

# Spinopelvic Parameters Predict Development of Proximal Junctional Kyphosis in Early Onset Scoliosis

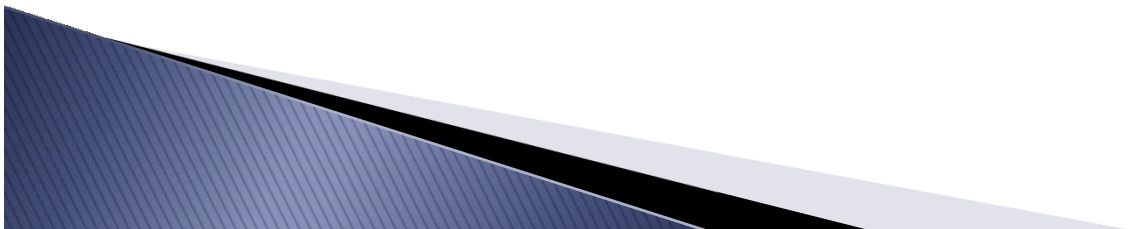
Ozren Kubat, Virginie Lafage,  
Jennifer Hurry, Alexandra Soroceanu,  
Frank Schwab, David L. Skaggs, Ron El-Hawary

Children's Spine and Growing Spine Study Groups



# Background

- ▶ Proximal Junctional Kyphosis (PJK) is diagnosed:
  - Radiographically using the proximal junctional angle (PJA).
  - Clinically, with the requirement for proximal extension of the upper instrumented vertebrae (UIV) during revision surgery.



# Background

- ▶ Early Onset Scoliosis (n=40)
- ▶ 28% Risk of PJK with minimum 2 yr follow-up
- ▶ Relative Risk 2.8 for Pre-op hyperkyphosis
- ▶ Relative Risk 3.1 for High Pelvic Incidence

# Background

- ▶ High PI has been found to increase risk of PJK in Adult Scoliosis.
- ▶ Other spinopelvic parameters have been found to predict post-op complications and HRQOL in Adult Scoliosis

## Sagittal Modifiers

### PI minus LL

0 : non pathologic ( $PI-LL < 10^\circ$ )  
+ : moderate deformity ( $10 < PI-LL < 20^\circ$ )  
++ : marked deformity ( $PI-LL > 20^\circ$ )

### Global Alignment

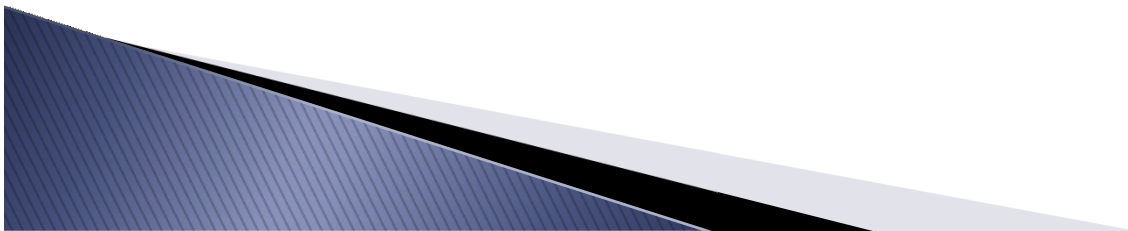
0 : non pathologic ( $SVA < 4\text{cm}$ )  
+ : moderate deformity ( $4\text{cm} < SVA < 9.5\text{cm}$ )  
++ : marked deformity ( $SVA > 9.5\text{cm}$ )

### Pelvic Tilt

0 : non pathologic ( $PT < 20^\circ$ )  
+ : moderate deformity ( $20^\circ < PT < 30^\circ$ )  
++ : marked deformity ( $PT > 30^\circ$ )

# Purpose

- ▶ To determine if abnormal spinopelvic alignment will increase the risk of developing PJK in children with Early Onset Scoliosis.



