Safety and Quality in Early Onset Scoliosis – International Perspective

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Disclosures

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Risk of complications high in growth-friendly management

58% Traditional growing rods during 5-yr FU (Bess et al. JBJS 2010)
88% until graduation in severe EOS (Helenius et al. Spine 2019)

How can we improve safety? Is this improving our quality of care at the same time

Preoperative assessment
Perioperative care
Follow-up

Ideal Outcomes (Quality)
Minimum # of surgical procedures & complications
Best available correction and growth of spine
Preoperative assessment in EOS

Recognition of high risk patient groups
- Severe deformity
- Skeletal dysplasia
- Syndromic patients

Identification of associated medical conditions
- Heart (pulmonary hypertension, cardiomyopathy)
- Pulmonary (restrictive lung disease)
- Great vessels (Loews-Dietz, Marfan)
- Epilepsy

The value of multiciplinary preoperative conference
Orthopaedics, pediatrician, neurologist etc.
Orthopaedic surgeon has to have the final responsibility
Standardization of Perioperative Care

”When a particular work flow is variable, unpredictable, and ambiguous, it is impossible to differentiate practices which yield value from those that produce waste” Founder of Lean Methodology, Taiichi Ohno

How much we can standardize perioperative care of early onset scoliosis as compared with adolescent idiopathic scoliosis?

Much more surgical options: Growth guidance, distraction based, compression based techniques available

1st task would be to describe our thinking process
A Surgical Safety Checklist to Reduce Morbidity and Mortality in a Global Population

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William R. Berry, M.D., M.P.H., Stuart R. Lipsitz, Sc.D.,
Abdel-Hadi S. Breizat, M.D., Ph.D., E. Patchen Dellinger, M.D.,
Teodoro Herbosa, M.D., Sudhir Joseph, M.S., Pascience L. Kibatala, M.D.,
Marie Carmela M. Lapitan, M.D., Alan F. Merry, M.B., Ch.B., F.A.N.Z.C.A., F.R.C.A.,
Krishna Moorthy, M.D., F.R.C.S., Richard K. Reznick, M.D., M.Ed., Bryce Taylor, M.D.,
and Atul A. Gawande, M.D., M.P.H., for the Safe Surgery Saves Lives Study Group*

3733 vs. 3955 consecutive non-cardiac patients >16 years before and after implementation of surgical check list

Risk of death: 1.5% → 0.8% (p=0.003)

Risk of Inpatient complication: 11.0% → 7.0% (p<0.001)
Improving quality and safety in paediatric spinal surgery

THE TEAM APPROACH

F. Miyanji, B. Greer, S. Desai, J. Choi, J. Mok, M. Nitikman, A. Morrison

From British Columbia Children’s Hospital, Vancouver, Canada

Aims
The aim of this study was to evaluate improvements in the quality and safety of paediatric spinal surgery following the implementation of a specialist Paediatric Spinal Surgical Team (PSST) in the operating theatre.

Patients and Methods
A retrospective consecutive case study of paediatric spinal operations before (between January 2008 and December 2009), and after (between January 2012 and December 2013) the implementation of PSST, was performed. A comparative analysis of outcome variables including surgical site infection (SSI), operating time (ORT), blood loss (BL), length of stay (LOS), unplanned staged procedures (USP) and transfusion rates (allogeneic and cell-saver) was performed between the two groups. The rate of complications during the first two postoperative years was also compared between the groups.

