Top 3 Articles That Changed My Approach to EOS

Kyphosis
Kyphosis
Pulmonary Outcome & T1-12 Length
Kyphosis and Early-onset Spine Deformity (EOSD)

A Problem Seeking a Solution ??

C.E. Johnston MD
ICEOS Warsaw 2014

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“Hyperkyphosis” - Effect on Treatment

• Complicates growth-friendly management (casts, brace, surgical) if apex above T8
How Does Thoracic Kyphosis Affect Patient Outcomes in Growing Rod Surgery?

Samuel R. Schroerlucke, MD,* Behrooz A. Akbarnia, MD,† Jeff B. Pawelek, BS,* Pooria Salari, MD,* Gregory M. Mundis, Jr., MD,* Muharrem Yazici, MD,* John B. Emans, MD,§ Paul D. Sponseller, MD|| and Growing Spine Study Group*
Non-flexible Kyphosis – Major Cause of Proximal Anchor Failure

Schroerlucke et al (GSSG), 2012 Spine
90 pts, f/u 5-7yr complic*/ #pts
K- <10° thor kyph 12/26
N 10-40° 16/35
K+ >40° 34/29
* - implant related

- Infection rate: K+ 28% N 2.8% K- 12%
Implant complications vs preop th kyph

Survival curve
Rod breakage complication

Observed odds ratio

Complication probability

Preoperative thoracic kyphosis (degrees)

Preoperative thoracic kyphosis (degrees)
Reinker et al: Can Veptr Control Progression of Early-onset Kyphoscoliosis? CORR 2011

14 pts, 5.8 yr f/u
Selection: rx plan altered to specifically treat problematic thoracic kyphosis ....normal kyphosis initially, hyperkyphosis during rx
• T2-12 mean kyph 68° → 91° @ f/u
• No change in T1-5... partial p.j.k. problem
• Scoliosis curves not improved (3-16 expansions)
• Thoracic length increase 2.6 cm (-1 – 7.5)
• 7/14 req’d revision of proximal cradle
  ➢ Cradle below 3rd rib
  ➢ Insufficient distal anchor point (above L3)
  ➢ Rib-rib constructs ineffective .....extend to pelvis if possible, 2nd device on opposite side

Reinker et al, 2011
PJK w/ VEPTR

Distracting upper Th ribs doesn’t necessarily move upper Th spine congruently, creates +ve sagittal balance
Flatback 2° repeated distractions (esp. with pelvic anchors in ambulatory patients)

JT Smith, *Bilateral Rib-to-Pelvis Technique. CORR 469, 2011*
Kyphosis - biomechanically not good for distraction-based methods

- Posterior pull-off forces large (use wires above)
- Cantilever plowing (screws) possible - ? Hooks/wires better?
- Distraction creates kyphosis
- Rod contour can become inappropriate as lengthening proceeds, worsens as more kyphosis occurs
Anti-kyphosis construct - match radius of curvature of 2 rod segments to sagittal plane

Exacerbated by distraction of L-S segments $\rightarrow +ve$ sagittal balance

“Veptr” concept
5 yo congenital myopathy

ROS benign, no significant respiratory episodes x 4 yr

Pft unable to obtain

Sat 99% RA, RR 14
Initial x-rays

traction
Ideal growing rod candidate?

Anti-kyphosis construct proximally

1. Fuse proximal anchors @ initial procedure - minimal distraction

2. Dominoes proximal (rod contour issue during lengthening)

3. Sublaminar backup for upper claw
2 yrs po (3 lengthenings)

T1-12=24 cm

#4
Last f/u before fusion age 11
1 broken rod revision, T1-12 = 28 cm
Non-flexible Kyphosis – Major Cause of Proximal Anchor Failure

What’s Changed?

