Early Onset Scoliosis Treated by Magnetically Controlled Growing Rods: Mid to Long-term Follow-up including 5 Graduates

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Disclosures

• Nil
Introduction

Magnetically-controlled growing rods (MCGR)
• Non-invasive distractions done at out-patient clinic
• No anaesthesia needed for distractions
• More frequent distractions to mimic normal spinal growth
• Potential cost-saving benefit at 4yrs
  • Wong JOS 2017

Magnetically controlled growing rods for severe spinal curvature in young children: a prospective case series

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Objective

- Most of the literature is based on short-term follow-up
- Behavior at mid to long-term FU not clarified

**Aim:**
1. Minimum 4 years follow-up of EOS patients with MCGR treatment
2. Outcomes of MCGR graduates
Methods

• Prospective EOS study
• Single and dual MCGRs since December 2009
• At least 4 years post-implantation FU
• Intended 2 mm distraction length monthly

• Parameters
  • Coronal & Sagittal Cobb Angle
  • T1-12, T1-S1, instrumented length
  • Expected vs Achieved lengthening

• Statistical Analysis
  • Wilcoxon Signed Rank Test
  • $P$-value of $< 0.05$ considered significant
Results

- 10 patients (M:3 and F:7)
  - Idiopathic: 4
  - Congenital: 1 (conversion from TGR)
  - Syndromal: 3
  - Neurofibromatosis: 2

- Mean
  - Age at diagnosis: 6.3 ± 4.7 yrs
  - Age at rod implantation: 10.1 ± 3.5 yrs
  - FU 6.1 ± 1.3 yrs
  - Distractions: 40.1 ± 20.7
<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Immediate post-operative</th>
<th>1-year</th>
<th>2-year</th>
<th>3-year</th>
<th>4-year</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>10.1±3.5</td>
<td></td>
<td>11.1±3.4</td>
<td>12.1±3.4</td>
<td>13.1±3.4</td>
<td>14.1±3.4</td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>130.9±12.3</td>
<td></td>
<td>135.9±15.2</td>
<td>136.9±12.1</td>
<td>141.0±18.4</td>
<td>143.4±9.9</td>
<td>0.002</td>
</tr>
<tr>
<td>Coronal Cobb angle (°)</td>
<td>58.2±9.2</td>
<td>27.7±7.2</td>
<td>28.7±7.8</td>
<td>31.7±11.3</td>
<td>34.1±12.3</td>
<td>30.5±10.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sagittal Cobb angle (°)</td>
<td>34.9±22.1</td>
<td>21.5±11.0</td>
<td>30.7±31.3</td>
<td>33.3±21.0</td>
<td>25.0±15.6</td>
<td>28.0±15.2</td>
<td>0.20</td>
</tr>
<tr>
<td>T1-12 length (mm)</td>
<td>200.2±24.4</td>
<td>207.1±24.9</td>
<td>220.0±25.2</td>
<td>221.1±30.5</td>
<td>227.4±28.7</td>
<td>229.8±21.3</td>
<td>0.001</td>
</tr>
<tr>
<td>T1-S1 length (mm)</td>
<td>327.1±35.4</td>
<td>342.8±44.7</td>
<td>352.5±41.5</td>
<td>361.1±44.1</td>
<td>370.8±38.0</td>
<td>378.2±40.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Instrumented length (mm)</td>
<td>226.8±43.4</td>
<td>238.7±40.4</td>
<td>243.2±45.3</td>
<td>250.7±36.1</td>
<td>287.9±55.9</td>
<td></td>
<td>0.005</td>
</tr>
<tr>
<td>Left rod expected lengthening (mm)</td>
<td>2.2±0.8</td>
<td>20.5±3.1</td>
<td>35.0±21.1</td>
<td>30.1±14.3</td>
<td>45.5±16.7</td>
<td></td>
<td>0.001</td>
</tr>
<tr>
<td>Right rod expected lengthening (mm)</td>
<td>2.1±0.7</td>
<td>20.5±4.3</td>
<td>31.2±18.8</td>
<td>40.0±15.8</td>
<td>55.4±16.7</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Left rod achieved lengthening (mm)</td>
<td>1.9±0.7</td>
<td>18.2±6.5</td>
<td>22.2±12.1</td>
<td>23.9±7.6</td>
<td>36.6±10.8</td>
<td></td>
<td>&lt;0.001</td>
</tr>
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<td>Right rod achieved lengthening (mm)</td>
<td>2.3±0.9</td>
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<td>33.2±9.5</td>
<td></td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Change in Coronal and Sagittal Cobb Angle – Pre-op to 4 years Post-op
Persistent gains especially T1-S1 & Instrumented length
Expected lengths did NOT translate to achieved lengths
MCGR - Rate of lengthening and height

