Proximal Junctional Kyphosis in Early Onset Scoliosis

Ron El-Hawary, MD, MSc, FRCS(C)
IWK Health Centre
Halifax, Nova Scotia, Canada

8th International Congress on Early Onset Scoliosis
November 2014, Warsaw, Poland

Disclosures

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

- Consultant
  - Depuy-Synthes Spine
  - Medtronic Canada
  - Halifax Biomedical Inc.

Overview

- PJK Definitions
  - Adult
  - Paediatric
- PJK Studies – Radiographic
- PJK Studies – Variability
- PJK Studies – Clinical Significance

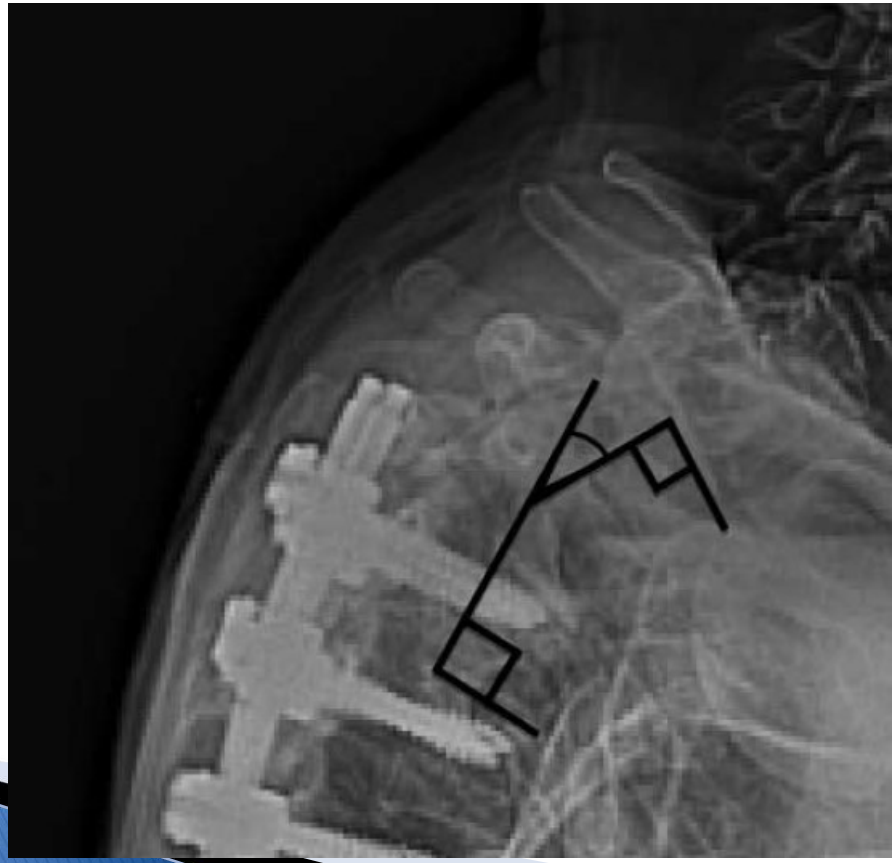
PJK – Non EOS Deformity

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

Yagi et al., Spine, 2011

PJA – Non EOS Deformity

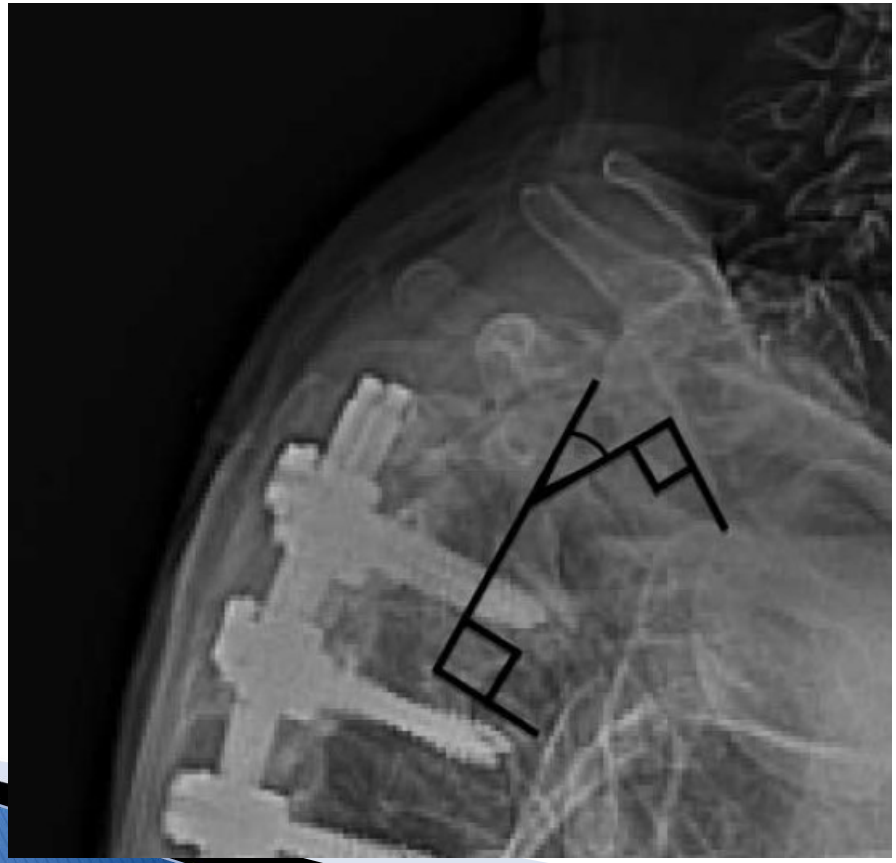
- Proximal Junctional Angle (PJA)
  - Caudal endplate of the upper instrumented vertebra (UIV) and the cephalad endplate of 2 levels above the UIV



Yagi et al., Spine, 2011

PJK – Non EOS Deformity

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



Yagi et al., Spine, 2011

PJK – Non EOS Deformity

- Systematic Review – 7 Studies
- PJK Incidence 17% – 39%
- Risk Factors
  - Increased age
  - Fusion to sacrum
  - Combined ASF/PSFI
  - Thoracoplasty
  - UIV at T1-T3
  - Non-Anatomic restoration of thoracic kyphosis

