Preparing Patients for Growth Friendly EOS Surgery

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Children’s Hospital Los Angeles
University of Southern California

Children’s Endowed Chair of Pediatric Spinal Disorders
Lindsay:
- risk assessment
- 

Elaine – clear expectations
Preparing Patients for Growth Friendly EOS Surgery

Medical Aspects
Psychologic aspects
expectations
EOS Patients Nutritionally Depleted

- **FAILURE TO THRIVE**
  - 47-78% <5 percentile weight for age
- Periactin
- GI consult, Gtube
- When improvement plateaus, operate
  - don’t wait for “normal”

Skaggs et. al, SRS, 2007, 2010
MRI - without contrast

• Cervical-thoracic-Lumbar
  – Any EOS patient curve >20 degrees or symptomatic
  – Chiari, syrinx, tumor, diatematomyelia, tethered cord, fatty filum, etc
Cardiac Echocardiogram

• All operative congenital scoliosis
  – 20% cardiac abnormaliteis, VSD most common
• Cobb angle >75° (not supported by data)
• Cardiac History
• All neuromuscular patients
• Syndromic - literature search
Pulmonary Consult

• Cobb >75°

• History of pulmonary issues. ASK!
  – Hospital admission
  – Recurrent pulmonary infections
Pediatric Spine Infections: Columbia, CHOP, CHLA: Vitale, et al
1252 pts, JBJS, 2012

- Idiopathic 2.5%, congenital 3.9%, NeuroMusc 9.2%,
- Idiopathic:
  - Fusions 1.6%
  - Growing implants 10%
Building Consensus: Development of a Best Practice Guideline (BPG) for Surgical Site Infection (SSI) Prevention in High-risk Pediatric Spine Surgery

Michael G. Vitale, MD, MPH,* Matthew D. Riedel, BA,* Michael P. Glotzbecker, MD,†

1. Patients should have a chlorhexidine skin wash at home the night before surgery.*
2. Patients should have preoperative urine cultures obtained and treated if positive.*
3. Patients should receive a preoperative Patient Education Sheet.*
4. Patients should have a preoperative nutritional assessment.*
Pre-Op Traction?

- Cervical-thoracic kyphosis
- Severe deformity, weak anchors
28% change of surgical plan for index surgeries

No cases cancelled
Outcome of Growing Rods

• Decreased Cobb Angle at first, then maintained
• Increased Spine length - Make kids taller!

• ??? Unknown Pulmonary Effects ???
# How Much Do they Grow?

<table>
<thead>
<tr>
<th></th>
<th>Dimeglio’s Normal T1-S1 Growth</th>
<th>Akbarnia et al. 2012 Growing Rod Series N=23</th>
<th>McCarthy et al. 2015 SHILLA Series N=40</th>
<th>GSSG Shilla Study N=20</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-S1 height change during growth period</td>
<td>10 mm/yr</td>
<td>10 mm/yr</td>
<td>8 mm/yr</td>
<td>2.5 mm/yr</td>
</tr>
</tbody>
</table>
Complications of Growing-Rod Treatment for Early-Onset Scoliosis: Analysis of One Hundred and Forty Patients

Shay Bess, Behrooz A. Akbarnia, George H. Thompson, Paul D. Sponseller, Suken A. Shah, Hazem El Sebaie, Oheneba Boachie-Adjei, Lawrence I. Karlin, Sarah Canale, Connie Poe-Kochert and David L. Skaggs

• 24% increased risk of CCX with each additional surgery
• 13% less risk of a CCX for each year surgery delayed
• 910 growing rod surgeries
• 120% CCXs / patient
• 20% CCXs / surgery
• Rod fracture 24% of pts.
• Hook dislodgement 21%
• Infection 14%
• Pulmonary 7%)
Nutritional improvement following growing rod surgery in children with early onset scoliosis

Karen S. Myung · David L. Skaggs ·
George H. Thompson · John B. Emans ·
Behrooz A. Akbarnia · Growing Spine Study Group

- Idopathics and congenitals gain weight %ile post op,
- Neuromuscular and syndromic don't

J Child Orthop (2014) 8:251–256
Conclusion in Abstract: “This study showed satisfactory growth.”

