Spine Deformity

www.spine-deformity.org

Spine Deformity 5 (2017) 277–282

Radiographic Outcomes of Shilla Growth Guidance System and Traditional Growing Rods Through Definitive Treatment

Scott J. Luhmann, MD[a,b,*], June C. Smith, MPH[c], Ann McClung, RN, BSN[d], Frances L. McCullough, RNP, MNSc, ONC[e], Richard E. McCarthy, MD[e], George H. Thompson, MD[f], Growing Spine Study Group

[a]*St Louis Shriners Hospital, 4400 Clayton Ave, St Louis, MO 63110, USA*
[b]*St Louis Childrens Hospital, One Childrens Place, St Louis, MO 63110, USA*
[c]*Wash U Ortho Surgery, 660 S. Euclid Ave, Campus Box 8233, St Louis, MO 63110, USA*
[d]*Growing Spine Study Group, Growing Spine Foundation, 555 East Wells St., Suite 1100, Milwaukee, WI 53202, USA*
[e]*Akansas Childrens Hospital, 1 Childrens Way, Little Rock, AR 72202, USA*
[f]*Rainbow Babies & Childrens Hospital, 11100 Euclid Ave, Cleveland, OH 44106, USA*

Received 15 August 2016; revised 25 January 2017; accepted 28 January 2017

Abstract

Study Design: Retrospective review of a multicenter database.
Objectives: To compare the radiographic outcomes of patients who had undergone the Shilla Growth Guidance System (SGGS) and traditional growing rod (GR) treatment for management of early-onset scoliosis (EOS) through definitive treatment.
Summary of Background Data: The efficacy of surgical treatment of EOS can only be determined after definitive treatment has been completed. We wanted to review our experience with the SGGS and GR for management of EOS through definitive treatment.
Methods: Patients who had surgical treatment with SGGS or GR and had undergone definitive treatment were included. The patients were matched by age, preoperative curve magnitude, and diagnosis. The study population consisted of 36 patients (18 in each group) whose mean age at initial surgery was as follows: SGGS, 7.9 years; and GR, 7.7 years (not significant [NS]). Length of follow-up after initial surgery was 6.1 years for SGGS and 7.4 years for GR (NS). Definitive treatment was posterior spinal fusion (15 SGGS, 17 GR), implant removal (3 SGGS), or completion of lengthenings (1 GR).
Results: The preoperative curve was 61 degrees for SGGS and 65 degrees for GR (NS). After index surgery, the major curve decreased to 24 degrees (−37 degrees) for SGGS and 38 (−27 degrees) for GR ($p < .05$). At last follow-up, the major curve was 34 degrees (44%) for SGGS and 36 degrees (45%) for GR (NS). The initial T1–T12 length for SGGS was 188 mm and for GR, 181 mm; at last follow-up, SGGS was 234 mm (46 mm increase) and GR was 233 mm (52 mm increase) (NS).
Conclusion: Our analysis shows the final radiographic outcomes (and changes) and complications (implant-related and infection) between the SGGS and GR groups were not statistically different. The main difference between the two groups was the threefold difference in overall surgeries.

Keywords: Early onset scoliosis; Growing spine; Shilla Growth Guidance System; Growing rods

Author disclosures: SJL (personal fees from Medtronic, Styker, Orthofix, Globus Medical, and Lippincott, outside the submitted work); JCS (none); AM (none); FLM (none); REM (other from Medtronic, outside the submitted work; and Medtronic consultant to teach Shilla procedure); GHT (personal fees from Wolters Kluwer, OrthoPediatrics, Shriner's Hospitals for Children, Broadwater, Medtronics, and Stryker; other from SpineForm and SICOT, outside the submitted work); Growing Spine Study Group (grants from Growing Spine Foundation, during the conduct of the study; grants from Nuvasive, outside the submitted work; in addition, The Growing Spine Foundation financially supports the Growing Spine Study Group, which provided the research data for this study. The GSF receives donations from the study group's surgeon members, medical device industry, grateful patients, and other donors).

This study was financially supported by the Growing Spine Foundation.

*Corresponding author. St. Louis Children's Hospital, 1 Children's Place, Suite 4S60, St. Louis, MO 63110, USA. Tel.: (314) 747-4705; fax: (314) 454-4562.

E-mail address: luhmanns@wustl.edu (S.J. Luhmann).

