Why Do We Need To Really Drive Growth?

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Disclosures: Medtronic, Elsevier
Questions to ask

• Spine deformity vs chest wall deformity ...or both
• Natural Hx?
• Treat now or can we delay / how bad IS it?
• Intrinsic growth possible, can we harness it... or do WE have to grow it?
• Outcome Data Needed to confirm value of C-EOS

1. Age 20 mo.
2. Growth potential poor
3. Growing construct compromised by sagittal plane

4+ = Trouble
My Concerns – if growth needed

- Merely keeping up with “normal” growth rate will not move the needle toward ↑’d PFT
- Maximum distraction lengthening with TGR at best just keeps up with a “normal” growth rate → not moving the needle
- MCGR, rib-based constructs do not currently produce enough length to even “keep up”
- Certain dx’s (e.g. congenital, syndromic) resistant to standard lengthening → more distractive force, more often
- Caution: may produce more stiffness and early auto-ankylosis
Distraction-based Rx and The 18cm hurdle
El–Hawary et GSSG,CSSG

135 pts. / mean lengthen 11
Final Th Ht > 18 cm  65%
   > 22 cm  30%

>18cm

Congen  48%
N-m  80%
Syndr  86%
JIS/IIS  68%
Pulmonary Function Following Early Thoracic Fusion in Non-Neuromuscular Scoliosis

By Lori A. Karol, MD, Charles Johnston, MD, Kirill Maidenov, MD, Peter Schorcher, MD, Patricia Walters, RRT-NPS, and Richard H. Browne, PhD

Investigation performed at the Department of Orthopaedic Surgery, Texas Scottish Rite Hospital for Children, Dallas, and the Department of Pulmonology, Children's Medical Center of Dallas, Dallas, Texas

Minimal correction
Congenital dx’s
Large residual curves (in situ rx)

The thoracic height at the time of follow-up versus the percentage of predicted forced vital capacity (FVC). Patients with the shortest thoracic spinal height (measured from T1 to T12) had the greatest restriction of pulmonary volume ($r = 0.73$, $p < 0.001$).
Limitations of Distraction-based RX

- MCGR -> ineffective lengthening w/ "standard" protocols

TD = true (actual) distraction
ID = intended distraction
TD/ID = 0.33
0.30 conversions
0.35 10° implantation
"...as the age, weight or BMI increases, the percentage of intended concave rod distraction decreases significantly by two years."

"Despite the decrease in the mean T/I ratio over time, the mean $T1-S1$ length increased from 222 mm to 243 mm at final follow-up and had no consistent drops."

Underwhelming ?!
**Let’s Compare… TGR**

- **GR Graduates/TSRH** *JBJS-A* 99:1037, 2017 n=12 mult dx’s

<table>
<thead>
<tr>
<th></th>
<th>Preop.</th>
<th>Postop.†</th>
<th>Most Recent F/u</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (yr)</strong></td>
<td>5.0 (1.3–7.9)</td>
<td>11.0 (7.4–13.1)</td>
<td>13.8 (9.8–17.0)</td>
</tr>
<tr>
<td><strong>Curve (°)</strong></td>
<td>88 (25–123)</td>
<td>48 (19–83)</td>
<td>47 (16–83)</td>
</tr>
<tr>
<td><strong>T1–T12 (cm)</strong></td>
<td>13.3 (8.4–17.7)</td>
<td>20.9 (9.8–29.5)</td>
<td>22.3 (9.7–32.9)</td>
</tr>
<tr>
<td><strong>T1–S1 (cm)</strong></td>
<td>22.3 (12.4–27.8)</td>
<td>33.4 (17.0–46.8)</td>
<td>34.7</td>
</tr>
</tbody>
</table>

**Akbarnia 3-11 yr f/u dual GR**  
*n=13 non-cong all final fusion*

- **T1–S1 cm**  
  24.4 ± 3.4  
  29.3 ± 3.6 (ipo)  
  35.0 ± 3.7

**T1-12 = 9 cm**

- **12.3**
  <6m. intrv

![Graph showing T1-S1 cm over time](chart.png)
NO COMPARISON ...