<table>
<thead>
<tr>
<th></th>
<th>6mo post-op</th>
<th>12mo post-op</th>
<th>24mo post-op</th>
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<tbody>
<tr>
<td>T1-T12 height</td>
<td>184mm</td>
<td>185mm</td>
<td>181mm</td>
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</table>
SHILLA crankshaft, growth? Neuromuscular, non-ambulator

8yo

Surgery age 7

9yo

11yo
Shilla

• Less surgery than traditional growing rods
• Less complications
• ? Growth compare to no treatment and growing rods
• ? Less surgery and CCXs than MCGRs
New Treatment

Results vs. Time
New Treatment

Results

Time

Grand Rounds Speaker
Good results tend to be presented more
Compression → Distraction?????
Ever needed surgery
Traditional Growing Rods - Distraction Based

- Spine or Rib Anchors
- Surgical Distraction – @ 6-9 months
- Final Fusion
Weight as Proxy for Pulmonary Function

Weight Gain following Growing Rods

- 162 pts. < 20%tile weight
- Mean weight gain 11% over 6 years

<table>
<thead>
<tr>
<th>implant</th>
<th>%tile weight gain</th>
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<tbody>
<tr>
<td>Growing rod spine anchors</td>
<td>13%</td>
</tr>
<tr>
<td>Growing rods rib anchors</td>
<td>9%</td>
</tr>
<tr>
<td>VEPTR</td>
<td>4%</td>
</tr>
<tr>
<td>Guided growth construct</td>
<td>5%</td>
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Pending Publication, Spinal Deformity
– This is an actor
– Actual results may vary
Complications of Growing-Rod Treatment for Early-Onset Scoliosis: Analysis of One Hundred and Forty Patients

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- 24% increased risk of CCX with each additional surgery
- 13% less risk of a CCX for each year surgery delayed

⇒ Operate less
⇒ Implant Later

Bess, JBJS, 2010
John Smith's Complication Initiative of Distraction Based Growing Rods

65 patients, 423 surgeries, (5 institutions)
Congenital 22, Neuromuscular 23, Syndromic 14, Idiopathic 6

VEPTR:46; Growing Rods:14; Hybrids:4

260% CCXs per patient
42% CCXs per procedure

A joint effort of the CWSDSG and GSSG
ICEOS, 2013
• repeated or lengthy use of general anesthetic and sedation drugs during surgery
• children<3 years
• may affect brain development
MCGR
Magnetic Controlled Growth Rods
MCGR + MRI FDA Clearance

- 1.5 Tesla
- maximum spatial field gradient of 3000 gauss/cm
- temperature rises no more than 3.7°C after 15 mins
- 20 cm of scatter
**MCGR + MRI Clinical Study**

- 10 patients
- No patient harm
- No device harm
- Brain, C-spine, other areas OK

T, L Spine MRI unreadable
TABLE 4. Radiographic Results (Mean)

<table>
<thead>
<tr>
<th>Major curve magnitude (°)</th>
<th>Baseline</th>
<th>Postoperation</th>
<th>6 Months</th>
<th>12 Months</th>
<th>24 Months</th>
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<tbody>
<tr>
<td>Primary</td>
<td>61.3</td>
<td>34.3</td>
<td>36.7</td>
<td>38</td>
<td>39.1</td>
</tr>
<tr>
<td>Conversion</td>
<td>49.4</td>
<td>43.8</td>
<td>37</td>
<td>39.5</td>
<td>44</td>
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Cobb Angle did not improve

Spinal Deformity, 2016
Magnetically controlled Growing Rods for Early-onset Scoliosis

