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Infantile Idiopathic Scoliosis: Factors Affecting EDF Casting Success

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Abstract

Study Design: IRB-approved retrospective single cohort study.
Objectives: To review our ten-year history with EDF (Elongation Derotation Flexion) casting in patients with infantile idiopathic scoliosis (IIS) to better understand which factors predict successful outcomes.
Summary of Background Data: Numerous studies have demonstrated the efficacy of EDF casting in the treatment of progressive infantile idiopathic scoliosis. But none have reproduced the success of Mehta's even with early intervention.
Methods: Patients with IIS treated with EDF casting with a minimum 24-month follow-up were included. Radiographs and clinical records were reviewed. Age, sex, and curve type were documented. Precast, traction, in cast, in brace, and final Cobb angles were measured and recorded. Outcomes were defined by Cobb angle at final follow-up out of cast or brace. Patients were considered cured if the final Cobb angle was $<10^{\circ}$, palliated at $10^{\circ}-45^{\circ}$, and failed if they required surgical treatment.
Results: Sixty-three patients with IIS were reviewed. Thirty-two were excluded for incomplete records or insufficient follow-up, leaving 31 patients. No patients progressed to surgical intervention during the study. Patients with a Cobb angle $>10^{\circ}$ in the final cast were 7.3 times more likely to fall into the palliative range at the most recent follow-up than if their Cobb angle was 10° or less even when adjusted for age. Earlier age at onset of casting (14.9 vs. 21.1 months) was not statistically significant ($p=.073$). Magnitude of initial curvature, flexibility, initial correction, sex, and curve type were also not found to be significant.
Conclusion: EDF casting is a valid treatment option for IIS with a high cure rate. Major Cobb angle at the end of casting is most predictive of outcome. Cobb angles $>10^{\circ}$ at the end of casting had a 7.3 times greater risk of falling into the palliated category versus Cobb angles less than or equal to 10° even when adjusted for age. Initial curve magnitude, curve flexibility, sex, and curve type were not predictive.
Level of Evidence: Level IV.

Keywords: Infantile idiopathic scoliosis; Early-onset scoliosis; Elongation derotation flexion (EDF) casting; Cured; Palliated

Introduction

Williams et al. developed a classification system for early-onset scoliosis in 2014 that identified patients with idiopathic scoliosis who developed scoliosis before 10 years of age as idiopathic early-onset scoliosis (IEOS) [1]. Infantile idiopathic scoliosis (IIS) is an older term for a subset of IEOS and is defined as scoliosis with no known underlying pathology with onset at age less than three years. IIS is a rare disorder that affects 0.25% to 12.8% of all patients with idiopathic scoliosis [2]. Of patients with IIS, approximately 52% to 90% will resolve spontaneously without treatment [2-7]. Resolution is often associated with a rib vertebral angle less than 20° [8], but in toddlers whose curve does not resolve, progression continues over time. If left untreated, patients with progressive IIS have a high risk of severe thoracic chest wall deformity and respiratory compromise leading to a shortened life. It has the shortest survival of all patients with idiopathic scoliosis. This increased mortality is generally attributed to associated respiratory complications [9].

Young age coupled with chest and spinal deformity can make management of IIS extremely challenging. Deformity progression can be rapid and relentless, resulting in significant aesthetic and function disability. Directly

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addressing the deformity through fusion limits thoracic growth potential and lung growth the majority of which occurs by eight years of age and may cause thoracic insufficiency syndrome [10]. Early surgery with growth-sparing or ''growth friendly'' systems have high complication rates, adverse psychosocial impact, and can result in decreased chest wall compliance through soft tissue fibrosis and auto fusion [11]. Growth-friendly systems have high complication rates, especially in younger patients, each additional procedure increases the risk of complications by 24%, and delaying surgery decreases complications by 13% each year it is delayed [12-14]. Previous studies demonstrated that patients who undergo surgery with either a traditional fusion or with a fusionless construct <10 years of age have significantly diminished pulmonary function with a mean FEV1 of 41% and FVC 40.8% compared with patients treated with surgery at >10 years of age who had FEV1 of 79% and a mean FVC 68.3% [15]. Even with the use of newer techniques such as magnetically controlled growing rod (MCGR), the complication rates are still very high, with Choi et al. reporting that although there is a much lower infection rate than traditional growing rods the overall complications are still very common, with 27.8% requiring revision surgery during the average 19.4-month follow-up time period in their study [16].