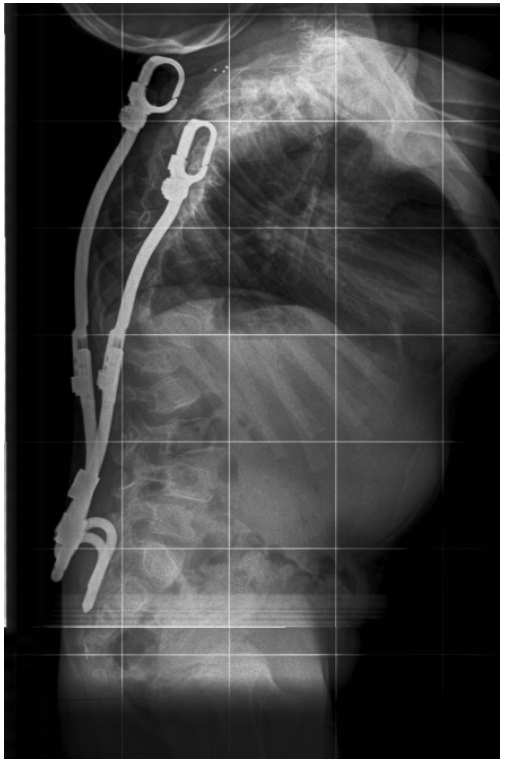
Kim et al., Spine, 2012

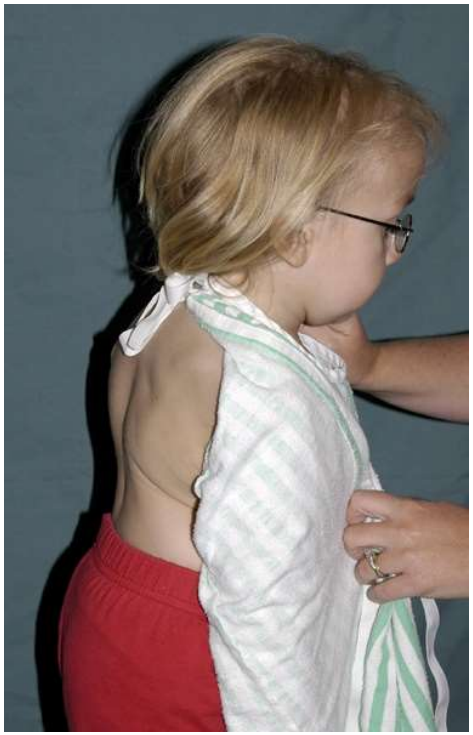
PJK – Non EOS Deformity

- Systematic Review – 7 Studies
- PJK Incidence 17% – 39%
- No Association
  - Type of implants used at proximal level

