Journal of Orthopaedics 15 (2018) 59–66

Contents lists available at ScienceDirect

Journal of Orthopaedics

journal homepage: www.elsevier.com/locate/jor

Magnetic growth modulation in orthopaedic and spine surgery

Adam E.M. Eltorai*, Carolina Fuentes

Warren Alpert Medical School of Brown University, United States

ARTICLE INFO

Keywords:
Magnetic growth
Orthopaedics
Spine
Scoliosis

ABSTRACT

Purpose: To examine distraction-based methods for treatment of early onset scoliosis (EOS), focusing on the magnetically controlled growing rod system (MCGR) relative to traditional growing rod system (TGR). To briefly discuss internal magnetically controlled nails for bone lengthening as another application of magnetic growth modulation.

Results: Relative to TGR, MCGR involves fewer complications related to infection and general anesthesia because of fewer successive surgeries required. Further, MCGR accounts for better psychosocial patient outcome and potentially a lower long-term cost, mainly because of shortened periods of hospitalization. Intramedullary lengthening nails involve fewer complications compared to internal limb lengthening devices related to infections, nerve damage, shortening, improper healing, stiffness, and scarring. Intramedullary lengthening nails appear to alleviate psychosocial burden of patients especially when compared to external fixators.

Conclusions: Although the current gold standard for treating some types of early onset scoliosis (EOS) is the traditional growing rod system, the magnetically controlled growing rod (MCGR) system is an alternative method for treating EOS. MCGR is promising in that it involves less surgical procedures, shorter hospital stays, and lower long-term cost relative to TGR. Similarly, the use of magnetically controlled intramedullary lengthening nails is a promising alternative to the Ilizarov method for limb lengthening.

1. Introduction

Novel magnetically controlled devices, such as magnetically controlled growth growing rod system and intramedullary lengthening nails, have emerged as alternatives to treat spine curvature and limb length deformities.

The diagnosis of early onset scoliosis (EOS) in children entails a spinal curvature greater than or equal to 10°.[19] EOS begins before 10 years of age[17] and is particularly problematic because of interference with normal pulmonary development and function. Treatment protocol first and foremost includes evaluation, and bracing and serial casting when appropriate for curvature severity and patient age.[16] However, for progressive congenital cases or for cases when less invasive treatments fail, surgical intervention is favored. Early fusion as a potential treatment for EOS does not allow full growth of the spine and thorax.[19] The current surgical "gold standard" for treatment of early onset scoliosis (EOS) with severe curvature of the spine is the traditional growing rod system (TGR)[2] (Fig. 1). The idea behind growth rods in treating EOS is to fix the spine deformity and still permit skeletal growth.[16] Early spine fusion, on the other hand, would not be appropriate for a patient who has not achieved optimal spinal or thoracic growth. Still, TGR is not an appropriate treatment for all cases of EOS.[1]

2. Early onset scoliosis severity, pulmonary function and surgery

EOS is a rare condition.[18] Spinal curvature is measured using the Cobb angle, which is the angle of intersection between perpendicular lines at the top and bottom of the curvature.[1] Cobb angle can be used to define scoliosis and its severity. Progression of scoliosis is associated with negative pulmonary function and cosmetic appearance.

Once scoliosis is diagnosed, the severity of the curvature and age of the patient must factor into the course of treatment. Bracing as non-invasive treatment is not effective in young patients, nor is it effective for treating neuromuscular or congenital scoliosis.[4] The main problem with early spinal fusion as a surgically invasive treatment, on the other hand, is its interruption of normal lung development. Patients with neuromuscular scoliosis are the most prone to pulmonary infection and restrictive lung disease.[10] For this reason, pulmonary function tests are useful for assessing respiratory impairment caused by the scoliosis. In fact, anesthesia involved for growth rod systems may not be advised for patients who present FVCs less than 30%. Yoon et al. found positive correlation between extent of distraction and positive change from preoperative to postoperative FVC and FEV1.

Surgery is recommended when curvature is severe and progressive. The goal is not only to address the deformity, but also to encourage

* Corresponding author at: Warren Alpert Medical School of Brown University, 100 Butler Drive, Providence, RI 02906, United States.
E-mail address: Adam_Eltorai@Brown.edu (A.E.M. Eltorai).

https://doi.org/10.1016/j.jor.2018.01.023
Received 19 July 2017; Accepted 14 January 2018

