Master Technique – Growing Rods

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Disclosures (Growing Spine)

Growing Spine Foundation (a)
DePuy Spine (a,b)
Ellipse Tech. (a,b)
K2M (a,b)
Kspine (b)

a. Grants/Research Support
b. Consultant
c. Stock/Shareholder
d. Speakers’ Bureau
e. Other Financial Support
Growing Rod Technique Tips

- Patient selection
- Dual rod vs single rod
- Rod contour
- Level selection
- Subcutaneous or Submuscular
- Connectors
- Foundations (anchors)
- Lengthening and exchange
- Post-op care
Growing Rod Technique Tips

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Treatment Goals

- Deformity Correction (spine and chest) and maintenance of correction
- Improve pulmonary and spinal function
- Normalize the spinal growth and avoid early fusion (maintain mobility)
- Minimize complications
- Improve quality of life and the care of the patient
Indications for Growth-Friendly Surgery

- **Progressive** curves not controlled or amenable to bracing or casting
- Curves where *growth preservation* would be beneficial
- Curves that require management of both the **chest wall and the scoliosis**
Significance of sagittal alignment

- **Syndromic** patients with early onset scoliosis with thoracic **kyphosis over 40** degrees who undergo growing rod treatment should be monitored very closely for complications, particularly for implant failure.
08/01/2005
Cobb 82°
T1-T12 150 mm
T1-S1 219 mm

06/04/2012
Cobb 58°
T1-T12 195 mm
T1-S1 291 mm
Cumulative survivorship dropped for 52% after 7\textsuperscript{th} surgery (p<0.05)
New Data Suggests Benefit to Delaying Surgery
Growing Rod Surgery

• 13% less complications each year older child is at initial surgery
• 24% higher risk of complications with each surgery
• Length gained drastically reduced by 7th lengthening
• Weight gain occurs only in those >4 yrs old

Must weigh against risk of worsening curve

Does casting delay need for surgery?
Classification of EOS (C-EOS)

**Etiology**
- Congenital/Structural
- Neuromuscular
- Syndromic
- Idiopathic

**Cobb Angle**
1: <20°
2: 21-50°
3: 51-90°
4: >90°

**Kyphosis**
(-): <20°
N: 21-50°
(+): >50°

**APR Modifier**
- P0: <10°/yr
- P1: 10-20°/yr
- P2: >20°/yr
Validation Studies

*(ICEOS)*

Risk by Classification:

**Lower Risk of Rapid Failure**
- Congenital (21-50, 51-90); C2, C3
- Syndromic (21-50); S2
- Idiopathic (51-90); I3

**Higher Risk of Rapid Failure**
- Congenital (>90); C4
- Neuromuscular (>51-90); N3
- Neuromuscular (>90); N4
- Syndromic (51-90); S3

*Flynn, Vitale et al.*
Halo – Wheelchair

Halo – Standing Frame

C. Johnston TSRH
Conradi’s Disease

11 Months

20 Months
SR – AGE 2 PRE-OP
SR - 28 YARS POST-OP
SR Age 32
Growing Rod Technique Tips

- Patient selection
- **Dual rod vs single rod**
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Growing Rods
## RESULTS (cont’d)

<table>
<thead>
<tr>
<th>GROUP</th>
<th>Cobb Angle (Pre-Initial to Post Final)</th>
<th>% Correction</th>
<th>Increase in T1-S1 Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single with apical</td>
<td>85° → 65°</td>
<td>23%</td>
<td>6.4cm</td>
</tr>
<tr>
<td>Single w/o apical</td>
<td>61° → 39°</td>
<td>36%</td>
<td>7.6cm</td>
</tr>
<tr>
<td>Dual w/o apical</td>
<td>92° → 26°</td>
<td>71%</td>
<td>11.8cm</td>
</tr>
</tbody>
</table>
First Patient at TCSC
NF1

Courtesy of
Robert Winter, M.D.
Six years after fusion, now age 16
Hooks
Growing Rod Technique Tips

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At age 6 y.o and 2 years after growing rod insertion

Poor Selection of Instrumentation levels

No Cross link

Too Short
Growing Rod Technique Tips

- Patient selection
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- Rod contour
- Level selection
- **Subcutaneous or Submuscular**
- Connectors
- Foundations (anchors)
- Lengthening and exchange
- Post-op care
• Underwent first lengthening 6 months later
  - Post-op evaluation were normal
  - Curve T10-L2: 42 degrees
  - T1S1: 291 mm
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N.O. 5+11 Girl (IIS)