Kim et al., Spine, 2012

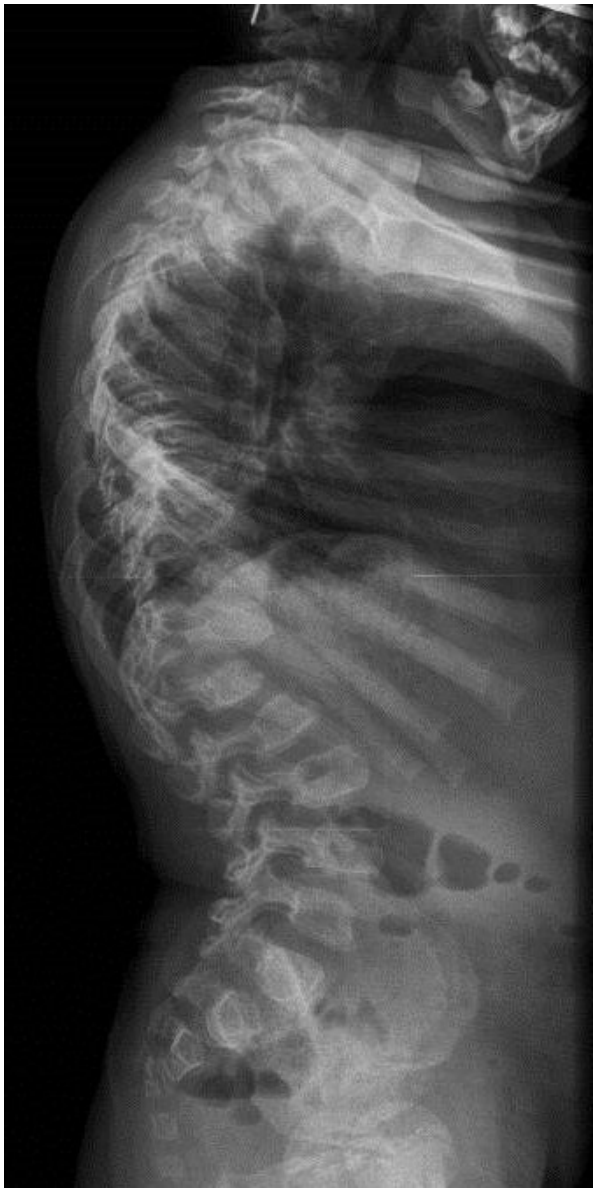
PJK – Early Onset Scoliosis



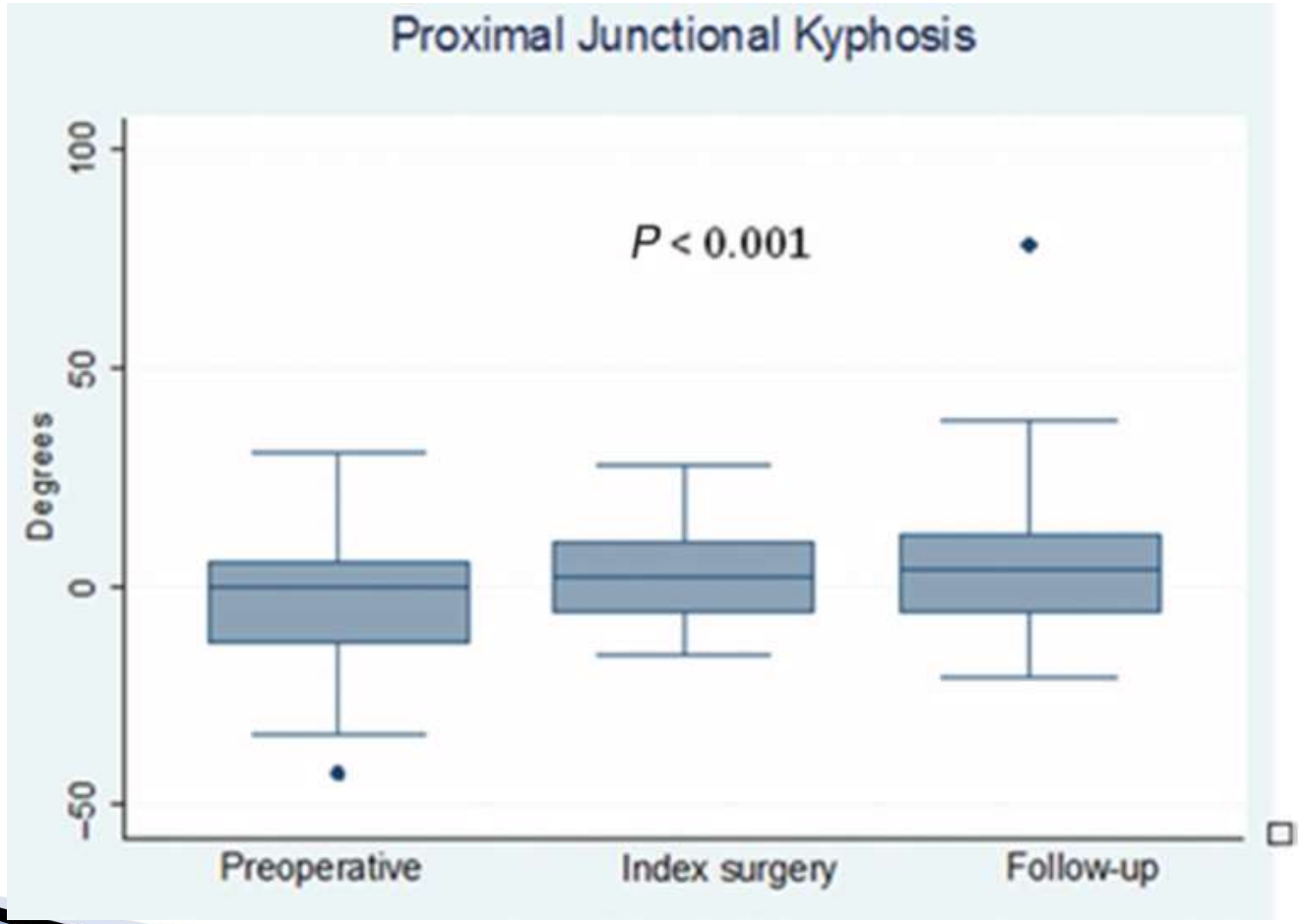


PJK – Early Onset Scoliosis

- Related to pre-operative sagittal-plane alignment?
- Related to surgical factors?
- Posterior Distraction Surgery
  - ?Kyphogenic



The Effect of Serial Growing Rod Lengthening on the Sagittal Profile and Pelvic Parameters in Early-Onset Scoliosis