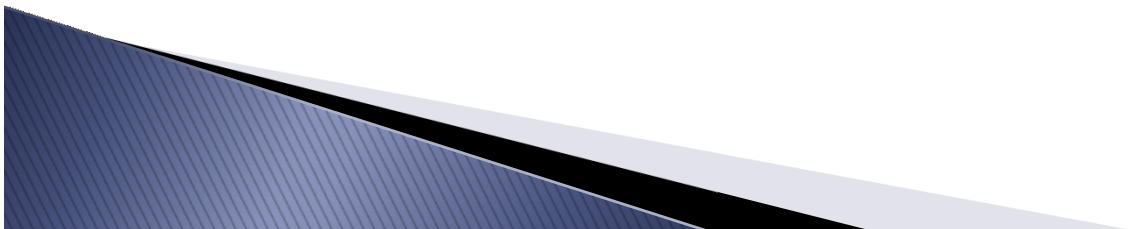
# Study Design

- ▶ Retrospective cohort study of children treated with distraction based implants from 2 Early Onset Scoliosis registries (minimum 2 year follow up).



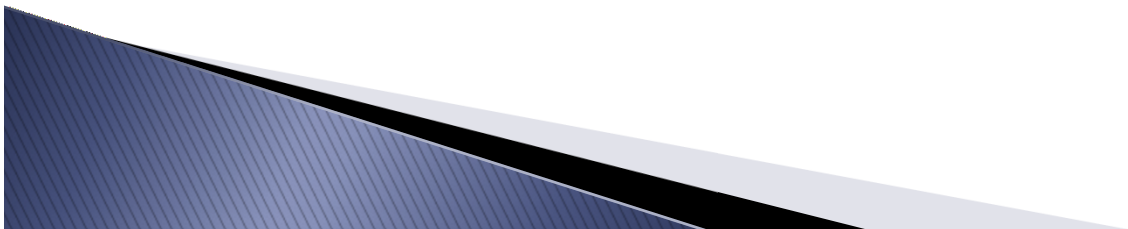
# Analysis

- ▶ Sagittal radiographs were analyzed to measure:
  - Spinopelvic parameters
  - PJA (angle between caudal endplate of the Upper Instrumented Vertebrae (UIV) to the cephalad endplate 2 vertebrae above UIV).
- ▶ Risk ratios were calculated and analyzed using chi squared testing.



# Results

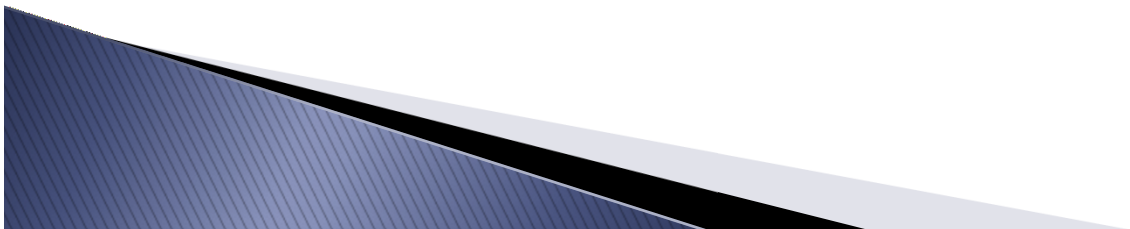
- ▶ 135 children with EOS with > 2 yr f/u
  - 89 Rib-Based and 46 Spine-Based Distraction
  
- ▶ Etiologies:
  - 54 congenital
  - 10 neuromuscular
  - 37 syndromic
  - 32 idiopathic
  - 2 unknown