Table III. Surgical outcomes

<table>
<thead>
<tr>
<th>Outcome variables of interest</th>
<th>Pre-PSST (n = 130)</th>
<th>Post-PSST (n = 277)</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical site infections, SSI, %</td>
<td>6.9</td>
<td>0.4</td>
<td>&lt; 0.001†</td>
</tr>
<tr>
<td>Mean operating time (ORT), mins (SD)</td>
<td>404.5 (14.4)</td>
<td>351.6 (6.7)</td>
<td>0.013†</td>
</tr>
<tr>
<td>Mean length of stay (LOS), days (SD)</td>
<td>14.3 (2.5)</td>
<td>8.9 (0.7)</td>
<td>0.019†</td>
</tr>
<tr>
<td>Mean estimated blood loss (BL), ml (SD)</td>
<td>909.1 (93.5)</td>
<td>580.2 (30.1)</td>
<td>0.135</td>
</tr>
<tr>
<td>Mean volume of allogeneic blood transfused volume, ml (SD)</td>
<td>268.7 (42.4)</td>
<td>86.9 (14.0)</td>
<td>&lt; 0.001†</td>
</tr>
<tr>
<td>Mean volume of cell-saver blood transfused volume, ml (SD)</td>
<td>201.5 (40.9)</td>
<td>87.3 (7.8)</td>
<td>0.401</td>
</tr>
<tr>
<td>Unplanned staged procedures (%)</td>
<td>6.2</td>
<td>2.9</td>
<td>0.001†</td>
</tr>
</tbody>
</table>
Early Onset Scoliosis (Before age of 10 years)

Not needing treatment: Resolving infantile
- RVAD<20 degrees
- Plagiocephaly typical
- Presenting before 4 months

Progressive EOS>30°
- Idiopathic: RVAD>20 degrees, Pedicles in phase 2
- Congenital scoliosis (CS), syndromic or neuromuscular (NMS)

Congenital Scoliosis with fused ribs
Myelodysplasia associated deformity

Chest Distractor (VEPTR)

Scoliosis <60°
- Idiopathic
- Syndromic, NMS (before 5 yrs)

Casting under anaesthesia

Scoliosis >60°
- Idiopathic, Syndromic, NMS

Growing Rods

Short angular deformity (CS)

Spinal osteotomy & short fusion
- Hemivertebrectomy
- Vertebral column resection

Magnetically controlled growing rods or Traditional growing rods if previous surgery, larger child

Helenius I. EOR 2018;3:287-293.
5-yr-old boy with Marfan
Conversion to MCGR – Is it safe?
Preliminary comparison of primary and conversion surgery with magnetically controlled growing rods in children with early onset scoliosis

Heli Keskinen¹ · Ilkka Helenius¹ · Colin Nnadi² · Kenneth Cheung³ · J. Ferguson⁴ · Gregory Mundis⁵ · Jeff Pawelek⁵ · Behrooz A. Akbarnia⁵
Neuromonitoring change

Standard rod exchange and difficult revision of fixation points results into left-sided loss of motor evoked signals

Bone loss around left-sided pedicle screws
Checklist Neuromonitoring change

Vitale et al. Spine Def 2015
Protocol: Neuromonitoring change

Checklist started

Turns out that pedicle probe has been too medial when preparing the revision screws

Surgery paused

MAP elevated >90mmHg

Hb, Arterial gas optimized

Left-sided MEPs return within 20 minutes

O-arm and navigation brought into the room

Navigated pedicle screws inserted without complications

No postoperative deficit
Screw Pull-Out with Neuro Deficit

Conversion to MCGR 2.5 years after index surgery (four Th PS & no cross-link)
1.5 years later screw pull-out and canal encroachment producing progressive paraplegia
After revision surgery complete recovery
107 severe EOS vs. 107 Matched moderate EOS

More complications in the severe group. Surgery can not be delayed beyond MC > 90°

Risk of neurologic deficits in severe EOS: 4.7% (5/107)

Mechanisms of neurologic deficits
1. Difficulties in placing upper thoracic pedicle screws revision (5 pts)
2. Pedicle screw pull-out (2 pts)
3. Correction of severe deformity (2 pts)

Other methods than pedicle screws should be considered at upper thoracic spine to improve safety at least in difficult revisions.

Neuromonitoring mandatory not only in index but also during revisions.
How should we end GR treatment?

