Rib-Based Distraction Treatment of Early Onset Scoliosis (EOS) in Children without Rib Abnormalities:

Long-Term Results of a Prospective, Multicenter Study

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Disclosures

- Nothing to disclose:
  - Kevin Morash, Muayad Kadhim
- As outlined in program:
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Background

- Rib-based distraction
  - Well known treatment for thoracic insufficiency syndrome
  - Also applied to treat various etiologies of EOS
- 2007
  - Children's Spine Study Group initiates prospective, multicenter study evaluating efficacy of rib-based distraction treatment of EOS in children *without* congenital rib abnormalities
  - 2 year results previously presented
- Hypothesis
  - At minimum 5 year follow-up, rib-based distraction treatment of EOS in children without rib abnormalities
    - Controls scoliosis
    - Allows spinal growth

Methods

- Prospective, multicenter observational cohort study
- Inclusion criteria
  - Progressive EOS measuring >45 degrees
  - Age 18 months to 10 years
- Enrollment
  - 11 North American sites
  - January 2007 to January 2015

Methods: Measurements

- Imaging
  - Erect spine (PA/Lateral) radiographs at each clinic visit
- Measurements
  - Coronal spine height (T1-T12 and T1-S1)
  - Sagittal spine length (T1-T12 and T1-S1)
  - Major/minor Cobb angles
  - Maximum kyphosis
- Also tracked
  - Complications, device changes, etc.

Methods: Long-Term Analysis

- Long-term analysis included patients with >4.5 years elapsed since implantation of rib-based device
  - 59 patients
- 2 cohorts analyzed
  - Pre-implantation images compared to:
    - Last images with rib-based device (if rib-based device remained in vivo > 4.5 years)
    - Images at last available follow-up (regardless of whether rib-based device remained in vivo)

Patients' Characteristics

Table 1. Study Patients' Characteristics	
Patient Characteristic	**n (%)**
Sex	
[redacted]	
Age at Implantation (years)	
< 3	6 (10)
3-10	53 (90)
Ethnicity	
Hispanic or Latino	13 (22)
Not Hispanic or Latino	44 (75)
Unknown	2 (3)
Etiology	
[redacted]	
Curve severity (deg.)	
[redacted]	
Kyphosis severity (deg.)	
<20	4 (7)
20-50	24 (41)
>50	29 (49)
Unknown	2 (3)

Comparison Groups

Table 2. Follow-up Intervals for Comparison Groups, from Rib-Based Device Implantation Date

Interval Comparison Group	Mean Years	(SD)	Min. Years	Max. Years
2 Year Rib-Based (n = 57)	2.16	(0.35)	1.68	3.32
		(1.08)	4.50	8.40
		(1.93)	1.19	8.40

Table 3. Last Known Device In Situ At Time of Data Analysis

Device	n=	(%)
Lost to follow-up/unknown	6	(10)
MCGR	6	(10)
Growing rods	3	(5)
No hardware in situ	3	(5)
Deceased	2	(3)
Hybrid	1	(2)
Shilla	1	(2)

