>
<td>less</td>
<td>more</td>
</tr>
<tr>
<td>Post-op ambulation</td>
<td>immediate FWB</td>
<td>PWB for months</td>
</tr>
<tr>
<td>Need for physiotherapy</td>
<td>One –two weeks</td>
<td>3-6 months</td>
</tr>
<tr>
<td>Cost</td>
<td>less</td>
<td>more</td>
</tr>
<tr>
<td>LLD</td>
<td>2 to 4 cm</td>
<td>any</td>
</tr>
<tr>
<td>Accuracy</td>
<td>less accurate</td>
<td>more accurate</td>
</tr>
<tr>
<td>Age</td>
<td>only skeletally immature with adequate growth remaining</td>
<td>No limit</td>
</tr>
<tr>
<td>Impact on height</td>
<td>Sacrifice some height</td>
<td>preserve full height</td>
</tr>
</tbody>
</table>
LEG LENGTH INEQUALITY

• 1-2 cm… shoe lift

• > 2 cm
  - shorten the long leg
  - lengthen the short leg
Permanent Epiphysiodesis

- Performed with drilling/curettage
- Used to equalize LLD between 2 - 5 cm
## Accuracy of Epiphysiodesis

Residual LLD at skeletal maturity compared to initial predicted LLD using various methods

<table>
<thead>
<tr>
<th>Article</th>
<th>Year</th>
<th>LLD (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little et al.</td>
<td>1997</td>
<td>39% (0 – 1.5), 34% (&gt; 1.5), 27% (&gt; 2.0)</td>
</tr>
<tr>
<td>Aguilar et al.</td>
<td>2005</td>
<td>87% (0 – 2.0), 13% (&gt;2.0)</td>
</tr>
<tr>
<td>Lee et al.</td>
<td>2013</td>
<td>47.7 (&lt;1.1), 40.9% (1.1 – 2.0), 11.4% (&gt;2.0)</td>
</tr>
</tbody>
</table>
IM Limb Lengthening

- Internal Lengthening Nails
- PRECICE intramedullary limb lengthening system
The Dilemma

• There are cases where the choice between performing epiphysiodesis or limb lengthening is clear.

• It is unknown whether the advantages and inaccuracy (and need for subsequent surgical correction) of epiphysiodesis outweigh the disadvantages (complications) and accuracy of limb lengthening.
The purpose of our study

Compare the accuracy of LLD correction at maturity for epiphysiodesis vs IM lengthening.
Methods

- Retrospective chart and x-ray review

- Inclusion criteria for epiphysiodesis group (Group A):
  - patients who had distal femur or proximal tibia epiphysiodesis with the intent of segment equalization
  - followed until skeletal maturity.

n= 26 patients included
Inclusion criteria for IM nail group (Group B):

- patients between 14 and 18 years old
- a segmental (femur or tibial) LLD of 2-5 cm that could have potentially been treated with epiphysiodesis at immaturity to eliminate the need for the current lengthening.

n= 24 patients included
• The Multiplier Method used to determine age at which patients were to undergo epiphysiodesis.

• Percutaneous epiphysiodesis was performed using the drilling and curettage technique.

• The intramedullary nail was magnetic, telescopic.
11 y.o. girl FH/CFD with 2 cm femoral LLD epiphysiodesis with the intention of equalization of the femur segment.

Planned for tibial lengthening and deformity correction.
15 y.o. boy with a 3 cm femoral LLD undergoing IM nail lengthening with the intention of equalization of the limb.
# Results

## Segment LLD Pre and Post-operatively

<table>
<thead>
<tr>
<th>Method</th>
<th>LLD before surgery</th>
<th>LLD at maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epiphysiodesis (N = 26)</td>
<td>2.2 cm (range, 0.8 – 4.5 cm)</td>
<td>1.1 cm (range, 0 – 4.0 cm)</td>
</tr>
<tr>
<td>IM lengthening nail (N = 24)</td>
<td>3.6 cm (range, 2.0 – 4.7 cm)</td>
<td>-0.03 cm (range, - 0.8 – 0.8 cm)</td>
</tr>
</tbody>
</table>
Comparison of Segment LLD Remaining at maturity after treatment between the two methods

<table>
<thead>
<tr>
<th>LLD Remaining (cm)</th>
<th>Epiphysiodesis, at maturity (N = 26)</th>
<th>IM Nail post-treatment (N= 24)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>=/&gt; 1.5</td>
<td>10/26 (39 %)</td>
<td>0</td>
<td>0.0007</td>
</tr>
<tr>
<td>1 – 1.49</td>
<td>5/26 (19 %)</td>
<td>0</td>
<td>0.0300</td>
</tr>
<tr>
<td>0.3 – 0.99</td>
<td>5/26 (19 %)</td>
<td>2/24 (8%)</td>
<td>0.26</td>
</tr>
<tr>
<td>0 – 0.299</td>
<td>6/26 (23%)</td>
<td>16/24 (67%)</td>
<td>0.002</td>
</tr>
<tr>
<td>- 0.01 – (- 0.2)</td>
<td>0/26 (0 %)</td>
<td>3/24 (13%)</td>
<td>0.06</td>
</tr>
<tr>
<td>- 0.21 – (- 0.8)</td>
<td>0/26 (0 %)</td>
<td>3/24 (13%)</td>
<td>0.38</td>
</tr>
</tbody>
</table>

Results

58 % 0 %
Complications

• No complications were reported in Group A

• Group B had 8 complications requiring surgery:
  – 4 delayed / partial union
    ➢ treated with Bone Marrow Concentrate injection
  – 1 mal-union
    ➢ treated with fixator assisted plating
  – 1 hip contracture
    ➢ treated with botox injection
  – 1 peroneal nerve involvement
    ➢ requiring decompression
  – 1 anterior compartment syndrome
    ➢ requiring fasciotomy and delayed primary closure.
Limitations

- Retrospective, non-randomized.

- The number of patients in both groups is relatively low. 
  ➢ *This is due to strict exclusion criteria that allowed for the groups to be comparable.*

- Institution is a specialized limb lengthening center which could create a bias in favor of lengthening.
Interpretation

- Our data showed:
  - Although there are fewer complications, many patients that undergo epiphysiodesis still have a significant residual LLD at maturity.
  - Although IM nail lengthening is accurate, one third of patients experienced a complication that required surgical intervention.

- It is unclear whether performing epiphysiodesis is more advantageous than simply waiting to perform limb lengthening at maturity in the same population.

Accuracy vs Safety

- A future long term study should be performed
Conclusion

• Decision regarding epiphyseodesis vs. lengthening should be individualized.
• Do not project your biases (height bias) onto the child/family.
• Lengthening with PRECICE is more accurate than epiphyseodesis.
• *Lengthening has many more complications than epiphyseodesis.*