Management of the Complex:
How to Approach the Complex Patients and Problems in EOS

Proximal Junctional Kyphosis with Anchor Failure

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Disclosures

• Grants / Research Support
  • Depuy-Synthes Spine
  • Medtronic Canada
  • Joint Solutions
  • EOS Imaging

• Consultant
  • Depuy-Synthes Spine
  • Medtronic Canada
  • Apifix Ltd.
  • Wishbone Medical
  • Globus Medical
2008 – 2 Year Old Girl with Infantile Idiopathic Scoliosis
December 2013
August 2014
General Definition of PJK

- Non-physiologic, sagittal plane angulation that occurs cephalad to an instrumented spine.

Yagi et al., Spine, 2011
What is the Risk of Developing Proximal Junctional Kyphosis During Growth Friendly Treatments for Early-onset Scoliosis?

Ron El-Hawary, MD, MSc, FRCSC,* Peter Sturm, MD,† Patrick Cahill, MD,‡
Amer Samdani, MD,‡ Michael Vitale, MD, MPH,§ Peter Gabos, MD,¶ Nathan Bodin, MD,¶
Charles d’Amato, MD,# Colin Harris, MD,** Ammar Al Khudairy, MBChB, MRCSI, MCh,*
and John T. Smith, MD††

• Subjects with PJK (Pre-Insertion)
  • Older Age
  • Higher Thoracic Kyphosis
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- Subjects with PJK (Post-Insertion)
  - Increased Cervical Lordosis
  - Normal Thoracic Kyphosis
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• Subjects with PJK (Final Follow Up)
  • Increased Cervical Lordosis / Increased PJA
  • Normal Thoracic Kyphosis / Increase +SVA
Pre-Operative Hyperkyphosis

- Subjects with PJK
Definition of PJK

- Abnormal Proximal Junctional Kyphosis
  - PJA $\geq 10^\circ$ and at least $10^\circ$ greater than pre-operative

Glattes et al., Spine 2005
Yagi et al., Spine, 2011
Other Definitions of PJK

• Abnormal Proximal Junctional Kyphosis
  • PJA (2 below UIV and 2 levels cephalad UIV) >10° and at least 10° greater than pre-operative.
Other Definitions of PJK

- Abnormal Proximal Junctional Kyphosis
  - PJA (UIV to one level cephalad to UIV) > 20°
ICEOS 2011 – 3 PJK Studies

• **Definition 1 = 28% risk**
  • (PJA) ≥ 10° and PJA at least 10° greater than pre-op

• **Definition 2 = 56% risk**
  • 2 below UIV to 2 above UIV > 10° and 10° greater than Pre-op

• **Definition 3 = 7% risk**
  • UIV to one cephalad to UIV > 20°

• Definition vs. Sample
Reliability of Proximal Junctional Kyphosis Measurements for Young Children With Scoliosis

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• Same Sample
• Definition 1 = 21%
• Definition 2 = 39%
• Definition 3 = 7%
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• PJK (Inter Observer)

• Definition 1 = Kappa 0.31 Fair
• Definition 2 = Kappa 0.40 Moderate
• Definition 3 = Kappa 0.38 Fair
PJA T1 vs. T2 (Intra Observer)

- Definition 1 = ICC 0.61  Good
- Definition 2 = ICC 0.82  Excellent
- Definition 3 = ICC 0.69  Good
Clinical Effects of PJK

Implant failure which requires **superior extension** of the upper instrumented level during revision surgery.
Superior Extension of Upper Instrumented Vertebrae in Distraction-based Surgery: A Surrogate for Clinically Significant Proximal Junctional Kyphosis

Nadim Joukhadar, MD\textsuperscript{a}, Ozren Kubat, MD\textsuperscript{b}, John Heflin, MD\textsuperscript{c}, Mohamad S. Yasin, MD\textsuperscript{d}, Anna McClung, RN\textsuperscript{e}, Tara Flynn, BSc\textsuperscript{f}, Megan Sheppard, BSc, MSc\textsuperscript{g}, David Skaggs, MD\textsuperscript{h}, Ron El-Hawary, MD\textsuperscript{d,e}

![Image of X-ray with markings]
419 patients with pre-op age of 5.6 years
5.2-year rib vs. 6.0-year spine (p<0.001)

Scoliosis 73°
69° rib vs 77° spine (p<0.001)

Kyphosis 51°
47° rib vs 56° spine (p<0.01)
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<table>
<thead>
<tr>
<th></th>
<th>Rib-based</th>
<th>Spine-based</th>
<th>( p )</th>
<th>Total</th>
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<tbody>
<tr>
<td>Number of subjects</td>
<td>219</td>
<td>200</td>
<td></td>
<td>419</td>
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<tr>
<td>Preoperative age (years)</td>
<td>5.2</td>
<td>6.0</td>
<td>&lt; .001</td>
<td>5.6</td>
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<tr>
<td>Preoperative scoliosis (°)</td>
<td>69</td>
<td>77</td>
<td>&lt; .001</td>
<td>73</td>
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<tr>
<td>Preoperative kyphosis (°)</td>
<td>47</td>
<td>56</td>
<td>&lt; .01</td>
<td>51</td>
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<tr>
<td>Clinical risk of PJK (%)</td>
<td>24</td>
<td>15</td>
<td>.03</td>
<td>20</td>
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</table>
Regression analysis demonstrated that these differences in age, scoliosis, and kyphosis between anchor type did not account for a significant proportion of the measured variance.
20% risk of developing clinically significant PJK

24% Rib-based proximal anchors
15% Spine-based proximal anchors
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![Graph showing data comparison for different types of spinal conditions.](image-url)
Implant Failure?
... or Rib Hook Drift?
August 2014 – Surgery (Not UPROR)
August 2014

• Medial Rod Exchange
  • Extended to T2 (wire), T3 rib hook and T5 lateral rib hook
  • Distal screws exchanged for larger diameter screws
The Future?
Summary

- PJK can occur during distraction-based surgery.
  - 28% risk with Traditional Growth Friendly
  - 12% risk with MCGR

- Reports of PJK vary depending upon definition
  - In EOS, most reliable definition of PJK/PJA
    - 2 above UIL to 2 below UIL
    - Moderate Inter-Rater Variability
    - Excellent Intra-Rater Variability
Summary

• Consider superior extension of upper instrumented level as surrogate for clinically significant PJK.

• 20% risk of clinically significant PJK with traditional growth friendly implants.
Thank You
At 24-month evaluation, PJK developed in 4 of 33 (12%) patients.
Rib Hook Drift