Growth Over Time

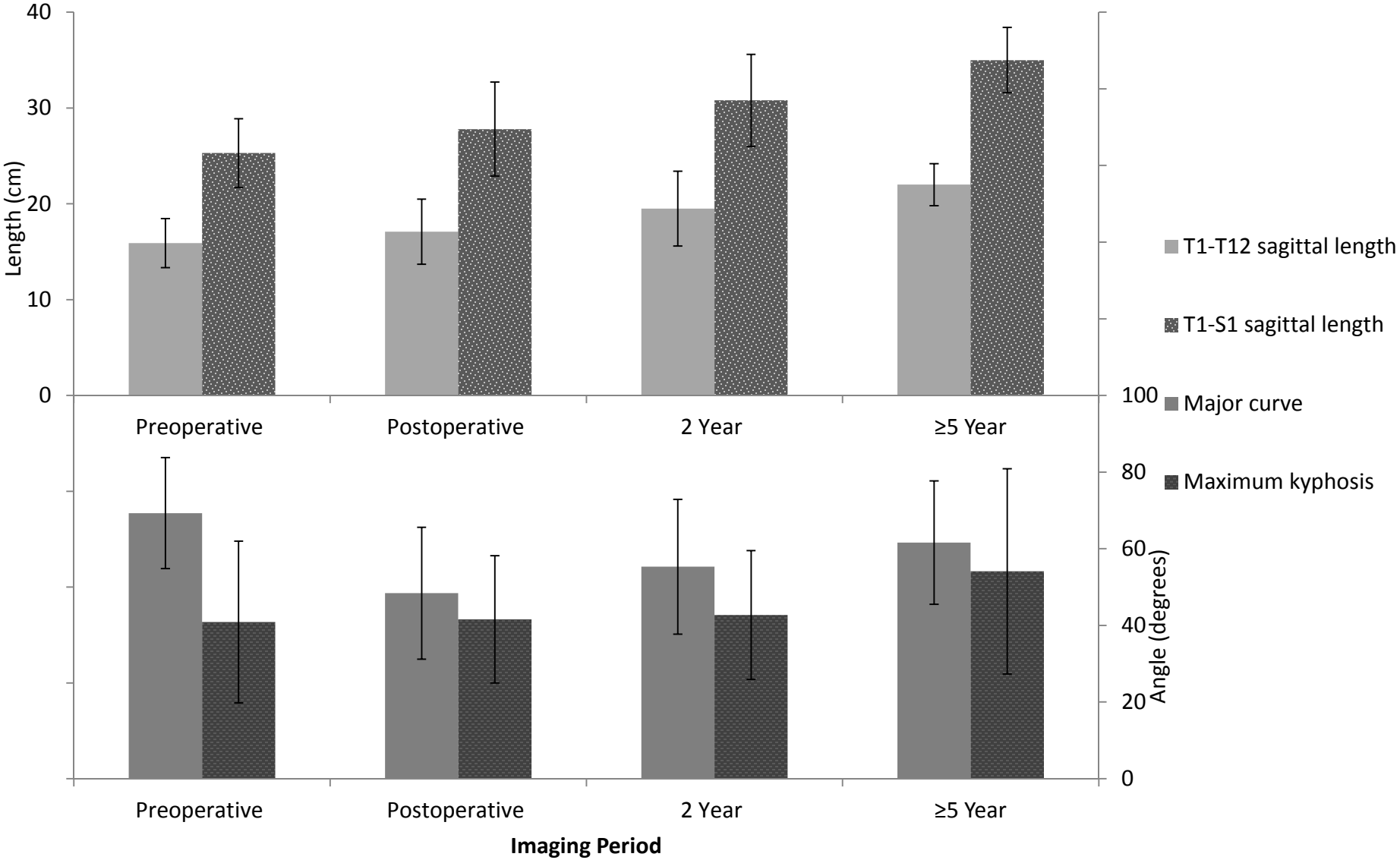

Figure 1. Spinal growth, scoliosis and kyphosis during rib-based distraction treatment (n=29).