A Multicenter Study of 23 Cases With Minimum 2 years Follow-up

Pooria Hosseini, MD, MSc, * Jeff Pawelek, BS, * Gregory M. Mundis, MD, * Burt Yaszay, MD, † John Ferguson, MD, ‡ Ilkka Helenius, MD, § Kenneth M. Cheung, MD, †† Gokhan Demirkiran, MD, †‖ Ahmet Alanay, MD, ** Alpaslan Senkoylu, MD, †† Hazem Elsebaie, MD, ††† and Behrooz A. Akbarnia, MD*

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<tr>
<td>T1–T12 height (mm)</td>
<td>Primary</td>
<td>156.2</td>
<td>177.9</td>
<td>183.7</td>
<td>185.1</td>
</tr>
<tr>
<td>T1–S1 height (mm)</td>
<td>Primary</td>
<td>252.7</td>
<td>288.9</td>
<td>295.1</td>
<td>293</td>
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PRIMARY: Spine did NOT grow from 6-24 months
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<tr>
<td>Conversion</td>
<td>171.3</td>
<td><strong>185.7</strong></td>
<td>175.1</td>
<td>188.6</td>
<td><strong>180.2</strong></td>
</tr>
<tr>
<td>Conversion</td>
<td>270.3</td>
<td><strong>294.4</strong></td>
<td>275.8</td>
<td>289.8</td>
<td><strong>290.2</strong></td>
</tr>
</tbody>
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Conversion Surgery: Spine Shrunk

- Device collapse, PJK

Spinal Deformity, 2016
TGR: Law of Diminishing Returns - Controversial

# Lengthening

Gain (mm)

Autofusion by 5 years?
Growing-Rod Graduates: Lessons Learned from Ninety-nine Patients Who Completed Lengthening

Flynn, GSSG

• 86% new implants and fusion
• 10% growing rod exchange and fusion
• 62% described as “completely stiff” in op report
• 24% osteotomies

JBJS, 2013
Graduation Protocol After Growing-Rod Treatment: Removal of Implants without New Instrumentation Is Not a Realistic Approach

Ismail Aykut Kocyigit, MD, Z. Deniz Olgun, MD, H. Gokhan Demirkiran, MD, Mehmet Ayvaz, MD, and Muharrem Yazici, MD

• “Plan on having spine implants in forever”

• 9/10 implant removals had clinically important worsening of the deformity and required reimplantation with fusion.
Is There an Optimal Time to Distract Dual Growing Rods?

Michael D. Paloski, DOa, Paul D. Sponseller, MDba,*, Behrooz A. Akbarnia, MDC,d,
George H. Thompson, MDe, David L. Skaggs, MDF, Jeff B. Pawelek, BSD,
Phuong T. Nguyen, MAg, Susan M. Odum, PhDg, Growing Spine Study Group

> 9 months = <9 months
Cobb Angle
T1-S1 Length
Instrumented length gain

Spine Deform, 2014
# Pain is the Greatest Preoperative Concern for Patients and Parents Before Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis

Chan, Priscella MS; Skaggs, David L. MD; MMM; Sanders, Austin E. BA; Villamor, Gabriela A. BA; Choi, Paul D. MD; Tolo, Vernon T. MD; Andras, Lindsay M. MD

*Spine: November 1, 2017 - Volume 42 - Issue 21 - p E1245–E1250*

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<thead>
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<th>Patient</th>
<th>Parent</th>
<th>Surgeon</th>
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<tbody>
<tr>
<td>1 Pain</td>
<td>Pain</td>
<td>Shoulder Balance</td>
</tr>
<tr>
<td>2 Return to Activities</td>
<td>Neuro Injury</td>
<td>Neuro Injury</td>
</tr>
<tr>
<td>3 Neuro Injury</td>
<td>Amount of Correction</td>
<td>LIV Selection</td>
</tr>
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</table>