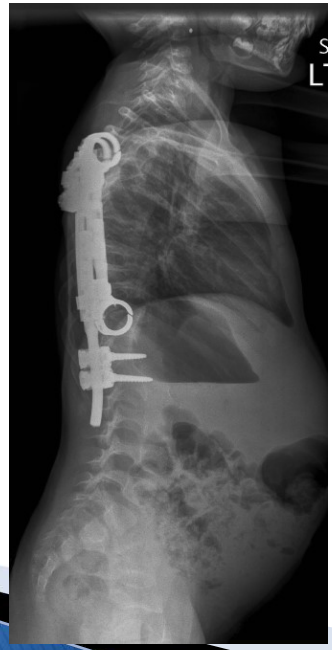
Shah et al., Spine Deformity 2014

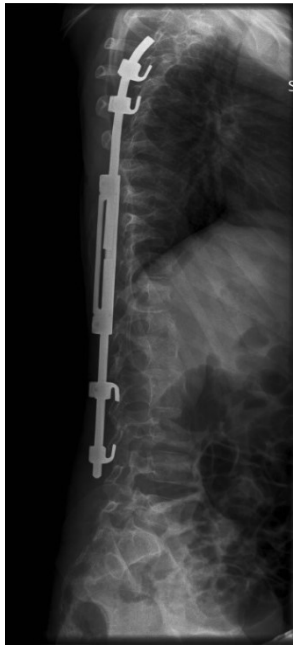
CSSG Study

CHILDREN'S SPINE STUDY GROUP

- Pre-operative and minimum 2-year follow-up

- N= 40 children with EOS:
  - 24 subjects – Rib-based.
  - 16 subjects – Spine-based.





CSSG Study

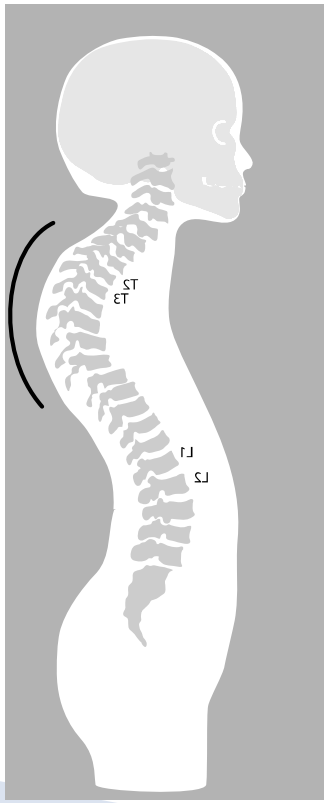
CHILDREN'S SPINE STUDY GROUP

- PJK – 27.5% of patients (11 of 40)
  - 6 treated with Rib-Based
  - 5 treated with Spine-Based
- Rib-Based 25% with PJK (6 of 24)
- Spine-Based 31% with PJK (5 of 16)
- No significant difference between treatment groups

CSSG Study

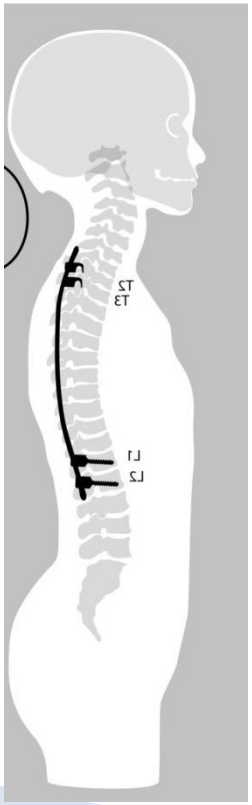
CHILDREN'S SPINE STUDY GROUP

- Subjects with PJK (Pre-Insertion)
  - Older Age
  - Higher Thoracic Kyphosis



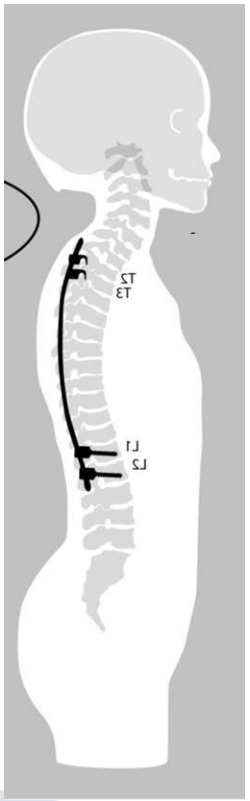
CSSG Study

- Subjects with PJK (Post-Insertion)
  - Increased Cervical Lordosis
  - Normal Thoracic Kyphosis