# Results

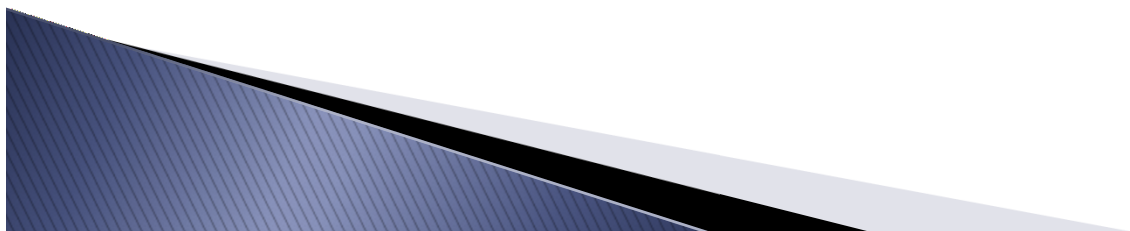
	Pre-op	2 Yr Post-op
Age	5.2 years	
Scoliosis	71°	56°
Thoracic Kyphosis	39°	42°
Lumbar Lordosis	52°	55°
Pelvic Tilt	11°	13°
Sacral Slope	38°	39°
Pelvic Incidence	49°	52°



# Results: Pre-Op Factors

Radiographic PJK: Final PJA > 10°

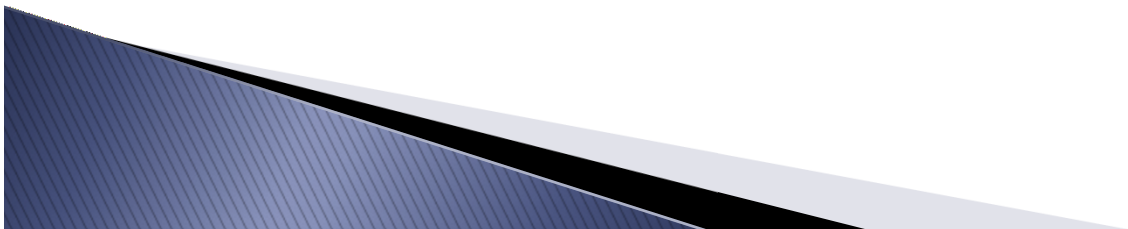
	Relative Risk	Significance
Thoracic Kyphosis > 50°	1.67 (0.98–2.8)	P<0.05, CI
Lumbar Lordosis > 70°	0.96	NS
Pelvic Tilt > 30°	0.65	NS
Pelvic Incidence > 60°	1.02	NS



# Results: Pre-Op Factors

Clinical PJK: Revision with proximal extension

	Relative Risk	Significance
Thoracic Kyphosis > 50°	0.95	NS
Lumbar Lordosis > 70°	0.72	NS
Pelvic Tilt > 30°	0.73	NS
Pelvic Incidence > 60°	0.82	NS



# Results: Post-Op Factors

## Radiographic PJK: Final PJA > 10°

	Relative Risk	Significance
Rib vs. Spine Based	0.58 (0.35–0.96)	P<0.05
Pelvic Tilt > 30°	1.54	NS
PI – LL > 20°	1.54	NS

36 children had Final PJA > 10° (38% Risk).

- 31% Rib-Based vs. 54% Spine-Based (p<0.05)



# Results: Post-Op Factors

## Clinical PJK: Revision with proximal extension

	Relative Risk	Significance
Rib vs. Spine Based	0.86 (0.4–1.8)	NS
Pelvic Tilt $> 30^\circ$	2.5 (1.1–5.5)	$P < 0.05$
PI – LL $> 20^\circ$	2.1 (0.9–4.8)	$P < 0.05$ , CI

24 children required revision surgery with proximal extension of UIV (18% Risk).

- 17% Rib vs. 20% Spine-Based (NS)

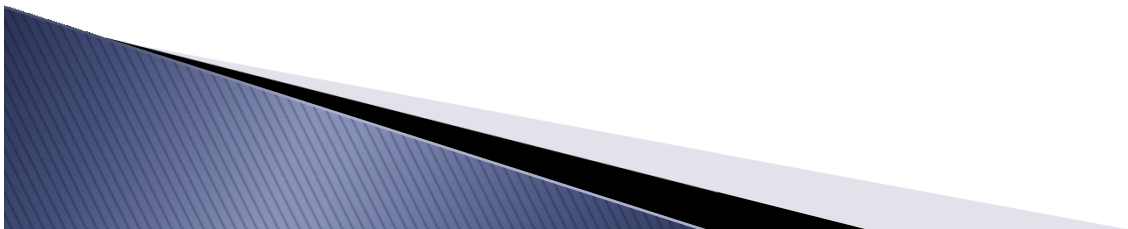
# Conclusions

## ▶ Radiographic PJK

- There was a 38% risk of developing radiographic PJK
- There was a significantly higher risk for spine-based (54%) vs. rib-based (31%) patients.

