

3-monthly 5 mm distractions (n=4, mean age 4.6 yrs) protocols. Body heights and X-rays were taken every 6 months. Rod length, coronal and sagittal Cobb angles, and proximal junctional angle were measured to determine rod length gain, curve progression and proximal junctional kyphosis (PJK).

**Results:** The greatest curve correction occurred at the initial surgery and was stable thereafter. The targeted increment length of 2 mm were only achieved in 7.5% of distraction attempts for the monthly distraction group, whereas the 5 mm targeted increment were achieved in 33% of attempts in the 3-monthly group (p=0.01). More increments of rod length were noted at the beginning of follow-up, and gradually decreased until the rods ran out at around 30 months in both groups. At 30-month follow up, there were no difference in height gain (12.8 vs 14.8 cm), and distracted rod length between both groups (4.0 vs 3.8 cm). There were also no differences in coronal Cobb angle (30.5° vs 28.9°), sagittal Cobb angle (28.0° vs 32.0°), proximal junctional angle (11.0° vs 15.9°) and rate of PJK occurrence between both groups at 4-year follow up.

**Conclusion:** This is the first study to compare two standardized distraction protocols for MCGR treatment. Variation in distraction frequency had no effect on rod length gain and curve control. However, target increment were more often achieved in the less frequent distraction attempts.

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## Paper #21

### Diminishing Returns of Magnetically Controlled Growing Rod Lengthenings Over Time

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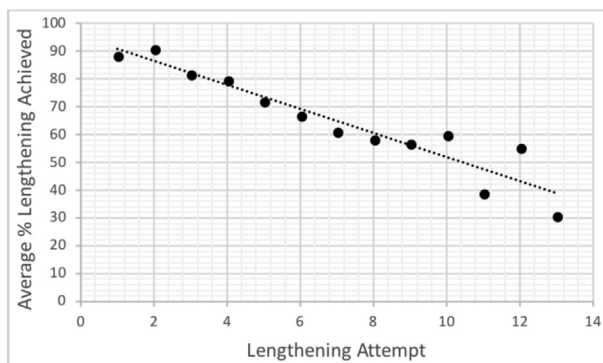


**Summary:** The law of diminishing returns appears to apply to distraction of magnetically controlled growing rods as the number of attempted lengthenings increases in patients with early onset scoliosis. In this series of 34 patients with a mean of 8.88 lengthening attempts, the average distraction achieved decreased from 88.49% to 31.0% between the 1st and 13th lengthening attempts.

**Hypothesis:** The amount of distraction of magnetically controlled growing rods (MCGRs) decreases over time.

**Introduction:** Magnetically controlled growing rods (MCGR) are used in early onset scoliosis (EOS) to stabilize a curve while maintaining spinal growth potential and avoiding repeated exposure to anesthesia. It is known that the law of diminishing returns applies to traditional growing rods (TGR) but few studies exist on the repeated ability to distract MCGRs.

**Methods:** A retrospective analysis of prospectively collected data was performed. Patients who underwent MCGR placement for EOS with a



minimum 2 years follow-up were identified. Demographics, lengthening data (# of lengthenings, time between lengthenings, % distraction achieved), and complications were analyzed. Distraction was measured by ultrasound for all but 7 of 302 lengthenings, which were measured on x-ray.

**Results:** 34 patients (19 male and 15 female) met inclusion criteria, including 20 primary and 14 conversion. Diagnoses included 8 idiopathic, 2 spinal muscular atrophy (SMA) I, 2 SMAII, 2 tethered cord, 1 congenital, and 19 other syndromes. Mean age at MCGR insertion was 7.8±2.77 years (range 4.1-12.2). Mean follow-up was 31.8±5.54 months (range 24.1-42.0). A total of 302 lengthening attempts were made. Each patient underwent a mean 8.88±1.96 (range 3-13) attempted lengthenings. Average distraction at 1st lengthening was 88.49% and decreased to 31.0% at the 13th attempt (Fig. 1). All patients initially had 2 rods placed; 1 patient had 1 rod converted to a TGR after 4 lengthenings. There were 5 complications in 5 patients; 4 required hardware revision and 1 had an infection requiring irrigation and debridement with retained hardware.

**Conclusion:** The amount of distraction obtained over time of MCGR rods for EOS decreased as the number of attempted lengthenings increased. The law of diminishing returns applies to MCGRs as it does to TGRs.

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## Paper #22

### 18% of EOS patients Treated with MCGR have Minimal Lengthening Episodes Resulting in < 1 mm of Distraction

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**Summary:** 18% of EOS patients Treated with MCGR have Minimal Lengthening Episodes Resulting in < 1mm of Distraction.

**Hypothesis:** In early-onset scoliosis (EOS) patients treated with magnetically controlled growth rods (MCGR), a large proportion of lengthening attempts producing minimal distraction will be followed by subsequent successful lengthening.

**Introduction:** MCGR allow deformity correction and spinal lengthening in EOS patients. There is limited information in the literature on the amount of MCGR distraction per lengthening episode and the outcome of patients that experience minimal distraction.

**Methods:** A multicenter, retrospective review of EOS patients who underwent MCGR implantation between 2014-2017 was performed. Inclusion criteria were age < 10 years at index surgery, ≥1 year follow-up, and at least one lengthening attempt. Patients were excluded if intended and actual lengthening were not documented. Minimal lengthening (ML) was defined as a lengthening attempt with intended lengthening ≥ 3 mm and actual lengthening < 1mm.

**Results:** 205 patients met inclusion criteria; 36/205 (18%) patients had at least 1 ML and the following diagnoses: neuromuscular (N = 13), idiopathic (N= 9), congenital (N=9) and syndromic (N=5). Mean age at index surgery for patients with at least 1 ML was 7.4 years (range: 4.1 to 9.9 years) and mean follow-up was 2.3 years (range: 1.0 to 3.9 years). Of the 36 patients with at least 1 ML, 6/36 (17%) had revision surgery following ML and 8/36 (22%) had 1 ML and no further documented lengthening attempts. Of the remaining 22 patients with ML and further documented lengthening attempts, 15/22 (68%) patients had a single ML followed by subsequent successful lengthening; 5/22 (23%) had 2