**Scoliosis:**
- Pre-op: 90°
- Post-op: 55°

**T1- S1(mm):**
- Pre-op: 224
- Post-op: 273
- FU: 331
- Elongation: 4.9
- Growth: 5.8
- Total: 10.7 cm
- 1.2 cm per year

Preop 6 years FU
6 year Follow-up
Post-op Rod change
MG – Loosening of hooks

9/2010
2/2011
Nutritional Improvement with Growing Rods

- Significant weight gain ($p=0.004$)
- 49% gained weight
  - 18 percentile increase

Myung, Skaggs, 2009
Screws Affected by Growth

Dr El-Sebaie

RESULTS

- No structural failures of the implants
- All failures were related to bone-implant interface
RESULTS

TYPICAL LOAD-DISPLACEMENT CURVES

<table>
<thead>
<tr>
<th>Displacement (mm)</th>
<th>Failure Force (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>250</td>
<td>3</td>
</tr>
<tr>
<td>500</td>
<td>6</td>
</tr>
<tr>
<td>750</td>
<td>9</td>
</tr>
<tr>
<td>1000</td>
<td>12</td>
</tr>
<tr>
<td>1250</td>
<td>15</td>
</tr>
</tbody>
</table>

- Screw-Screw without
- Screw-Screw with
- Hook-Hook
- Hook-Screw
Conclusion

- Four pedicle screws construct in two adjacent vertebrae had the highest failure load

- Cross Link does not seem to enhance the fixation

- Hook constructs are stronger in lumbar vs thoracic vertebra
Methods

- 20 EOS patients, treated with GR
- Foundations were classified as:
  - Adequate
  - Inadequate
- Adequate foundations defined as:
  - Combination of four hooks and a cross connector
  - Four pedicle screws
- Everything else defines as inadequate
Supra-laminar

Infra-laminar

Cross link

Adequate or Classic

Inadequate
Results

• Over all complication rate
  – Screws 12.3% (8/65)
  – Hooks 5.3% (7/131)
  – Mean time to complication: 20.8 months for screws and 17.7 months for hooks

• Complications in adequate group
  – Screws 2.7% (1/37)
  – Hooks 3% (3/99)

• Complications in inadequate foundations
  – Screws 25% (7/28)
  – Hooks 12.5% (4/32)
Biomechanical Evaluation of 4 Different Foundation Constructs Commonly Used in Growing Spine Surgery: Are Rib Anchors Comparable to Spine Anchors?

Behrooz A. Akbarnia, MD
Burt Yaszay, MD
Muharrem Yazici, MD
Nima Kabirian, MD
Kevin R. Strauss, ME
Diana Glaser, PhD
A unique fixture was designed to brace the specimen and provide a counter-force.
Pedicle Screw-Screw (SS)

Laminar Hook-Hook (HH)
Rib-Rib Hook (RR)

Transverse Process-Laminar Hook (TPL)
Results

• All specimens eventually failed at the **bone-anchor interface**. No failures were observed in the instrumentation utilized.

<table>
<thead>
<tr>
<th>Construct Type</th>
<th>Maximum load for failure (Mean &amp; Standard Deviation)</th>
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<tr>
<td>(Screw-Screw) SS</td>
<td>349 ± 89 N</td>
</tr>
<tr>
<td>(Laminar Hook-Hook) HH</td>
<td>283 ± 48 N</td>
</tr>
<tr>
<td>(Rib Hook-Hook) RR</td>
<td>429 ± 133 N</td>
</tr>
<tr>
<td>(Transverse Process-Laminar Hook-Hook) TPL</td>
<td>236 ± 60 N</td>
</tr>
</tbody>
</table>

Young’s Modulus was calculated for each construct type and no statistically significant difference was determined.
Rib to Spine
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• Lengthening and exchange
• Post-op care
Pre-lengthening: 350mm

Post-lengthening: 377mm

27 mm of lengthening
Rod Replacement

- Both rods were weak or broken at same level
How to Avoid and how to Treat Complications

- Patient selection (age, diagnosis...)
- Correct surgical procedure (levels, sagittal alignment, techniques of exposure and instrumentation)
- Early detection of potential complications
- Treatment of complication (long term goal)
- Minimize number of surgeries
Thank you