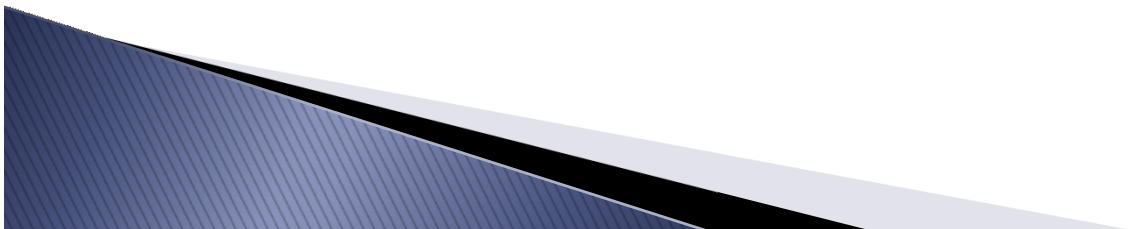
## ▶ Clinical PJK

- There was an 18% risk of developing clinical PJK.
- There was not a significant difference in risk between spine-based and rib-based patients.



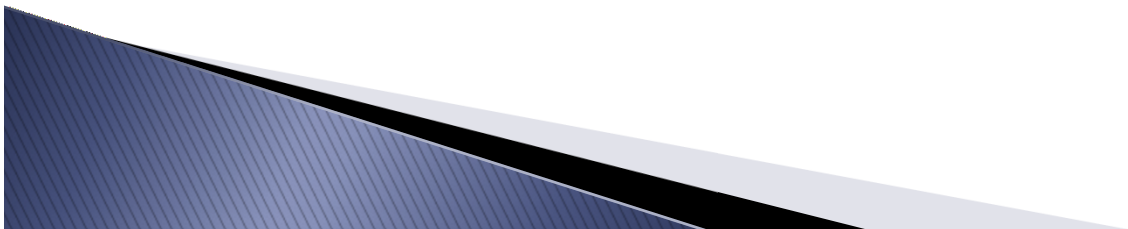
# Conclusions

- ▶ For patients undergoing growth-friendly surgery, pre-operative hyperkyphosis increased the risk for developing post-operative radiographic PJK.
- ▶ Final post-operative PI-LL $>20^{\circ}$  and final post-operative PT $>30^{\circ}$  were each associated with increased risk for clinical PJK.



# References

- ▶ Mac-Thiong JM, Labelle H, Berthonnaud E, et al. Sagittal spinopelvic balance in normal children and adolescents. *Eur Spine J.* 2007;16:227–234.
- ▶ Schwab F, Ungar B, Blondel B, et al. Scoliosis research society–schwab adult spinal deformity classification: a validation study. *Spine (Phila Pa 1976).* 2012;37(12):1077–1082.
- ▶ El-Hawary R, Sturm PF, Cahill PJ, Samdani AF, Vitale MG, Gabos PG, Bodin ND, d'Amato CR, Harris C, Smith J. Sagittal Spinopelvic Parameters Help Predict the Risk of Proximal Junctional Kyphosis for Children Treated with Posterior Distraction Based Implants. *J Pediatr Orthop.* 2015 Jul 17.
- ▶ El-Hawary R, Sturm PF, Cahill PJ, Samdani AF, Vitale MG, Gabos PG, Bodin ND, d'Amato CR, Harris C, Howard J, Morris S, Smith J. Sagittal Spinopelvic Parameters of Young Children with Scoliosis. *Spine Deformity* 2013; 1(5), 343–347.





# Thank You

