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Magnetically controlled growing rods for rigid scoliosis

An alternative to halo-gravity traction in preparing for definitive correction?

Surgical correction of severe rigid idiopathic scoliosis poses many limitations and can result in severe complications, such as neurological deficits or implant failure. It is often preceded by a distraction phase, which is necessary to mobilize the surrounding soft tissue and to gradually correct the deformity. These patients usually undergo either an external spinal distraction using halo traction or operative internal distraction of previously implanted growth rods.

The aim of this article is to present the successful use of a magnetically controlled distraction rod in preparing patients with severe rigid idiopathic scoliosis for posterior fusion.

Case history

A 14-year-old female patient suffered from rapid progressive spinal deformity and shortness of breath. The patient also complained of activity-related back pain, which rendered her wheelchair-dependent. Furthermore, the patient had a history of congenital dysplasia of the left hip. This was the first case to be detected in the patient's family and its etiology is unknown.

Clinical findings

The patient showed a significant kyphoscoliosis with marked shoulder and pelvis imbalance and a rib hump on the right side. Radiographs showed a right convex scoliotic curve with a Cobb angle of 129° between T3 and L1 (Fig. 1). The bending film did not reveal a significant correction (<25% the initial angle).

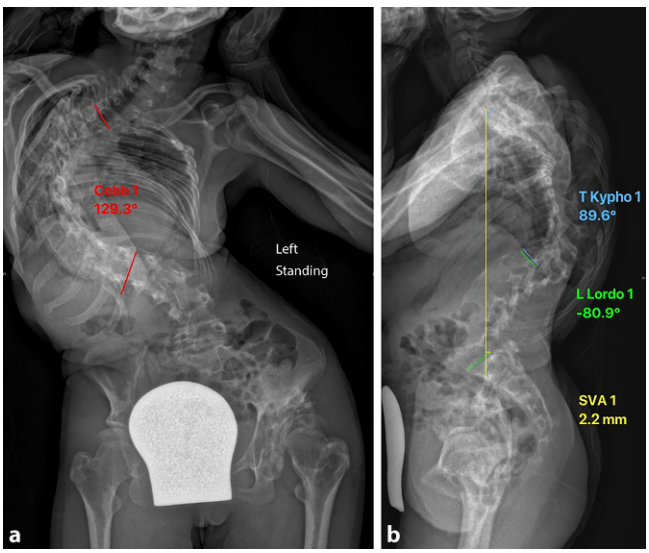

Fig. 1 ◄ Radiographs in an anteroposterior (**a**) and lateral (**b**) view of the patient in a standing position. *T Kypho* thoracic kyphosis, *L Lordo* lumbar lordosis, *SVA* sagittal vertical axis

Diagnosis

A rapidly progressing severe rigid idiopathic scoliosis.

Management

The patient was advised to undergo a two-stage surgical correction. As standard procedure a halo-traction device is applied for 6–8 weeks, followed by surgical correction and fusion. In this case, it was decided to use the magnetic rod for 6 weeks instead. The patient and family were informed that the use of the magnetic rod in such cases is not yet established. Furthermore, they were informed that this method would be conducted in an inpatient setting under close supervision. Before initiation of the distraction, the patient underwent postoperative AP and lateral full-spine radiography using the biplanar radiostereoradiography® device (EOS Imaging, Paris, France; Fig. 2).

Distraction was initiated on the 4th postoperative day after appropriate pain relief. Approximately 3 mm rod distraction was performed every other day for

Abbreviations	
AP	Anteroposterior
CN	Cranial nerve
EOS	Early onset scoliosis
L Lordo	Lumbar lordosis
SVA	Sagittal vertical axis
T Kypho	Thoracic kyphosis