CSSG Study

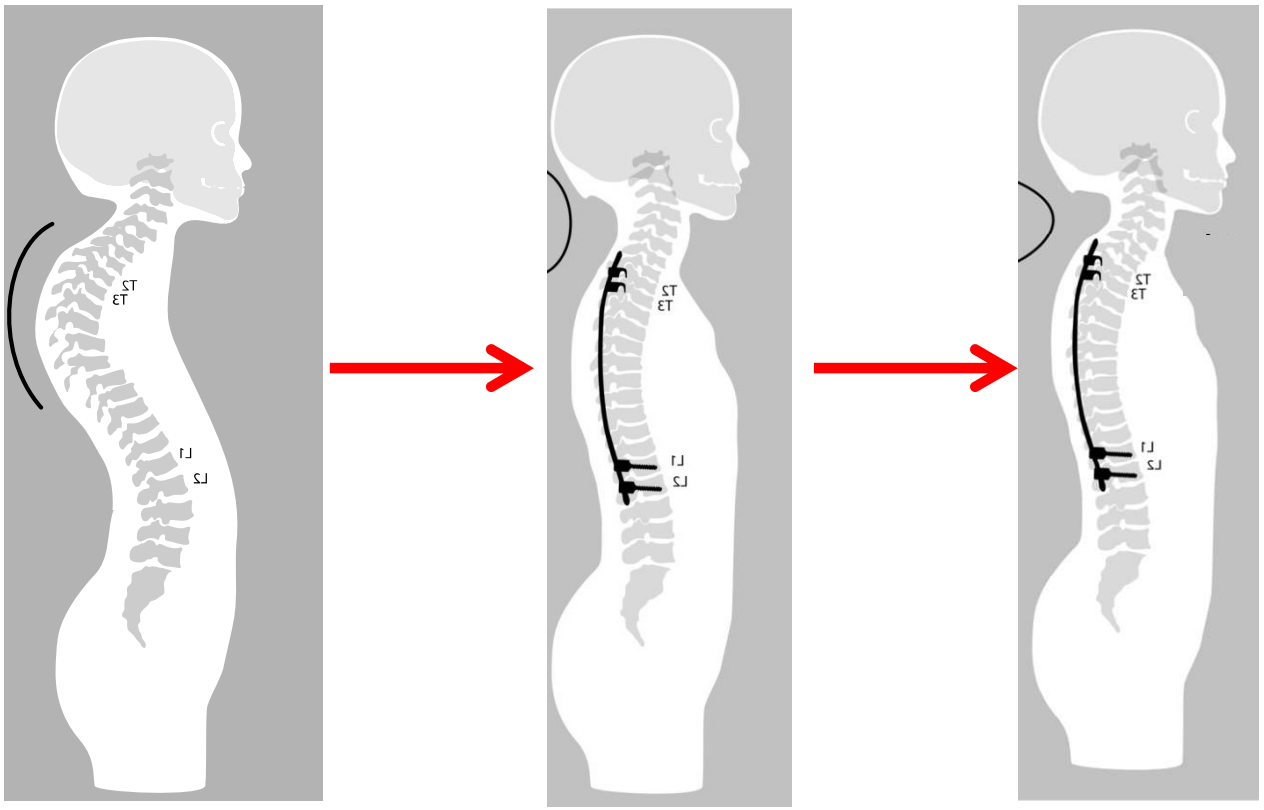
- Subjects with PJK (Final Follow Up)
  - Increased Cervical Lordosis / Increased PJA
  - Normal Thoracic Kyphosis / Increase +SVA



CSSG Study

CHILDREN'S SPINE STUDY GROUP

- Subjects with PJK



ICEOS 2011 – Spinal GR

- Skaggs
  - 2 below UIV to 2 above UIV > 10 degrees and 10 degrees greater than pre-op.
  - 56% rate.

