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Comparison of Percentile Weight Gain of Growth-Friendly Constructs in Early-Onset Scoliosis

Liam R. Harris, MD[a], Lindsay M. Andras, MD[a], Paul D. Sponseller, MD[b], Charles E. Johnston, MD[c], John B. Emans, MD[d], David L. Skaggs, MD, MMM[a,*], Growing Spine Study Group[e]

[a]Children's Orthopaedic Center, Children's Hospital Los Angeles, 4650 Sunset Blvd, Los Angeles, CA 90027, USA
[b]Department of Orthopaedic Surgery, Johns Hopkins University, Baltimore, MD 21218, USA
[c]Department of Orthopaedic Surgery, Texas Scottish Rite Hospital for Children, 2222 Welborn St, Dallas, TX 75219, USA
[d]Department of Orthopaedic Surgery, Boston Children's Hospital, 300 Longwood Ave, Boston, MA 02115, USA
[e]Growing Spine Study Group, Growing Spine Foundation, 555 East Wells Street, Suite 1100, Milwaukee, WI 53202, USA

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Abstract

Study Design: Multicenter retrospective cohort.
Objective: To compare improvement in nutritional status seen in early-onset scoliosis (EOS) patients following treatment with various growth-friendly techniques, especially in underweight patients (<20th weight percentile).
Background: Thoracic insufficiency resulting from EOS can lead to severe cardiopulmonary disease. In this age group, pulmonary function tests are often difficult or impossible to perform. Weight gain has been used in prior studies as a proxy for improvement and has been demonstrated following VEPTR and growing rod implantation. In this study, we aim to analyze weight gain of EOS patients treated with four different spinal implants to evaluate if significant differences in weight percentile change exist between them.
Methods: Retrospective review of patients treated surgically for EOS was performed from a multicenter database. Exclusion criteria were index instrumentation at >10 years old and <2 years' follow-up.
Results: 287 patients met the inclusion criteria and etiologies were as follows: congenital = 85; syndromic = 79; neuromuscular = 69; and idiopathic = 52. Average patient age at surgery was 5.41 years, with an average follow-up of 5.8 years. Preoperatively, 55.4% (162/287) fell below the 20th weight percentile. There was no significant difference in preoperative weight between implants (p = .77), or diagnoses (p = .25). Among this group, the mean change in weight percentile was 10.5% (range: −16.7% to 88.7%) and all implant groups increased in mean weight percentile at final follow-up. There were no significant differences in weight percentile change between the groups when divided by implant type (p = .17).
Conclusions: Treatment of EOS with growth-friendly constructs resulted in an increase in weight percentile for underweight patients (<20th percentile), with no significant difference between constructs.
Level of Evidence: Level III.

Keywords: Early-onset scoliosis; Weight gain; Nutrition; Growth-friendly construct; Growing rod; VEPTR; Guided growth; Malnutrition

IRB Approval: This study has been carried out with approval from the Institutional Review Board at Children's Hospital Los Angeles.

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*Corresponding author. Children's Orthopaedic Center, Children's Hospital Los Angeles, 4650 Sunset Blvd., Mailstop #69, Los Angeles, CA 90027, USA. Tel.: (323) 361-4658; fax: (323) 361-1310.
E-mail address: dskaggs@chla.usc.edu (D.L. Skaggs).

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Introduction

The effect of spinal deformity on pulmonary function is well established [1-4]. In particular, early-onset scoliosis (EOS) frequently results in the development of thoracic insufficiency, with increased work of breathing often leading to subsequent nutritional deficiency, malnutrition, and decreased body mass index (BMI) [5-9]. Malnutrition among patients undergoing spinal surgery is in turn associated with increased risk of overall complications, postoperative infection, and hospital admission [10-12]. Consequently, nutritional deficiencies in children with EOS have come to represent a pressing issue in the long-term treatment and care of these patients. Additionally, given that patients in these age groups are often unable to perform pulmonary function testing because of their age, the pulmonary literature has used weight gain as a proxy for improvement in work of breathing and general well-being [13,14]. To this end, the effect of surgical treatment of EOS on weight gain and increases in percentile weight among these patients has become a useful adjunct in evaluating EOS patients.