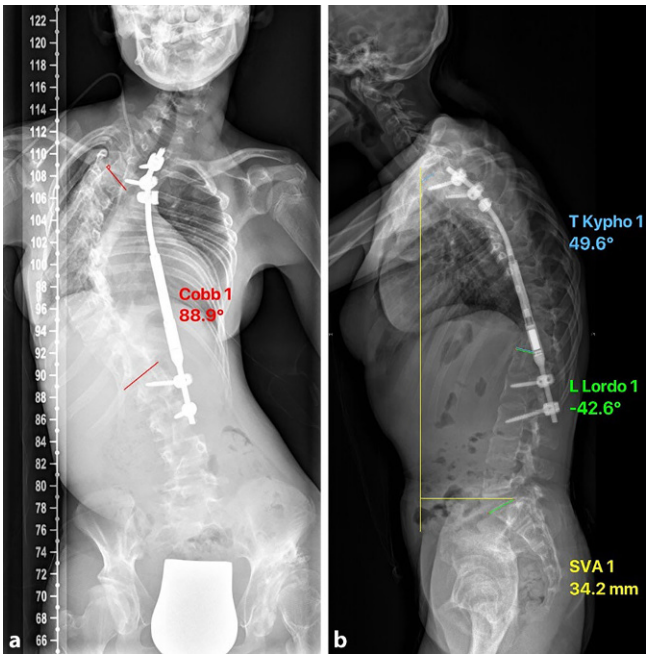

Fig. 2 ▲ Radiographs of the patient in anteroposterior (**a**) and lateral (**b**) views before initiating rod distraction. *T Kypho* thoracic kyphosis, *L Lordo* lumbar lordosis, *SVA* sagittal vertical axis

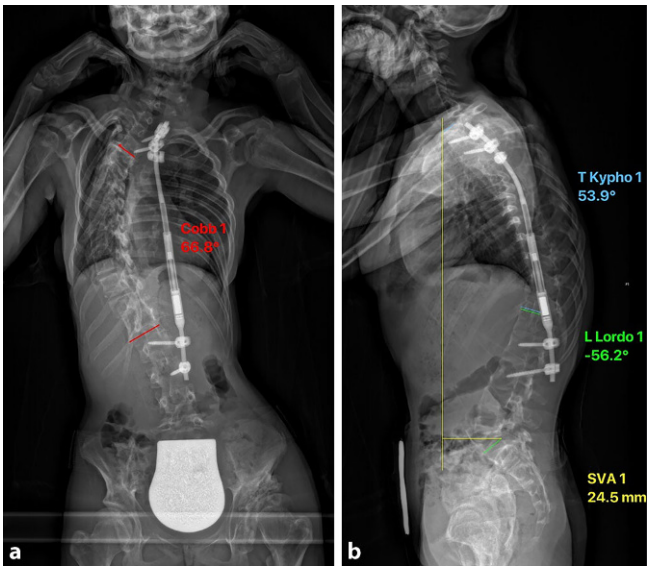

Fig. 3 ▲ Postoperative anteroposterior (**a**) and lateral (**b**) radiographs 3 weeks after rod distraction. *T Kypho* thoracic kyphosis, *L Lordo* lumbar lordosis, *SVA* sagittal vertical axis

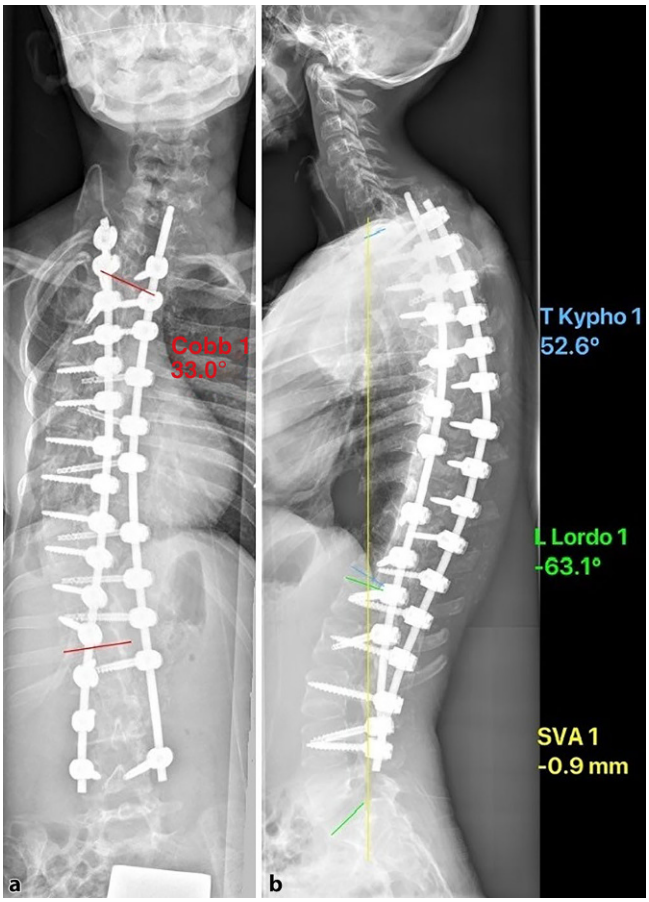

Fig. 4 ◄ Postoperative radiographs of the patient in an anteroposterior (**a**) and lateral (**b**) view of the vertebral column after posterior fusion. *T Kypho* thoracic kyphosis, *L Lordo* lumbar lordosis, *SVA* sagittal vertical axis

