Congenital Spine Deformity with Fused Ribs Treated with Proximal Rib- vs. Spine-Based Growing Constructs

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Background

- Severe early-onset spinal deformity with rib fusions can be treated with growing spine devices with proximal rib or spine anchors.

- Limited comparative studies between spine-based vs. rib-based proximal anchors.

Objective

- To determine outcomes (thoracic height and Cobb angle) in patients with fused ribs treated with proximal spine anchors (spine-based growing devices) compared to constructs with proximal rib anchors (rib-based devices).

Study Design

- Retrospective review of primarily prospectively collected data (GSSG & CSSG).

- Minimum 2 year follow-up

- Early onset scoliosis and rib fusions

- 176 patients identified
  - 16 proximal spine anchors
  - 160 proximal rib anchors
    - 154 VEPTR, 6 other
    - 106 had thoracoplasty at implantation
    - 90 had rib-to-rib construct

Methods

- Rated rib fusions as: mild/moderate/severe

Mild
1-2 Rib Fusions
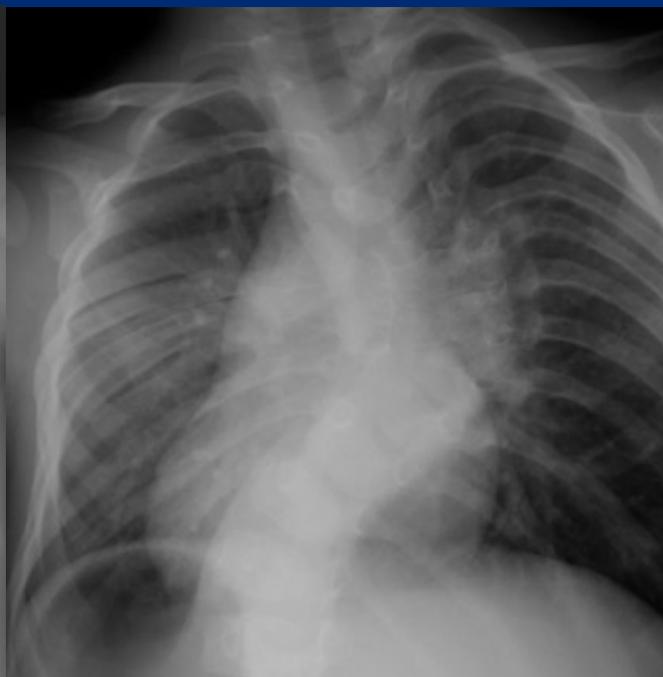
Moderate
> 2 Rib Fusions

Severe
Altered Chest
Architecture

Methods

Proximal fixation assessed as spine-based or rib-based
(excluded those with both types of anchors)

Spine-based
Proximal Anchors

Rib-based
Proximal Anchors

Results: Baseline Parameters

	Spine-Based Devices (N=16)	Rib-Based Devices (N=160)	P-value
Gender (M/F)	5/11	75/85	0.23
Mean Age at Index Surgery	5.9 (1.5-14.9)	4.5 (0.2 - 16.5)	0.19
Preop Mean Major Cobb Angle	61 (25-85)	66 (22-112)	0.28
Mean Preop Kyphosis	52.8 (15-120)	39.7 (6-91)	0.13
Mean Preop T1-S1 (cm)	24.1 (13-32)	23.5 (13-38)	0.73
Mean Preop T1-T12 (cm)	13.4 (6-20.1)	13.7 (5.9-24)	0.88
Time to Follow-up (Yrs)	5.9 (1.5-10.1)	6.5 (0.7-15.7)	0.41

Results: Severity of Rib Fusions

Rib Deformity	Spine-Based Devices (N=16)	Rib-Based Devices (N=160)
Mild (%)	6 (38%)	60 (38%)
Moderate (%)	6 (38%)	66 (41%)
Severe (%)	2 (13%)	26 (16%)
Indeterminate	2 (13%)	8 (5%)

Results: # of Surgeries

	Spine-Based Devices (N=16)	Rib-Based Devices (N=160)	P-value
# Lengthening Surgeries	6.3 (1-14)	7.9 (1-21)	0.12
# All Surgeries	8.0 (2-18)	11.2 (2-30)	**0.007**
# Revision Surgeries	1.6 (0-7)	2.3 (0-12)	0.17

Results: Spinal Height

	Spine-Based Devices (N=16)	Rib-Based Devices (N=160)	P-value
Total Change in T1-T12	6.0 (-4.5-22.4)	3.4 (-3.01-11.7)	0.26
Total Change in T1-S1	9.1 (3.0-13.1)	6.3 (-4.1-18.2)	0.06
Distraction Change T1-T12	5.7 (-4.5-22.4)	3.3 (-3.3-11.7)	0.35
Distraction Change T1-S1	**8.1 (-1.3-7)**	**5.9 (-5-10.3)**	**0.04**
Length/Distraction	0.29	0.3	0.45
Final Fusion Change* T1T12	0.75 (-0.7-2.4)	1.4 (-2.1-6.2)	0.36
Final Fusion Change T1S1*	0.58 (-2.2-2.7)	2.1 (-5.5-8.2)	0.16

**Only 46 patients (40 rib-construct and 6 spine-construct) had final fusion.

Results: Coronal and Sagittal Plane

	Spine-Based Devices (N=16)	Rib-Based Devices (N=160)	P-value
Post-Treatment Cobb	36.7 (0-62)	57.8 (11-117)	<0.001
Δ in Cobb Angle	24.4 (-18-66)	11.3 (-31-88)	0.049
Post-Treatment Kyphosis	34.7 (0-72)	52.4 (0-108)	0.003
Δ in Kyphosis	20.3 (-10-62)	-7.3 (-63 - 74)	0.002

Results: Space Available for the Lung (SAL)

	Spine-Based Devices	Rib-Based Devices	p-value
Pre-Implant SAL	**0.710**	**0.799**	**0.02**
Post-Index Surgery SAL	0.756	0.825	0.12
Most Recent Follow-up	0.906	0.862	0.06
Total Change SAL	0.242	0.170	0.51

Discussion

- No difference in T1-T12/T1-S1 growth achieved

- More surgeries in the rib-based group, more height achieved at final fusion surgery

- No difference detected in space available for the lung

- Increased thoracic Cobb angle and kyphosis at latest follow-up in rib-based group
  - Previously rib-based devices have been found to be associated with increasing kyphosis
    - Murphy RF et al. *JPO.* 2016 Jun; 36(4):329-35.
    - Waldhausen JH et al. *JPO*. 2016. 51:1747-1750.

Limitations

- Retrospective review of prospectively collected data, without randomization

- No pulmonary outcomes

- Treating surgeons may have selected rib-based devices for specific patients
  - No detectible differences in preoperative parameters (T1-T12 height, Cobb, kyphosis, # rib fusions)

Conclusions

- More work to determine role of rib-based devices and expansion thoracoplasty , esp. pulmonary outcomes

- Increased kyphosis and scoliosis in rib-based group, similar changes in spinal height
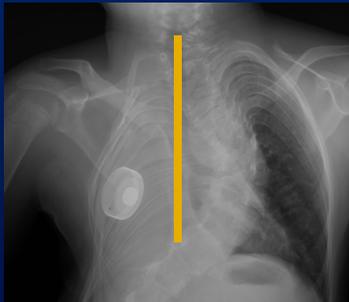
T1-T12 Ht

Thank you!

- Children's Spine Study Group

- Growing Spine Study Group

- Participating patients