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>1 year</th>
<th>2 year</th>
<th>3 year</th>
<th>4 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of rod exchange</td>
<td>0.0</td>
<td>16.3</td>
<td>4.0</td>
<td>1.7</td>
<td>3</td>
</tr>
<tr>
<td>Left - Rate of lengthening</td>
<td>0.0</td>
<td>12.2</td>
<td>7.4</td>
<td>-0.1</td>
<td>11.3</td>
</tr>
<tr>
<td>Right - Rate of Lengthening</td>
<td>0.0</td>
<td>5.0</td>
<td>0.9</td>
<td>4.1</td>
<td>2.4</td>
</tr>
<tr>
<td>Rate of Height</td>
<td>0.0</td>
<td>5.0</td>
<td>0.9</td>
<td>4.1</td>
<td>2.4</td>
</tr>
</tbody>
</table>
Subgroup analyses

- **Younger** 5.8 ±1.2yrs vs **older** 12.0 ±2.1yrs

- Younger group had **more length gain** before first rod exchange
  - 34.1 ± 4.2mm vs 28.8 ±15mm

- **Duration of distraction**
  - 31.6 ±13.7mths vs 25.7 ±16.3mths
Revision/complications

• 7 patients had one rod exchange

• Complication rate (40% of patients)
  • PJK (n=2)
  • Distraction failure (n=3)
  • Infection (n=1)
  • Nonunion of proximal foundation (n=1)
  • Metallosis (n=6)
# Pre- and Post-final Surgery Parameters for MCGR Graduates

<table>
<thead>
<tr>
<th></th>
<th>Coronal Cobb angle (°)</th>
<th>Sagittal Cobb angle (°)</th>
<th>T1-12 spine length (mm)</th>
<th>T1-S1 spine length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Final fusion (n=4)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-final fusion</td>
<td>37.1±11.1</td>
<td>30.6±21.9</td>
<td>244.4±37.6</td>
<td>385.7±56.0</td>
</tr>
<tr>
<td>Post-final fusion</td>
<td>30.0±8.9</td>
<td>31.1±20.8</td>
<td>251.2±40.7</td>
<td>405.7±40.4</td>
</tr>
<tr>
<td>2-year post-final</td>
<td>34.0±11.4</td>
<td>29.4±25.1</td>
<td>253.8±26.8</td>
<td>405.9±49.0</td>
</tr>
<tr>
<td><strong>p-value</strong></td>
<td>0.273</td>
<td>0.068</td>
<td>0.273</td>
<td>0.715</td>
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</tbody>
</table>

|                      |                        |                         |                         |                         |
| **Rod explant without fusion (n=1)** |                        |                         |                         |                         |
| Pre-explant          | 52.2                   | 49.6                    | 200.6                   | 328.1                   |
| Post-explant         | 58.6                   | 44.6                    | 191.1                   | 332.7                   |
| 2-year post-explant  | 58.4                   | 40.9                    | 199.7                   | 336.8                   |
Discussion

• Consistent rod and spine length gains are observed
  • Do not expect full 4.8cm lengthening

• Diminishing returns after certain rod usage

• Complications and re-operation rates are high due to rod distraction failure and proximal functional problems

• MCGR graduates have limited correction during final surgery

• Possible rod explant without fusion
Thank You