- CSSG
  - (PJA) ≥ 10° and PJA at least 10° greater than pre-op
  - 31% rate.

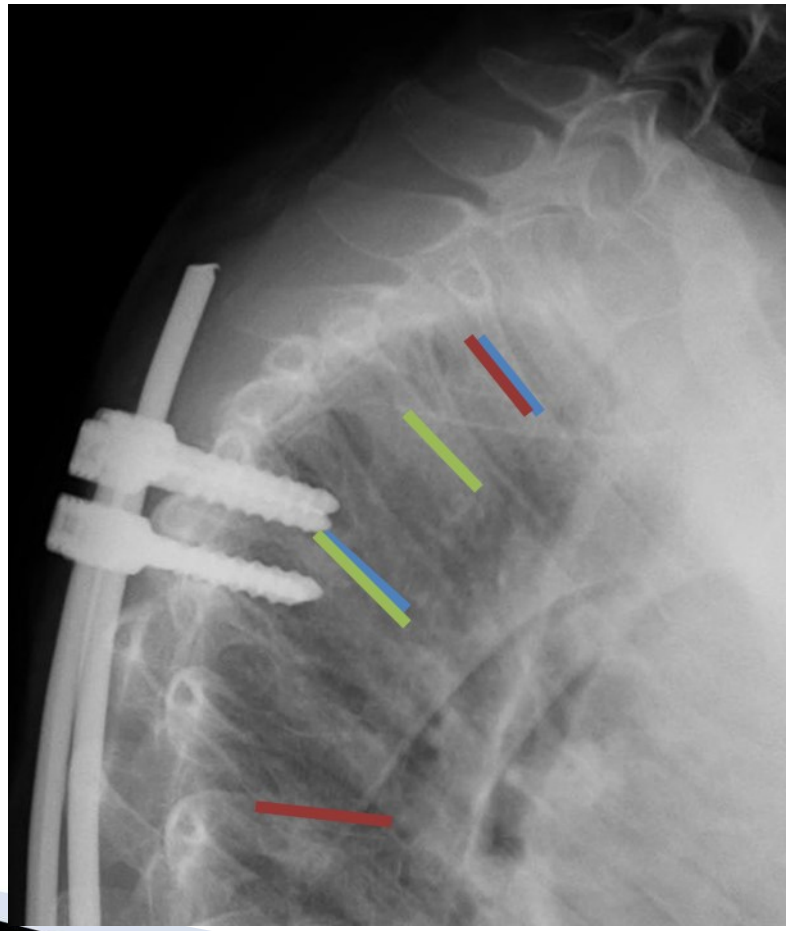
ICEOS 2011 – Rib Based

- Karlin
  - "Proximal Segmental Kyphosis"
  - UIV to one cephalad to UIV > 20 Degrees
  - 7% rate.

- CSSG
  - (PJA) ≥ 10° and PJA at least 10° greater than pre-op
  - 25% rate.

Variability

- Definition vs. Population



Variability – Same Population

- Definition 1 = 21.0% T1 vs. 21.8% T2
- Definition 2 = 38.8% T1 vs. 42.2% T2
- Definition 3 = 7.2% T1 vs. 6.5% T2

Al Khudairy et al., Spine Deformity, 2014

Variability – Same Population

- PJK (Inter Observer)

- Definition 1 = Kappa 0.31 Fair
- **Definition 2 = Kappa 0.40 Moderate**
- Definition 3 = Kappa 0.38 Fair

Al Khudairy et al., Spine Deformity, 2014

Variability – Same Population

- PJA T1 vs. T2 (Intra Observer)

- Definition 1 = ICC 0.61 Good
- **Definition 2 = ICC 0.82 Excellent**
- Definition 3 = ICC 0.69 Good

