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Serial Derotational Casting in Idiopathic and Non-Idiopathic Progressive Early-Onset Scoliosis

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Abstract

Introduction: Serial derotational casting has been used as a definitive treatment or as delaying strategy in progressive idiopathic (IS) and non-idiopathic (NIS) early-onset scoliosis (EOS).
Methods: Retrospective chart and radiographic review of patients who underwent serial casting for progressive EOS between 2005 and 2012 at a single institution.
Results: A total of 74 consecutive patients entered serial cast treatment. Twenty-eight were currently being casted, 30 completed cast treatment and were converted to thoracolumbosacral orthosis (TLSO), 9 were treated surgically, 6 were lost to follow-up, and 1 had no further treatment. The researchers diagnosed IS in 41 patients; 33 had NIS. At presentation the IS group had an average Cobb angle (CA) of 49° and a rib vertebral angle difference (RVAD) of 37°. The NIS group had a CA of 51° ($p = .69$) and RVAD of 37° ($p = .94$). In patients currently being casted, 19 IS patients had a decreased CA, from 47° to 27°. The 9 NIS patients had a decreased CA, from 62° to 57° ($p = .0002$). Cobb angle improvement was significantly better in IS ($p = .0005$). In the TLSO group the 17 IS patients had a decreased average CA, from 46° to 18°, after serial casting and the 13 NIS patients decreased CA from 42° to 32°. Patients with IS had better improvement in CA than the NIS group ($p < .001$). At last follow-up, this was reduced to 11° in the IS group and maintained at 32° in the NIS. In the IS group, 5 of 41 patients were converted to growth constructs, and 4 of 26 in the NIS group. Casting initiated before age 2 years yielded better curve correction for IS ($p < .01$) compared with NIS.
Conclusions: Progressive idiopathic scoliosis patients had better curve correction with casting than NIS patients. Casting in IS patients before age 24 months yielded better curve correction. Patients who required surgery had a higher age and Cobb angle at presentation than those who transitioned to a TLSO. The surgical group was observed for a similar duration of time and there was no significant statistical difference. Although RVAD is a predictor of progression in infantile IS, it did not show a predictive value in the response to casting of either the IS or NIS groups.

Keywords: Scoliosis; Early-onset scoliosis; Idiopathic infantile scoliosis; Serial derotational casting

Introduction

Casting has been used as a definitive or delaying modality for the treatment of progressive early-onset scoliosis (EOS). The underlying etiology and factors that lead to curve progression remain unclear. Often, progressive EOS is linked to syndromal or neuromuscular etiologies. There is a potential for the spine deformity to affect the chest wall; therefore, pulmonary function makes early corrective

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treatment imperative. In 2005, Mehta [1] reported the results for a series of 136 patients treated with Cotrel and Morel's derotational casting technique [2].

Casting under general anesthesia allows for the application of traction and corrective derotational forces to the thoracic cage and pelvis. These forces translate to the spine, achieving significant correction tailored to the character of the scoliotic curve.

Over time, the cast harnesses the growth potential of young children and externally guides the growth of the patient's thorax and spine. Treatment of these children should take into consideration the effect on remaining growth and respiratory capacity. Thoracic insufficiency in EOS can result from severe curve progression at a young age, or from early surgical fusion [3,4].

Bracing is a nonsurgical option that theoretically can apply similar corrective force on the thoracic cage and spine. Casting, however, has the advantage of providing continuous corrective forces, and avoids the problem of compliance. This ability to maintain continuous control of the curve while taking advantage of the child's growth gives casting a major advantage over brace treatment except for repeated general anesthesia.

Surgical treatment for EOS is currently classified as distraction-based, guided growth, or convex compression growth inhibition techniques.

Distraction-based techniques currently in use include growing rods and Vertical Expandable Prosthetic Titanium Rib (VEPTR; Synthesis Spine Co., West Chester, PA). The Shilla technique is a guided growth method. Both the VEPTR and growing rods require multiple surgical procedures over the course of treatment and all 3 techniques are associated with a relatively high complication rate that is partially a factor of the length of treatment [5].

All of these devices may be associated with unintended auto-fusion, preventing the thoracic spine from reaching its full growth potential and limiting the space available for lungs. For this reason it is generally accepted that it is advantageous to delay surgery for these patients when possible [6].

The current researchers report the results of serial casting in patients with idiopathic (IS) and non-idiopathic (NIS) EOS. The latter includes a heterogeneous group of patients with problems including syndromic, neuromuscular, and congenital scoliosis. The authors have attempted to ascertain potential factors that are predictive of response to treatment with serial casting. To date, all patients were receiving some form of treatment.

Methods

The authors conducted a retrospective chart and radiographic review at a single institution for patients who underwent serial casting for progressive EOS between July 2005 and August 2012. A university institutional review board approved the protocol for this investigation. All patients included in this study had scoliosis recognized before age 5 years.

Data collected included the gender, diagnosis, age at start of casting, age at last cast, age at final follow-up visit, age at time of surgery, Cobb angle (CA) of the major curve, CA at final follow-up, number of casts, rib vertebral angle difference, space available for lungs before initiating treatment and after completion of cast treatment when applicable, and transition to subsequent treatment including bracing or surgical treatment.

Space available for lung was calculated as described by Campbell et al. [7]. Two of the authors (YMG and KWH) made all radiographic measurements. The researchers collected data from the chart regarding patient complications related to cast treatment and general anesthesia. The decision to treat with serial casting was made by 2 pediatric spinal surgeons on a case-to-case basis and was discussed in weekly spine conferences. Casting was initiated in patients who were believed to have progressive scoliosis, based on the age of the patient, the magnitude of the curve, the rib vertebral angle difference, the etiology of scoliosis, and the observed progression of the curvature.

Serial derotational casting was performed on all patients using the technique described by Mehta [1]. Patients underwent general anesthesia and a cast shirt was applied. The patients were then transferred to the spinal casting frame, where cervical and pelvic traction were applied. Cotton under-cast padding was applied and felt padding was placed on bony prominences. Plaster was applied and molded with derotational forces to correct the scoliosis. An over-wrap of fiberglass casting material was applied, the traction was released, and the patient returned to a standard operating room table. Abdominal and posterior concave windows were created. The edges of the cast were trimmed and padded for soft tissue protection. Patients were extubated and transferred to the recovery room after final X-rays were obtained. All casts were over the shoulders. Casts were planned to be changed every 2 to 3 months depending on the patient's growth.

Patients who achieved satisfactory correction with serial cast treatment, defined as a CA less than 10° on radiographs taken with the patient standing out of the cast, were converted to a thoracolumbar orthosis (TLSO). Under-corrected curves in children over age 4 years were converted to a TLSO or surgical treatment depending on the magnitude of the curve. If the curvature was progressing despite casting, surgical treatment was considered. Patients had either a VEPTR or growing rod construct inserted and underwent subsequent serial lengthening.

Statistical method

Because the distribution of CA was approximately symmetric, the researchers used a 2-sample *t* test to compare the CA (initial CA and CA change) between groups. A single outlier was observed for the space available for lungs. The authors used the Wilcoxon–Mann–Whitney test to compare the improvement in space available for lungs among different patient groups. By analogy with the CA, the rib vertebral