After repeated lengthenings spine becomes stiff (autofusion) and no formal final fusion may be necessary allowing observation only (Jain et al. JBJS 2016)

Removal of GR instrumentation results into recurring deformity (Kocyigit et al. JBJS 2017)
Growing Rod Graduate

4-year-old girl with 94° idiopathic early onset scoliosis. 10-yr FU. Two rod fractures. No final fusion. 3 years follow-up after last lengthening / Courtesy of Professor Paul Sponseller, MD
Same patient as in the previous slide. Note elongation of vertebral bodies.
Mean 6-Year Follow-up of Magnetically Controlled Growing Rod Patients With Early Onset Scoliosis: A Glimpse of What Happens to Graduates

**BACKGROUND:** There is no agreement on frequency of distractions of magnetically controlled growing rods (MCGRs) but more frequent and smaller amounts of distractions mimic physiological spine growth. The mid- to long-term follow-up and management at skeletal maturity is unknown.

**OBJECTIVE:** To analyze patients with mean 6 yr of follow-up and describe the fate of MCGR graduates.

**METHODS:** Early onset scoliosis (EOS) patients treated with MCGRs with minimum 4 yr of follow-up and/or at graduation were studied. Parameters under study included Cobb angle, spine and instrumented lengths, and rod distraction gains. Relationship between timing of rod exchanges with changes in rate of lengthening was studied.

+ 10 children (mean age 10.1 years)
+ Min 4-yr FU (mean 6.1 years), mean 40.1 distractions
+ Mean T1-S1 growth (post-index - 4yr FU): 35 mm = 8.8 mm / year
+ 40% risk for rod distraction failure
+ 4 underwent posterior spinal fusion
  - Limited major curve correction (stiff spine)
  - Additional T1-S1 length gain 20 mm
  - Metallosis around the rod-anchor junction and extendable portion of MCGR
+ ”Surgeons should consider removal of the rods as soon as the patient is in the graduation stage”
Final Fusion after MCGR

Preop | Postop | 3yr | Final fusion
Perioperative Outcome in Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis

A Prospective Study Comparing Single Versus Two Attending Surgeons Strategy

Chris Yin Wei Chan, MS, Orth, and Mun Keong Kwan, MS, Orth

In AIS two attending surgeons shorten operative time (-30%, p<0.001) and reduce blood loss (-26%, p<0.05)

Postoperative morphine use reduced by 50%, p<0.001
Tranexamic acid is efficacious at decreasing the rate of blood loss in adolescent scoliosis surgery. A Randomized Placebo-Controlled Trial

Susan M. Goobie, MD, FRCPC, David Zurakowski, PhD, Michael P. Glotzbecker, MD, Mary E. McCann, MD, MPH, Daniel Hedequist, MD, Robert M. Brustowicz, MD, Navil F. Sethna, MD, Lawrence I. Karlin, MD, John B. Emans, MD, and M. Timothy Hresko, MD

Tranexamic acid 50 mg/kg as a bolus and infusion 10 mg/kg/h

Significant reduction in intraoperative and postoperative drain output

Level I evidence
• Gelatin matrix with human thrombin
  – Decreased blood loss by 171 mL (-31%), p = 0.027
  – Hb decreased less (-6g/l), p = 0.013
  – Level I evidence
Preemptive Pregabalin: No Reduction in Pain or Opioid Use

- Double-blind, randomized clinical trial on 63 children undergoing posterior spinal fusion (Level I evidence) JBJS 2020, in press.
Our intraoperative protocol

- Dedicated Spine Team (Surgical & Anesthesiology)
- Tranexamic acid 30mg/kg iv + bolus 10mg/kg/h
- Cefuroxime 30mg/kg iv 15 min before incision
- Two attending surgeons
- Use of gelatin matrix with human thrombin for bleeding pedicles & tunneling if bleeds
- O-arm & navigation in every revision of fixation points
Postoperative care

- At our institution at postoperative intensive care unit
  - MAP aim for 24 hours postop
  - Mobilization more than difficult than on ward
- Do we need brace?
- Standardization of lengthening intervals and final fusion
Conclusions

Description of protocols is important to reduce variability
  Anaesthetic and surgical protocols
  How to select method: MCGR, TGR, VEPTR etc

Checklist to increase awareness
  WHO surgical checklist (preop & postop)
  Checklist for neuromonitoring change

Difficult to provide Level I evidence on early onset scoliosis
  RCT on MCGR vs. TGR ongoing (PSSG)
  Extrapolation from AIS studies typically employed