In a cohort of 88 patients, Myung et al. found significant improvement in BMI among EOS patients older than four years treated with growing rod implantation [15]. Similarly, a study by Skaggs et al. demonstrated significant improvement in weight percentile in spinal deformity patients at risk of developing thoracic insufficiency that were treated with VEPTR constructs [16]. As the number of options for growth-friendly constructs increases, an understanding of their efficacy in improving respiratory function and resultant nutritional measures is becoming increasingly significant. Understanding differences in nutritional improvement among constructs, and between diagnoses, may allow for more refined surgical decision making. Although the efficacy of these procedures in the mechanical correction of spinal curvature has been demonstrated, comparative investigation of their impact on nutritional status and weight gain has not been conducted [17-24].

In this study, we aim to determine if differences in type of growth-friendly implants for the treatment of EOS result in differences in weight gain following surgery.

Materials and Methods

Collection

A multicenter EOS database of patients was queried to identify patients that underwent growing rod (with either spine or proximal rib anchors), VEPTR, or growth guidance (Shilla) implantation. Exclusion criteria included subjects older than 10 years at primary surgery, use of a thoracotomy during surgery, and follow-up less than two years. A total of 287 patients from 16 centers met these criteria.

Patient age at initial surgery, BMI before surgery, type of surgical implant, Cobb angle, and total number of surgeries were obtained. Weight measurements, Cobb angle, and weight were recorded at regular follow-ups and tracked along the weight percentile growth curve for child gender and age for a minimum of two years. The weight percentile growth curves utilized for data collection and analysis were obtained from the CDC and used for children over the age of two years. These curves follow the average weight percentile for children based on gender and age.

Analysis

Generalized estimating equation analysis was used for univariate evaluation of the relationship between patient weight percentile and implant class, diagnosis class, primary Cobb angle, and time postsurgery. This statistical method approach was used to adjust the correlation within subjects for repeated measure. In addition, multivariate analysis using generalized estimating equation was utilized to examine the influence of implant class on patients' weight percentile after controlling for other covariates. The results were summarized in coefficient estimate that represents the linear relationship between weight percentile and study variables (implant class, diagnosis class, primary Cobb angle, and time postsurgery) with 95% confidence interval and significance of the relationship between weight percentile and study variables in p value. All analyses were based on a two-sided test at the 5% significance level.

Results

A total of 287 patients met the inclusion criteria, with an average follow-up of 5.79 years (range: 2.01–14.48). The average age at index surgery was 5.42 years, with a range of 0.88–8.99. Average preoperative Cobb angle was 76.36° (range: 18°–138°). There was no significant association between age at index surgery ($p = .444$), length of follow-up ($p = .326$), or preoperative Cobb angle ($p = .370$) and change in weight percentile following surgery.

Patients were classified by diagnosis according to C-EOS described by Williams et al., with patients grouped into four etiologies: congenital, neuromuscular, syndromic, and idiopathic [25]. Using this classification, there were 86 congenital cases, 80 syndromic cases, 69 neuromuscular cases, and 52 idiopathic cases.

Mean weight percentile for the total group was 27.9 (range: 0.5–99.0, ±31.5) at their preoperative visit. Average final weight percentile was 31.91 (range: 0.52–99.48, ±33.84), with a mean change in weight percentile of +4.0 percent (range: −98.0 to 88.7, ±28.74). A total of 136 patients increased in weight percentile.

Ninety-five percent (272/287) of patients decreased in Cobb angle at final follow-up, with an average Cobb angle at final follow-up of 45° (range: 2°–105°, ±18.75°) and average change in Cobb angle of 32° (range: −36° to 93°, ±20.95°). There was a weak, yet significant, association between greater improvement in Cobb angle and increase