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Clinical Study

Treatment of early-onset scoliosis with a hybrid of a concave magnetic driver (magnetic controlled growth rod) and a contralateral passive sliding rod construct with apical control: preliminary report on 17 cases

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Abstract

BACKGROUND CONTEXT: Magnetic controlled growth rods (MCGRs) are increasingly popular for surgical treatment of severe early-onset scoliosis (EOS), because they allow noninvasive extensions with good growth maintenance. We combined an MCGR with a contralateral passive sliding rod construct with apical control on the convex side to improve efficiency in terms of costs and three-dimensional (3D) correction.

PURPOSE: To investigate the feasibility, 3D correction, spinal growth, and complications of the apical control MCGR sliding rod hybrid.

STUDY DESIGN: Two-center retrospective cohort study.

PATIENT SAMPLE: A consecutive series of 17 children with EOS from two European spine centers were treated with the hybrid principle: 13 primary cases and 4 conversion cases from other growth instrumentation. Median age at surgery was 9 years (range: 6–18). Median follow-up time was 24 months (range: 12–31).

OUTCOMES: Cobb angles (frontal Cobb, kyphosis, lordosis), rotation, spinal length gain, growth rate, and complications.

METHODS: Radiographs and patient files were reviewed. All the patients received fully financed treatment within the national public health-care systems.

RESULTS: Mean preoperative frontal Cobb angle was 59°, reduced postoperatively to 30° and was maintained throughout follow-up. Mean rotation of the apical vertebra improved from 27° to 18°, but was partially lost over time. Kyphosis decreased and lordosis was largely unaltered. Instrumented spine growth was maintained at a mean of 12 mm per year. One child had surgical revision because of progressive trunk shift, unrelated to the technique. The same child fell and sustained T1 and T2 fractures that were treated conservatively. Another child is planned for revision because of MCGR distraction failure.

FDA device/drug status: Not applicable.

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CB holds global patents on scoliosis instrumentation for EOS (not applied in the present study).

No conflicts of interest.

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CONCLUSION: These early results show satisfactory frontal Cobb curve reduction and maintenance of spinal growth after using a new hybrid concept of a single magnetic growth rod and contralateral apical control sliding rods. A single magnetic growth rod in this combination may work equally well as traditional or dual magnetic growth rods. This new concept may represent a significant gain in both cost-effectiveness of growth rod treatment and 3D correction in EOS.

Keywords: Early onset scoliosis; Growing rods; Instrumentation without fusion; Magnetically controlled growing rods; MCGR; Minimal invasive surgical procedure

Introduction

Early-onset scoliosis (EOS) is a potentially life-threatening condition that may need surgical intervention to ensure pulmonary function and development [1,2]. Several technical solutions have been developed in recent years, aimed at allowing for growth in a stabilized and corrected spine, and thereby retaining thoracic growth potential and pulmonary function [3–7]. Traditional distraction-based growing rod systems require frequent surgical lengthening procedures [8]. Gliding systems providing "guided growth" are alternatives, for example, the Luqué trolley [7] and the Shilla system [6]. These systems all have disadvantages: multiple planned surgical lengthening procedures, unpredictable lengthening capacity, and a high frequency of reoperations [9–12].

The worldwide application of magnetic controlled growth rods (MCGR) that allow for non-invasive lengthening has increased over the recent years. Early results from several papers are promising and suggest efficacy and cost-effectiveness of the system [5,13–16]. The technique (Magec, Ellipse Technologies Inc, Irvine, CA, USA) was approved in 2014 by The United States Food and Drug Administration for use in the United States. The manufacturer recommends to use two magnetic rods per patient, which might rely on recommendations in the literature [17,18]. One of the disadvantages of the system is the relatively high initial costs of the magnetic rods. Other disadvantages of the double MCGR application may be the lack of apical control [19], and difficulties in balancing the growth action of the two rods.

We have used a hybrid technique, using a single MCGR to drive the lengthening on the scoliosis concave side combined with a passive sliding system with apical control on the convexity. The sliding system allows for passive lengthening during growth and interval MCGR extension procedures.

The purpose of this study is to investigate the feasibility, three-dimensional (3D) correction, spinal growth rate, and complications of a combined spinal growth principle with a hybrid system consisting of a single concave MCGR and a passive convex sliding system with apical control on the convexity.

We report the early experiences and the preliminary results from two European scoliosis centers, Department of Orthopaedic Surgery, University Medical Center Utrecht, Utrecht, The Netherlands (Utrecht), and Department of Orthopaedic Surgery, Aarhus University Hospital, Aarhus, Denmark (Aarhus).

Materials and methods

Study design

This is a two-center retrospective cohort study with growth assessment, 3D correction, and complication registration. All patients received fully financed treatment within the national public health-care systems in Denmark and The Netherlands.

Patients

We included all patients who were operated from September 24, 2014 to May 3, 2016, and received the hybrid system consisting of a single MCGR on the concave side and a sliding system with apical control on the convexity. This yielded 17 consecutive patients (Table 1) with completed 1 year or longer postoperative radiographic follow-up, and a minimum of four lengthening procedures.

All the patients were skeletally immature and had a progressive scoliosis of at least 40° before primary surgery.

Surgical techniques

Standard surgical techniques were used on all patients. The patients were placed in balanced prone position without traction, cell saver, and intraoperative neuromonitoring was used according to the local procedure guidelines.

Proximal and distal anchors were created through separate skin incisions, each consisting of at least two consecutive vertebrae. An apical anchor was created in addition unilaterally on the convex side by one or more pedicle screws. The anchor vertebrae were decorticated, facet joints were removed, and local or autologous bone graft was placed to stimulate fusion. On the concave side, an MCGR was inserted under distraction. On the convexity, the sliding system was fixed to the apex, and both rods were contoured proximally in kyphosis and distally in lordosis.

In Utrecht, the 5.5 mm Mesa (K2M, Leesburg, VI, USA) system and 4.5 or 5.5 mm Magec rods were used. The convex sliding bar was mounted to the proximal and distal anchors by parallel connectors, with the oversize hole left open for the rod (Fig. 1, left).

In Aarhus, the 4.5 Xia (Stryker, Kalamazoo, MI, USA) and Mesa 4.5 or 5.5 CD Horizon Legacy (Medtronic, Minneapolis, MN, USA) system and 4.5 or 5.5 mm Magec rods were used. For the convex sliding part, the Cody Bünger (CB) system was applied, mounted on the three anchors. A pre-bend oversized