Effects and Complications of Percutaneous Epiphysiodesis with Transphyseal Screw in the Management of LLD

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What is PETS?

- Percutaneous Epiphysiodesis with Transphyseal Screw (PETS)

- First described by Metaizeau (1998)
Bright side vs. Dark side

- **Low postop. morbidity**
  - Short incision / Short op time / Less postop. pain / Short hospital stay / Early ambulation & full weight bearing /

- **Reversible & versatile**

  vs.

- **Directly involve the physis**
Angular Deformity Correction by Asymmetrical Physeal Suppression in Growing Children: Stapling Versus Percutaneous Transphyseal Screw

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JPO, 2010
Purpose

To analyze effects and complications of PETS in the management of LLD
Materials

- Inclusion criteria:
  1. Management of LLD
  2. Followed until skeletal maturity or screw removal
  3. Not combined with other bony procedures
- 59 patients
  - 36 boys (13.7±1.10 yrs), 23 girls (11.8±0.64 yrs)
  - 69 physes (50 distal femur, 19 proximal tibia)
## Etiology

<table>
<thead>
<tr>
<th>Condition</th>
<th>Overgrowth</th>
<th>Undergrowth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital hemihypertrophy</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Post-traumatic</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>LCPD</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Post-infectious</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Neurofibromatosis</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>DDH</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>HME</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Congenital hemimelia</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>SCFE</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Paralytic</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Congenital pseudoarthrosis of the tibia</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Congenital hemihypotrophy</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>McCune-Albright syndrome</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
Methods

- Measurements from the medical record and teleradiograph
  - Segment length & LLD at operation
  - Chronologic age at operation
  - Final segment length & LLD *with* PETS
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- Measurements from the medical record and teleradiograph
  - Segment length & LLD at operation
  - Chronologic age at operation
  - Final segment length & LLD with PETS

- Retrospective growth calculations using multiplier method
  - Optimal epiphysiodesis timing
  - Predicted segment length & LLD without PETS
  - Predicted segment length with PETS
  - Estimated shortening of segment by PETS
Evaluate effects of the PETS (n = 57, late comers excluded)

- Definition of “Efficacy”

\[
\text{Efficacy in the femoral group (\%)} = \frac{(\text{predicted length without PETS} - \text{final length}) \times 100}{(\text{predicted length without PETS} - \text{length at operation}) \times 0.71}
\]

\[
\text{Efficacy in the tibial group (\%)} = \frac{(\text{predicted length without PETS} - \text{final length}) \times 100}{(\text{predicted length without PETS} - \text{length at operation}) \times 0.57}
\]

- Predicted segment length with PETS vs. Final

- Final LLD with PETS
Methods

- Screw insertion angle in 3-D

\[ \tan \gamma = \frac{\sin \alpha}{\sqrt{(\frac{\sin \alpha}{\tan \beta})^2 + \cos^2}} \]

- Average \( \gamma \) angle = \( \frac{\text{medial } \gamma + \text{lateral } \gamma}{2} \)

- Compare efficacy between two groups
  average \( \gamma \) angle \( \geq \) vs. < median value
Methods

- Complications
  - Angular deformity
    - MAD changes to other zone
    - > 5° angular differences on LDFA, MTPA
  - Screw dislodgement from the epiphysis
  - Difficulty or failure of the screw removal
    - Need instrument(s) other than screw driver
    - Final failure to remove
  - Overcorrection: reverse LLD > 10mm
  - Undercorrection: residual LLD > 10mm
  - Persistent pain, infection, neurological injury, or hematoma
Results

Operation timing

Epiphysiodesis timing calculated by multiplier method

Mean

N=48

Latecomers: excluded

N=11

-3.5 -3.0 -2.5 -2.0 -1.5 -1.0 -0.5 0.5 1.0 1.5 year

Epiphysiodesis timing calculated by multiplier method

N=48

N=11
Results

Estimated shortening (cm)

**Femur (N=42)**

At operation: 2.4cm
Final: 45cm

**Predicted /s PETS**

**Tibia (N=15)**

At operation: 1.4cm
Final: 40cm

**Predicted /s PETS**
Results

Efficacy (%)

![Box plots showing efficacy comparison between Femur (N=42) and Tibia (N=15).](image)
Results

Final length was larger than predicted by multiplier method in most cases.

- Femur (N=42): Predicted PETS = 46.0, Final = 46.7, \( P<0.001 \)
- Tibia (N=15): Predicted PETS = 37.3, Final = 37.7, \( P=0.0139 \)
Results

LLD (mm) (N=48)

At operation

Final

Predicted /s PETS

Predicted /c PETS

19

21

5.5
Results

Efficacy via screw insertion angle (independent t-test)

Femur
(N=42)

Tibia
(N=15)

Screw insertion angle

>= median
< median

P=0.003
P=0.298
Results

- Complications (25)

- Development of angular deformity
- Screw dislodgement
- Difficulty or failure of removal
- Overcorrection
- Undercorrection
- Pain, infection, neurologic, hematoma
Results

Screw dislodgement + development of angular deformity
Results

Difficulty or failure of the screw removal
Discussion

- Effect of PETS is delayed.
  - 89% inhibition in DF, 95% in PT (Metaizeau, 1998)
  - 66% inhibition in DF and PT (Illharreborde, 2012)
  - 76% inhibition in DF, 80% in PT (current study)

*PETS will under-correct LLD if performed as predicted by multiplier method.*
Technical Points

- Retrograde guide pin insertion
- Screws cross at different coronal planes
- Screws penetrated one-fourth of the physeal width at coronal plane
- Screws centered at sagittal plane
- Screws as vertical as possible
- Screws as symmetrical as possible
- As many threads in the epiphysis as possible
- Sufficient thread height preferred
- Screw head large enough
- Screw heads away from the cortex
- Reverse cutting thread preferred
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6.5 mm titanium screw  
7.0 mm stainless steel screws
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7.0 mm stainless steel screw
Summary

- PETS is a minimally invasive and effective method in the management of LLD.

- Considering its delayed effect, we recommend to perform PETS at least 1 year earlier than calculated by multiplier method.

- Efficacy may be affected by the screw insertion angle.

- Detailed technical points should be kept in mind to minimize complications.
경청해주셔서 감사합니다.