Reliability of Proximal Junctional Kyphosis Measurements for Early Onset Scoliosis

Ammar Al Khudairy
Luke Gauthier
Jacob Matz
John Heflin
Ron El-Hawary
Disclosures

- **Ron El-Hawary**
  - Consultant: Depuy-Synthes, Medtronic, Halifax Biomedical
  - Institutional Research Support: Depuy-Synthes, Medtronic

- **Ammar Al Khudairy**
  - Nothing to disclose

- **Luke Gauthier**
  - Nothing to disclose

- **Jacob Matz**
  - Nothing to disclose

- **John Heflin**
  - Nothing to disclose
Introduction

- Proximal Junctional Kyphosis (PJK) is a complication of growth friendly surgery.
  - May lead to pre-mature implant failure.
  - May affect choice of Upper Instrumented Vertebrae (UIV) at definitive fusion.
Introduction

- Incidence of PJK in distraction-based surgery is not established and its definition has varied in recent studies (ICEOS 2011)
  - CWSDSG\(^{(1)}\) 31% **Spine-based**
  - Skaggs\(^{(2)}\) 56% **Spine-based**
  - CWSDSG\(^{(1)}\) 25% **Rib-based**
  - Karlin\(^{(3)}\) 7% **Rib-based**
To use three recently used definitions to report the rates of PJK for a single group of children treated with growth friendly surgery.

To define the variability associated with these measurements.
Methods

- A multicentre review of radiographs of 36 patients with scoliosis treated with posterior distraction-based surgery.

- Inclusion criteria
  - Age 6 months – 10 years at time of diagnosis
  - Open tri-radiate cartilages
  - Treated with distraction-based implants
  - At least 2 years follow up
Methods

- Three radiographic definitions of PJK
  - Two raters

- Radiographic Measurement
  - (Pre-op, Immediate post-op, 2 years post-op)

- Reproducibility
  - 20 random radiographs
  - 14 days apart
  - Intra- and inter-observer agreement
  - (Wilcoxon Signed Ranks Test and Kappa analysis)
PJK Definitions

- **Definition A**  PJA $\geq 10^\circ$ between the caudal endplate of UIV to the cranial endplate of the second proximal vertebrae AND PJA $\geq 10^\circ$ greater than pre-operatively

- **Definition B**  PJA $> 10^\circ$ between the caudal endplate of 2 vertebrae below the UIV to the cranial endplate of 2 vertebrae above the UIV AND PJA $\geq 10^\circ$ greater than pre-operatively

- **Definition C**  PJA $> 20^\circ$ between the caudal endplate of the UIV to the cranial endplate of the first proximal vertebrae

- PJA: Proximal Junctional Angle
Results

- Mean age at the time of surgery was 5.7 yrs.
- Rates of PJK between Rib–based and Spine–based implant was similar.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Rate of PJK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition A</td>
<td>8 %</td>
</tr>
<tr>
<td>Definition B</td>
<td>33 %</td>
</tr>
<tr>
<td>Definition C</td>
<td>3 %</td>
</tr>
</tbody>
</table>
## Results

<table>
<thead>
<tr>
<th>Definition</th>
<th>Inter-Observer Agreement</th>
<th>Intra-Observer Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>50%</td>
<td>31%</td>
</tr>
<tr>
<td>B</td>
<td>41%</td>
<td>48%</td>
</tr>
<tr>
<td>C</td>
<td>47%</td>
<td>68%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Definition</th>
<th>Inter-Observer Agreement</th>
<th>Intra-Observer Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Moderate</td>
<td>Poor</td>
</tr>
<tr>
<td>B</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>C</td>
<td>Poor</td>
<td>Moderate</td>
</tr>
</tbody>
</table>
Discussion

- There is little evidence available on PJK for distraction-based surgery for EOS.
- Current definitions of PJK yield variable results and demonstrate moderate inter and intra-rater agreement at best.
Discussion

- Increasing the number of segments measured could contribute to an increased rate of PJK.

- **Definition A**
  - PJK = 8%

- **Definition B**
  - PJK = 33%

- **Definition C**
  - PJK = 3%
UIV level close to the cervical–thoracic junction could affect PJA measurements and reliability.

- Lordotic–kyphotic junction
- Anatomical crowding in the upper thoracic region
Conclusions

- For the same cohort of patients, different definitions for PJK resulted in different rates of PJK (3%–33%).

- Poor inter-rater agreement was found
  - Except for definition A (moderate)

- Poor intra-rater agreement was found
  - Except for definition C (moderate).

- Efforts should be made to unify a definition for PJK.
Thank You


# Results

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Odds Ratio</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition A &amp; B</td>
<td>0.18</td>
<td>0.009</td>
</tr>
<tr>
<td>Definition A &amp; C</td>
<td>3.00</td>
<td>0.303</td>
</tr>
<tr>
<td>Definition B &amp; C</td>
<td>16.67</td>
<td>0.001</td>
</tr>
</tbody>
</table>