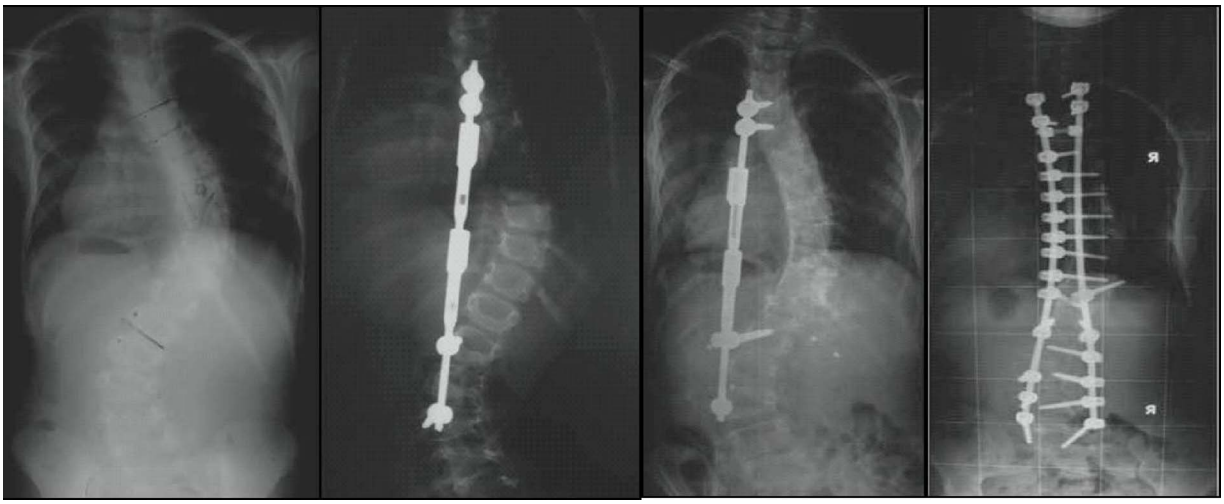

Fig. 1. Preoperative postero-anterior radiograph of 7-year old with infantile idiopathic scoliosis showing 62° curve (first). Postoperative radiograph of single TGR system showing 30° major curve (second). Postoperative radiograph showing 40-fold improvement of curve (third). Postoperative postero-anterior radiograph following fusion procedure (fourth).[16]

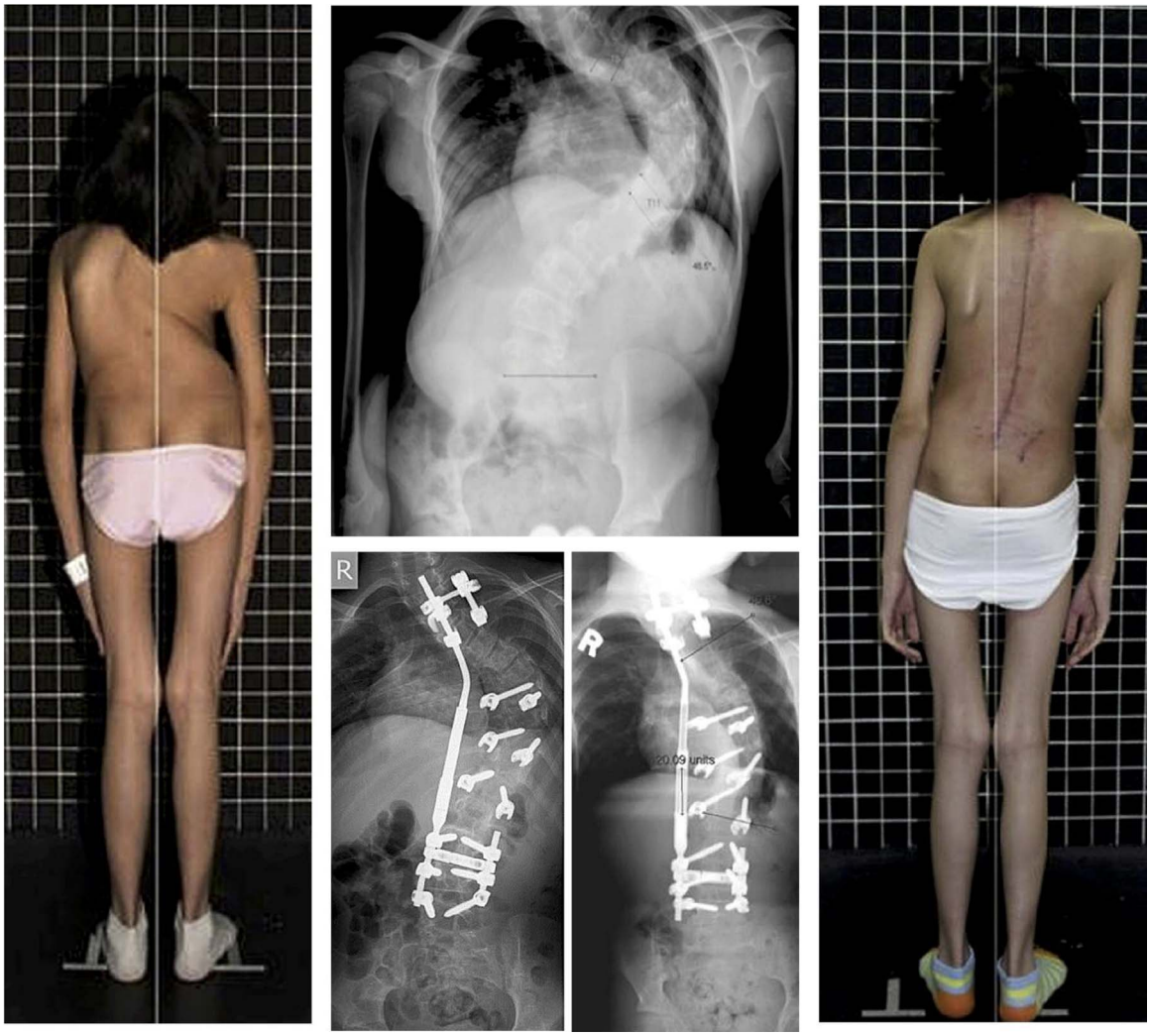

Fig. 2. Preoperative photograph of patient with kyphoscoliosis (left). Preoperative standing plain radiograph (top). Immediate postoperative standing anteroposterior radiograph (bottom left). Postoperative anteroposterior standing plain radiograph (bottom right). Postoperative photo of treatment results (right).[8]