- Preop HGT to decrease deformity (Emans SRS 07)
- Instrument into cervical lordosis (not chest wall)
- Fuse upper anchors first, include T1-4/5 prn, then distract for correction @ 1st lengthening (not chest wall)
Preop

Traction x 2mo

Lengthen x4
Over-interpretation of Karol et al

Worst PFT’s at f/u were in patients fused to T1-2......but all were fused T1/2 -> low Th or L levels = entire T spine up to T1/2
Pulmonary and Radiographic Outcomes of VEPTR (Vertical Expandable Prosthetic Titanium Rib) Treatment in Early-Onset Scoliosis

Ozgur Dede, MD, Etsuro K. Motoyama, MD, Charles I. Yang, MD, Rebecca L. Mutlch, RT, Stephen A. Walczak, RRT, Austin J. Bowles, MS, and Vincent F. Deeney, MD

Investigation performed at the Children’s Hospital of Pittsburgh of University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania

Are we sure we know what we’re doing?
### Dede, Motoyama et al JBJS 2014
Pulmonary and radiographic outcomes of VEPTR
Age 4.8 yr /11 expansions/ 6 yr f/u

<table>
<thead>
<tr>
<th></th>
<th>Pre-implant</th>
<th>1st Expansion</th>
<th>Last FU</th>
<th>P</th>
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<tbody>
<tr>
<td>Cobb (degrees)</td>
<td>80</td>
<td>68</td>
<td>67</td>
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<td>Maximum thoracic kyphosis (degrees)</td>
<td>57</td>
<td>50</td>
<td>66</td>
<td>0.08</td>
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<tr>
<td>T1-T12 height (mm)</td>
<td>123</td>
<td>131</td>
<td>149</td>
<td>0.054</td>
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<td>Crs/kg</td>
<td>1.4</td>
<td>1.2</td>
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<td>FVC (L)</td>
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<td>0.96</td>
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<td>FVC% arm</td>
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<td>77</td>
<td>58</td>
<td>0.0001</td>
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<tr>
<td>SAL</td>
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<td>0.80</td>
<td>0.87</td>
<td>0.006</td>
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T1-12=14.9 cm ......NOT NEARLY ENOUGH
(Karol et al JBJS '08)
Dede, Motoyama et al JBJS 2014
Pulmonary and radiographic outcomes of VEPTR

• Th kyphosis ↑ (57 -> 66 all patients)
• +ve sagittal imbalance
• ↑ high Th kyphosis
• Inverse correlation between hyperkyphosis and FVC %pred
• Similar outcomes reported by Reinker and Lattig

• Counterpoint – most severely involved congenital spine/chest wall cases
**Conclusions:** In spite of what appears to be satisfactory thoracic length gain and curve correction during 7 year of surgical management with acceptable complication rate, pulmonary outcomes are diminished by % pred outcomes criteria.
Have pulmonary outcomes affected my practice?

- Surgical lengthening and expansions
  worsome lack of "improvement"
- Re-assessment of early intervention in favor of delaying tactics
- Emphasizes lack of clinically important outcome data re TIS and natural hx, especially severe congenital cases
2 y.o. male w/ J-L

Mother age 22 - no rx
Asymptomatic
T1-12 = 18.1 cm

Grandmother age 49 - no rx
Respiratory sx - ? Age, BMI
T1-12 = 18.7 cm
✓ Sagittal plane (kyphosis) problems --> use HGT + fuse in prox anchors before start
More severe chest wall deformities (rib anchors):
✓ Constant surveillance for kyphosis
✓ Better nat’l hx info before start
✓ Avoid ineffective serial surgeries
Arthrogryposis
• Early vs Late Rx

Vigorous early prophylactic intervention results in CT lung vol 605cc
Hypoplastic thorax
TIS likely -> expansion technique

<table>
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<tr>
<th>Date</th>
<th>T1-12</th>
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<tbody>
<tr>
<td>1/03</td>
<td>14.5</td>
</tr>
<tr>
<td>8/05</td>
<td>14.9</td>
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<tr>
<td>6/10</td>
<td>15.6</td>
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Inflexible deformity
Extra Anchors, more distraction, but.....

Thorax expanded, curve larger, length?
Cong Scoli w/ rib fusions
age 7 / 20 operations

Price of “early” surgery
FVC (pred) & Lung compliance
TSRH Growing Rod “Graduates”

- 5 idiopathic-like, 1 cong, 1 amb n-m
- 74 mo 1st surgery; 44 mo delay in 4/7
- 8 procedures (incl. initial), 1 unplanned, 6 lengthenings
- f/u age 13 yr (156 mo)
- 5 definitive fusion 1-2.5 yr, 2 obs after last lengthen 3 yrs
Initial Rx - Traction x 2 mos.