Growth to Last Follow-Up

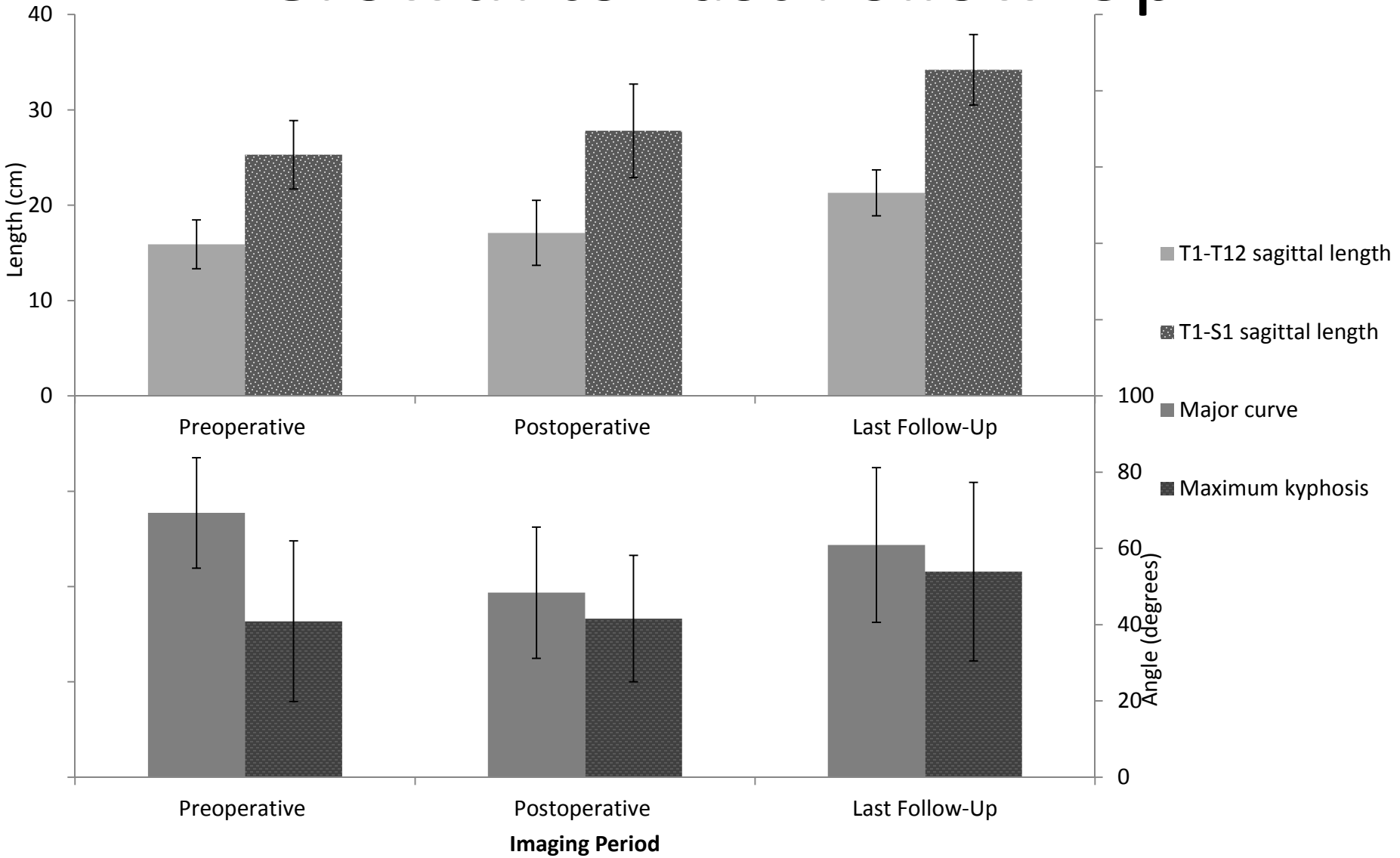

Figure 2. Spinal growth, scoliosis and kyphosis to last follow-up (n=59).

Improvement Rates of Radiographic Parameters

Table 4. Improvement Rate of the Radiographic Parameters, Relative to Pre-Operative Values

	5-Year Rib-Based		Last Overall Follow-Up	
Radiographic Measurement	**% Improved**	**% Deteriorated**	**% Improved**	**% Deteriorated**
Minor curve	48	52	49	51
Maximum kyphosis	39	61	50	50
T1-T12 height	100	0	96	4
T1-T12 sagittal length	100	0	88	12
T1-S1 sagittal length	100	0	88	12
Instrumented sagittal length	100	0	--	--

Age-Matched Growth

Table 5. Comparison to Age Matched T1-S1 Coronal Spine Growth at 2-Year Rib-Based, 5-Year Rib-Based and Last Overall Follow-up

	2-Year Rib-Based		5-Year Rib-Based		Last Overall Follow-Up	
T1-S1 Coronal Spine Growth Interval	Mean	(SD)	Mean	(SD)	Mean	(SD)
% Age-matched growth, from preoperative	195	(196)				
% Age-matched growth, distraction phase	64	(259)	56	(69)	41	(98)

*Age-matched growth calculated using Dimeglio's reference numbers (Dimeglio JPO-B, 1992).

Complication Profile

Table 6. Complications of Treatment of EOS With Rib-Based Distraction (Total Number =105)

Complication	n =	(%)
Wound Dehiscence	9	(9)
Hardware Failure	8	(8)
Pain	8	(8)
Pneumonia	7	(7)
Other Wound Complication	6	(6)
Other Medical Illness	5	(5)
Other Respiratory Illness	5	(5)
Prominent Hardware	4	(4)
Other Fracture	3	(3)
Abdominal Injury	2	(2)
Death	2	(2)
Neurologic Injury	2	(2)
Rib Fracture	2	(2)
Cardiac Arrest	1	(1)
Pneumothorax	1	(1)

Table 7. Complications of Treatment of EOS With Rib-Based Distraction By Smith Classification

Device Related	
IIB - Requires multiple unplanned surgeries	5
III - Requires abandoning growth-friendly strategy	1
IV - Death	0
Total	**68**
Disease Related	
II - Inpatient medical management	15
III - Requires abandoning growth-friendly strategy	0
IV - Death	2
Total	**32**

Conclusion

- At minimum 5-year follow-up, rib-based distraction treatment continues to control scoliosis and allow spinal growth in children with EOS without rib abnormalities

Thank You