Because surgical treatment of IIS is plagued with complications, renewed efforts to treat with conservative methods such as casting and bracing has reemerged. Elongation, derotation, and flexion (EDF) casting is a treatment method described for treating IIS. It is similar to the Risser method but uses a three-dimensional approach to dealing with spinal deformity as opposed to the two-dimensional Risser technique. Mehta et al. reported the largest series of patients treated with EDF-style casting, and found that up to 100% of patients treated <20 months resolved [8]. Numerous reports have subsequently studied EDF casting, but none have reproduced Mehta and colleagues' successful results [17-21].

This purpose of this article is to review our 10-year experience with EDF casting and evaluate factors that may be associated with cure, palliation, and treatment failure in patients with IIS. Specifically, evaluating the effect of sex, age at initiation, initial curve magnitude, amount of initial correction, curve flexibility, amount of correction over time, and Cobb angle in final cast. We hypothesized that younger age at onset of treatment, increased flexibility, and increased correction in cast would be predictive of success.

Methods

This was an IRB-approved retrospective study. All patients who underwent casting were identified from a single institutional scoliosis database. From this cohort, patients with IIS with curve magnitude measuring greater than or equal to 20° were identified. All patients who had documented progression of greater than 5° and were treated with EDF-style casting. Our inclusion criteria require all patients to have a minimum of 24 months' follow-up. Patients were excluded if they had nonidiopathic scoliosis, incomplete or <24-month follow-up, or were never casted.

All patients underwent application of an over-the-shoulder plaster and fiberglass EDF cast on a specially modified Risser casting table under general anesthesia. An elongation force was applied through occiput and pelvis via traction, whereas a manual flexion and derotation correction force was applied to the spine through the chest wall by the surgeon and assistant during the cast application. Abdominal and thoracic windows were cut in the cast to allow for thoracic and abdominal motion. Cast edges were trimmed and padded appropriately.

Routine cast changes were performed every six weeks to four months based on patient age. Postoperative standing radiographs were taken to confirm appropriate correction of the curvature before discharge home, if patients were unable to stand they were taken in a seated position. Criteria for discontinuation of casting was correction of the curve magnitude to less than 15°, failure to control the curvature, medical or skin complications that precluded continued casting (ie, significant pulmonary disease), or intolerance of further cast treatment by the patient and/or family.

Following completion of casting, patients were transitioned into a thoracolumbosacral orthosis and periodic radiographs taken in or out of brace (OOB) as appropriate. Bracing was continued for 18 to 20 hours per day for a minimum of one year. If the curve remained stable, patients were transitioned to night-time use for six months then were transitioned OOB. Bracing or casting was resumed if there was a documented increase in Cobb angle during follow-up. Patients were followed until they were skeletally mature. At recent follow-up, most patients had not achieved skeletal maturity and were still being followed. For the purpose of this study, the patient was categorized as cured (Cobb less than or equal to 10°), palliated (Cobb 11°–45°), or progressing based on OOB radiographs at the most recent follow-up (we use the term ''failed'' cautiously as they still avoided or at minimum delayed surgical intervention).

Statistical analysis

Analyses of variance were performed to compare study groups for patient age, preoperative rib-vertebral angle difference (RVAD), pre- and post-treatment Cobb angle, Cobb correction on traction radiographs, curve flexibility, and the number of casts applied. Fisher exact test was performed for sex and direction of thoracic curves (left vs. right). Lastly a linear regression was performed to determine if there was a correlation with percent correction over time.

Results

A total of 578 patients casted or braced over a four-year period representing 1,242 individual patient encounters