- TGR’s $\rightarrow$ 12+ cm T1-S1 length - final
- MCGR’s $\rightarrow$ 2 cm T1-S1 length - 51 mo, decreasing 2/2 LODRs

Conversion Cases - actually *shortened* over 2 yr f/u period

- 270mm @ baseline
- 294mm ipo
- 290mm @ 2 yr

Underpowered magic

Magnetically controlled Growing Rods for Early-onset Scoliosis

*Spine 41:1456, 2016*

*23 pts. / 15 centers non-US*
*15 primary, 8 conversions*
PFT Summary - GR “graduates”
Johnston, JBJS 99-A:1036, 2017

- FEV1 abs vol $\uparrow$ 900 cm$^3$ (200-1200)
- FVC abs vol $\uparrow$ 1100 cm$^3$ (100-1800)
- FEV1 %pred $\downarrow$ 1.7% (52.1%)
- FVC %pred $\uparrow$ 1.8% (55.3%)
- Deformity corrected $88^\circ \rightarrow 47^\circ$ mean
- over 6.7 yr f/u (5-11 yr)

= no change
TGR
Normalized for pelvic width
**GR vs Veptr for idiopathic EOS**

- 50 GR’s (age 5.5y), 22 Veptrs (4.3)  
  \[ p = .04 \]
- Procedures:  
  \[ p < .001 \]
- Wound cx:  
  \[ p = .011 \]

Rib-Based Less effective

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<table>
<thead>
<tr>
<th>Time Point</th>
<th>Radiographic Parameter</th>
<th>GRs</th>
<th>VEPTRs</th>
<th>( p )-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRE-OP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Major curve size (*)</td>
<td>78</td>
<td>74</td>
<td>.388</td>
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<tr>
<td></td>
<td>T5-T12 thoracic kyphosis (°)</td>
<td>36</td>
<td>31</td>
<td>.319</td>
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<tr>
<td></td>
<td>Spinal height (mm)</td>
<td>255</td>
<td>237</td>
<td>.062</td>
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<td>Thoracic height (mm)</td>
<td>153</td>
<td>145</td>
<td>.397</td>
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<td></td>
<td><strong>Major curve correction (%)</strong></td>
<td>50.0</td>
<td>27.3</td>
<td>&lt;.001</td>
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<td><strong>POST-OP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>T5-T12 thoracic kyphosis (°)</td>
<td>19</td>
<td>22</td>
<td>.549</td>
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<tr>
<td></td>
<td>Spinal height (% gain)</td>
<td>17.2</td>
<td>11.6</td>
<td>.737</td>
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<td></td>
<td>Thoracic height (% gain)</td>
<td>18.0</td>
<td>18.3</td>
<td>.651</td>
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<td><strong>Loss of index curve correction (%)</strong></td>
<td>14.2</td>
<td>20.2</td>
<td>.629</td>
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<td><strong>LENGTHENING PERIOD (POST-OP TO MOST RECENT)</strong></td>
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<td>Spinal height (% gain)</td>
<td>18.5</td>
<td>15.5</td>
<td>.281</td>
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<td>Thoracic height (% gain)</td>
<td>24.2</td>
<td>11.6</td>
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<td><strong>Major curve correction (%)</strong></td>
<td>43.4</td>
<td>16.7</td>
<td>&lt;.001</td>
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<td><strong>OVERALL (PRE-INDEX TO MOST RECENT)</strong></td>
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<tr>
<td></td>
<td>T5-T12 thoracic kyphosis (°)</td>
<td>35</td>
<td>49</td>
<td>.018</td>
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<tr>
<td></td>
<td>Spinal height (% gain)</td>
<td>34.8</td>
<td>34.2</td>
<td>.885</td>
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<tr>
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<td>Thoracic height (% gain)</td>
<td>45.0</td>
<td>30.4</td>
<td>.199</td>
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</tbody>
</table>

Sponseller et al (GSSG,CSSG) Prague SRS 2016

Start @ 12cm -> hard pressed to reach 18cm
### Lengthening Equation (annual) RCT

\[
1.25 \times \# \text{ instr vert} \times 22 \text{ mm} \div 17
\]

- \((1.25 \times 13 \text{ vert.} \times 22 \text{ mm}) \div 17 = 21.0 \text{ mm/yr}\)

- If 6 week group: \(21.0 \div 8.66 = 2.42 \text{ mm/visit}\)
- If 16 week group: \(21.0 \div 3.25 = 6.46 \text{ mm/visit}\)

Age 5 7/14  \(\text{ipo T1-12 =} 17.6\)

4 mm X 3/yr  =  \(36 \text{ mm}\) intended

Age 8 7/17  \(\text{T1-12 =} 18.1\)

MCGR length 32 mm L 29 mm R actual
Conclusions

- If we truly need to drive growth (2° inherent growth inhibition).....

  Previous distraction protocol with TGR just maintains initial %ile, PFT's

- Mcgr limitations insufficient spine length to be expected ?

- Lengthen to MAX - ? Best technique TBD Anchors, ankylosis, j.k.’s
Thanks