2212-134X/$ - see front matter
http://dx.doi.org/10.1016/j.jspd.2017.01.011

Introduction

The implications of early-onset scoliosis (EOS) on the pulmonary system, due to shortening and distortion of the spine and ribs, have been well described in the literature [1-3]. Treatment of EOS has focused on maximizing pulmonary development by improving/controlling the spinal deformity while optimizing the vertical growth of the thoracolumbar spine [4,5]. Mild to moderate spinal deformities can typically be managed through medical/interventional means, whereas severe spinal deformities require operative interventions.

Dual-rod, distraction-based constructs, or "growing rods" (GRs), popularized by Akbarnia et al., have become the surgical standard of care for severe EOS [5]. Since their initial report, other researchers have supported the efficacy and safety of GRs, but have also identified limitations, or drawbacks, of traditional GR treatment. Traditional GRs require intermittent operative lengthenings, which translates to multiple anesthetics and increasing risk of deep wound and implant infections [6]. Additionally, gradual stiffening of the spine, over the levels of instrumentation, has been reported, with the decreasing ability to lengthen the spine [7,8]. In response to these drawbacks, the Shilla Growth Guidance System (SGGS) was developed [9]. This growth modulation concept centers on maximally correcting, and fusing, the apex of the spinal deformity while guiding cephalad and caudal spinal growth along spinal rods, without active distraction [10]. Two comparative studies have reported midterm outcomes with conflicting results [11,12]. No study thus far has compared these two surgical interventions at the most important time point, specifically after the completion of treatment. The purpose of this study was to compare the outcomes of patients who had undergone SGGS and traditional GR treatment for management of EOS through definitive treatment.

Methods

After Internal Review Board approval, a multicenter EOS database was queried to identify all patients who underwent surgical treatment with SGGS or GR and had undergone definitive treatment of their spinal deformity. The patients were matched between the two surgical treatments by age, preoperative curve magnitude, and diagnosis. Inclusion criteria were age <10 years at time of surgery treated with GR or SGGS for their EOS, follow-up through definitive treatment, and complete data set. We selected 18 patients from a possible 155 GR patients who met the inclusion criteria. These 155 patients had a mean age of 7 years at the GR index procedure and a mean coronal Cobb measure of 75 degrees. Demographic and radiographic data were collected. Routine radiographic measures (ie, major curve measure, sagittal alignment, etc.) were collected at the preoperative, post-index, predefinitive treatment and final follow-up time points. Spinal height was quantified by the T1–T12 and T1–S1 lengths. Changes in the radiographic measures were additionally calculated: preoperative to final, post-index to predefinitive, and predefinitive to final. Complications available in the database were collected, and included rod fracture, anchor pullout, infection, skin problems and medical complications.

Pulmonary function studies and computed tomography (axial rotation and pulmonary volume quantification) were not part of the routine clinical care. Paired *t* test was used to test for significant differences from each time. SPSS 23.0 (SPSS Inc., Chicago, IL) was used for statistical analysis. A subanalysis was additionally performed only on patients in both groups who had undergone a definitive posterior spinal fusion/instrumentation. Statistical significance was determined at the $p < .05$ level.

Results

The study population consisted of 36 patients (18 in each group) (Table 1). In the SGGS group, there were 8 idiopathic, 7 neuromuscular, 3 syndromic, and 0 congenital patients. In the GR group, there were 9 idiopathic, 7 neuromuscular, 1 syndromic, and 1 congenital patient. The mean age at initial surgery was as follows: SGGS, 7.9 years; and GR, 7.7 years ($p > .05$; not significant [NS]). The overall mean number of surgeries was 3.1 (range: 1–7, standard deviation 1.5) for SGGS and 9.3 (range: 4–24, standard deviation 4.8) for GR (including 5.8 lengthenings). Mean length of follow-up after initial surgery was 6.1 years for SGGS and 7.4 years for GR. Definitive treatment

Table 1
Summary.

	Growing rod	Shilla
Number of patients	18	18
Diagnosis		
Idiopathic	9	8
Neuromuscular	7	7
Syndromic	1	3
Congenital	1	0
Age at initial surgery	7.7	7.9 (p = .84)
Age at most recent visit	14.9	14.0 (p = .25)
Years of follow-up	7.4	6.1 (p = .23)
Time between initial surgery and last visit (years)	6.3	4.4
Total number of surgeries (includes PSF)	9.3 (4–24)	3.1 (1–7)
Number of lengthenings	5.8 (4–13)	
Definitive treatment		
Fusion	17	15
Removal of implants		3
Discontinuation of lengthening	1	

PSF, posterior spinal fusion.