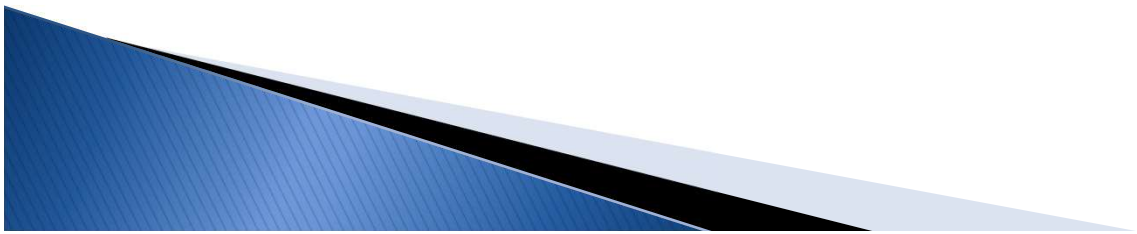
Al Khudairy et al., Spine Deformity, 2014

Variability – Same Population

- Not as variable as we initially thought
- We want to determine if PJA is predictive of a clinically significant event.
- Variability does not matter… if a measure is predictive, then we look at ways to improve the variability.

Proximal Junctional Angle

- Is PJA Predictive?
  - Surrogate for clinically significant PJK
- How can we improve upon variability?
  - EOS Imager



Clinical Effects of PJK

- Unwanted clinical effects of radiographic PJK
  - Implant failure which requires **superior extension** of the upper instrumented level during growth friendly treatment for EOS or during graduate surgery.

Clinical Effects of PJK

- Purpose – Determine the **rate of clinically significant** proximal junctional kyphosis (PJK) during distraction based growth friendly surgery.

Clinical Effects of PJK

- CSSG Registry
  - 397 patients (rib-based)
- At Implantation
  - Age 5.5 yrs
  - Scoliosis 70^{o}
  - Kyphosis 50^{o}

Clinical Effects of PJK

- 40 of 397 required a revision surgery that involved superior extension of the UIL
- 10% rate of clinically significant PJK
- Younger (4.9 vs 5.5 yrs, $p<0.05$),
- Otherwise, the revision group was characteristic of the entire study population

Clinical Effects of PJK

- Time to revision was 2.3 yrs
- Scoliosis 67°
- Kyphosis 55°

Clinical Effects of PJK

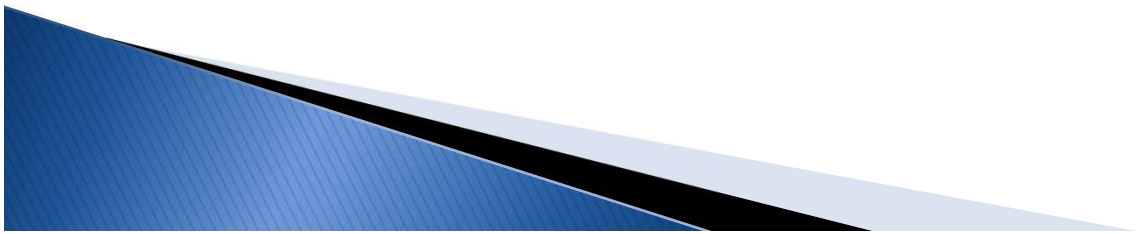
- Two definitions of PJA were predictive of this clinically significant event:

- PJA-A
  - 5.6º pre-op vs 11.8º at time of revision ($p<0.05$).

- PJA-B
  - 13.1º pre-op vs 21.4º at time of revision ($p=0.07$).

Summary

- PJK can occur during distraction-based surgery for Early Onset Scoliosis
- Rates 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
- 10% rate of clinically significant PJK
- Quality of radiographs may be an important variable

Thank You

Other Studies

- PJK in Surgically Treated Young Children with Scoliosis: Incidence, Risk Factors, and Management

- 61 patients with Congenital Scoliosis Rx'ed PSFI

  - 18% rate of PJK
  - Hyperkyphosis
  - Overcorrection of kyphosis
  - >/= 5 levels
  - Un-matching of rod contour

Qian et al., ICEOS 2014