The Spine Journal 16 (2016) S34–S39

Clinical Study

Magnetic controlled growing rods for early-onset scoliosis: a 4-year follow-up

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Received 1 September 2015; revised 17 December 2015; accepted 28 December 2015

Abstract

BACKGROUND CONTEXT: There have been no studies with medium-term follow-up of magnetic controlled growing rods (MCGRs).

PURPOSE: This study aimed to report our single center experience of a magnetic growing rod system with an average of 4 years' follow-up.

STUDY DESIGN/SETTING: A retrospective case series was carried out.

PATIENT SAMPLE: The sample comprised patients with early-onset scoliosis treated with magnetic controlled growth rods who were operated in 2011.

OUTCOME MEASURES: Cobb angle, spinal growth rate, complications, and revision were the outcome measures.

METHODS: Clinical case notes and radiographs were reviewed.

RESULTS: There were 8 patients (5 dual-rod construct, 3 single-rod construct) who had a minimum of 44 months' follow-up and average of 48 months (44–55 months). Mean age at surgery was 8.2 years (range 3–10). Mean preoperative Cobb angle was 60° (34–94), whereas mean postoperative Cobb angle was 42° (32–63). The average number of extensions was 13.8 (range: 12–20). There were 6 patients (75%) who required 8 revision surgeries: rod problems (N=4), proximal screw pull-out (N=3), and development of proximal junction kyphosis (N=1). All three patients who had single-rod construct underwent revision procedure. Currently, four patients (50%) still have the magnetic rods in situ. The mean duration of MCGR in the patient in the removed group was 39 months (range: 34–46).

CONCLUSIONS: Medium-term results of MCGR are not as promising as previously reported early results. Hence, MCGRs should be used with caution. Single-rod constructs should definitely be avoided. The role of MCGRs in revision cases still remains unknown.

Keywords: Early-onset scoliosis; Magnetic controlled growing rods; MAGnetic Expansion Control system; Medium-term follow-up; Revision; Survivorship

FDA device/drug status: Approved (MAGEC Spinal Bracing and Distraction System).

Author disclosures: ***KHT:*** Nothing to disclose. ***DMGW:*** Nothing to disclose. ***SHJ:*** Other: K2M (Educational contract), NuVasive (Educational contract), outside the submitted work. ***AJ:*** Other: NuVasive (Teaching contract), outside the submitted work. ***JH:*** Other: Alphatec (Educational contract), outside the submitted work. ***PRD:*** Other: K2M (Educational meetings), Globus (Educational meetings), outside the submitted work. ***SA:*** Other: Depuy Synthes UK Ltd (Fund a fellowship for the unit), NuVasive UK Ltd (Fund a fellowship for the unit); Personal Fees: Globus Medical (Consulting fee for convening a course in 2013 and 2015), Medtronic (Consulting fee in 2015), outside the submitted work.

The disclosure key can be found on the Table of Contents and at www.TheSpineJournalOnline.com.

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http://dx.doi.org/10.1016/j.spinee.2015.12.098

Introduction

The use of magnetic controlled growing rod (MCGR) system in early-onset scoliosis following failure of conservative treatment such as bracing or casting is now well recognized [1–3]. Magnetic controlled growing rods have gained popularity over the recent years because control of scoliosis is achieved without the need for invasive surgical lengthening. This allows spinal growth until a definitive correction and fusion can be made when the child reaches skeletal maturity. Recently, the National Institute for Health and Care Excellence (NICE) and the National Health Service England have approved MCGRs as an alternative to conventional growing rods for management of early-onset scoliosis [4,5].

The most important benefit of MCGRs over conventional growing rod systems is the avoidance of multiple rod lengthening surgical procedures as the child grows. The MCGRs are implanted in a similar way as conventional rods. However, non-invasive rod lengthening is performed by using an external remote controller (ERC) in an outpatient setting without the need for anesthesia or sedation. The magnet within the actuator in the MCGR is connected to a lead screw and is rotated non-invasively by the ERC, which also contains a permanent magnet. This system causes lengthening of the rod, thus distracting the spine.

The other potential benefits of MCGRs include reduction in the incidence of surgical complications, for example, infections, because non-surgical lengthening does not involve exposing the instrumentation; absence of the need for further general anesthetic to lengthen the rods every six months, which can lead to improved quality of life due to reduction in psychological trauma to the child and family (eg, time away from school for the child and from work for the parent is lessened); avoidance of costs associated with repeated surgical interventions for the health-care service, for example, theater time, consumables, inpatient stay, treatment of complications; and reduction in costs to society associated with the parent or carer taking time off work and the child being away from school. The NICE estimates that MCGR is cost saving compared with conventional growth rods 3 years after first insertion based on cost modeling [4].

Our center was one of the initial centers to adopt MCGRs in 2011 when the company achieved its Conformité Européenne (CE) mark in 2009. We have previously reported our early results of the MAGnetic Expansion Control (MAGEC) system (Ellipse Technologies, Inc, Aliso Viejo, CA, USA) [6]. Unfortunately since then, we have noticed that there has been a high revision rate in this cohort of patients. The aim of this study was to report our single center experience of a magnetic growing rod system with an average of 4 years' follow-up.

Materials and methods

We reviewed our first cohort of patients with early-onset scoliosis treated with magnetic controlled growth rods (MAGEC system, Ellipse Technologies, Inc) who were operated in 2011. This case series consisted of 8 patients, with a minimum of 44 months' follow-up and average of 48 months (44–55 months). Clinical case notes were reviewed for demographics, complications, return to theater, number of non-invasive rod lengthening procedures performed using remote controller device, and whether the MAGEC rods were still in situ.

Radiographs were also reviewed and Cobb angles were measured from preoperative, immediate postoperative, and most recent follow-up spine radiographs to determine the degree of spinal deformity and correction. We also measured T1–S1 length to determine spinal growth rates. Spinal growth rate was calculated by averaging the increase in T1–S1 length between initial postoperative and final follow-up radiographs.

Surgical procedure and our follow-up protocol

The MAGEC system comprises one or two sterile titanium implantable growth rods with a magnet in the actuator that drives the lengthening process magnetically. The diameter of the rods used depended on the child's body weight, and the choice of a single- or a dual-rod construct was down to surgeon's preference.

Under general anesthesia, patients were positioned prone, with intravenous antibiotics given on induction. All procedures were performed through a standard open posterior midline approach with insertion of pedicle screws or lamina hooks proximally and distally of the curve. The length of the MAGEC rod was cut to fit the patient and contoured. The MAGEC rod was then railroaded subcutaneously to connect to the proximal and distal anchorages. The diameter of the MAGEC rods used in our series was all 5.5 mm.

After surgery, patients were followed up in clinic at 6 weeks initially. Non-invasive distraction of the MAGEC rods were started between 3 and 6 months from initial implantation. In our center, distractions are carried out at 8 weekly intervals. During each visit, patients were positioned prone. Using a handheld magnet wand, the magnet in the actuator was located, and this site was marked. A handheld magnetic ERC was placed over this marking to lengthen the rod, thus distracting the spine. The MAGEC rods were distracted, and the distraction was measured as per the display on the ERC. This was checked using radiographs in the initial stages of the study period and subsequently using ultrasound to measure the amount of distraction achieved.

Results

Demographics

There were six men and two women in our series. Mean age at surgery was 8.2 years (range 3–10). The diagnoses were as follows: idiopathic scoliosis, N=6; syndromic scoliosis, N=1; congenital scoliosis, N=1. Four of the cases were primary procedure whereas four were revisions from conventional growing rod system. Three were single-rod constructs whereas five were