14 times within 4 weeks. The neurological function was evaluated before and after distraction. Low-dose stereoradiographs were taken once a week to control the implant for malfunction and to measure the achieved distraction and spinal correction. The patient described a gradual improvement of breathing and increased self-dependence in daily activities as well as a markedly decreased activity-dependent back pain. The regular radiological follow-up revealed a progressive correction with an end result of approximately 67° in the coronal view (**Fig. 3**).

The second stage of surgery was performed under neuromonitoring and encompassed rod removal and posterior release, Ponte osteotomy, apical resection of the prominent ribs as well as posterior fusion from T2 to L4. The postoperative radiological follow-up revealed a Cobb angle of 33° in the coronal plane as well as 53° thoracic kyphosis and 63° lumbar lordosis in the sagittal plane (**Fig. 4**).

The patient did not show any clinical deterioration during the hospital stay. Pain medications were gradually reduced and the patient was discharged on the 17th postoperative day. The surgical wound achieved optimal healing.

Discussion

Severe rigid idiopathic scoliosis is characterized by less than 25% correction of the Cobb angle on bending films and a major curve over 90° [11]. In such patients, an adequate mobilization of the spine and surrounding soft tissues is pivotal to achieve targeted correction and to safeguard neurological functions. Halo traction is an effective procedure used to prepare patients for posterior fusion. Because of its limitations on activities of daily life and associated complications, other surgical procedures have been discussed as alternative options [4, 5, 9, 13, 14]. The use of internal distraction was first reported by Grass et al. in the context of high neurologic risk congenital scoliosis [3]. Buchowski et al. used temporary internal distraction using growing rods in patients with severe rigid scoliosis and/or rigid spine who showed contraindications to the halo traction device. The distraction process was performed in a multiple step intervention. They observed that internal distraction is a feasible procedure [1]. Hence, it is assumed that internal distraction via magnetic rods is an alternative to the halo traction device and could be as effective as internal distraction using growing rods in severe rigid idiopathic scoliosis, which was traditionally used in the management of EOS. In addition, it is not associated with postoperative restriction of daily activities, such as with halo traction. An obvious advantage of magnetic rods is that multiple interventions to perform the distraction can be avoided and, therefore, also possible medical and surgical complications. It also enables real-time monitoring of the clinical and neurological status. Unlike EOS, the magnetic rods are distracted daily over a short period of time (4–6 weeks). To our knowledge, this is the first report of this kind in the literature. As magnetic rods are not yet used in the setting of severe rigid idiopathic scoliosis, only general results of using traditional growing rods can be given as well as the technical aspects and some complications of magnetic rods in EOS.

The magnetic rod system is designed for internal bracing of the growing spine in EOS patients. The patient usually receives two rods which are inserted through relatively small incisions and subcutaneously tunnelled. They are anchored at the cranial and caudal segments of the scoliotic curve through two pairs of pedicle screws with additional hooks to provide more stability of the construct. Postoperatively, patients undergo rod distraction every 4–6 months in an outpatient setting.

In a retrospective evaluation of 43 patients who underwent internal distraction using growing rods, the authors reported a postoperative and final coronal Cobb angle correction of 76.8% and 75.6%, respectively [8]. A systematic review revealed that several factors increase the risk for rod breakage including distraction through a single rod [12]; however, a prospective study conducted on 34 patients with EOS treated with magnetically controlled distracting rods revealed equal incidence of rod breakage in single and double rod groups [2]. In the patient described here the rod was anchored through a pair of pedicle screws at the proximal and distal segments of the scoliotic curve, with an additional rib clamp at the proximal segment to provide additive stability of the proximal anchoring screws and minimize the risk of screw dislocation; however, it is suggested that more anchoring points could be necessary to avoid implant failure, depending on bone quality. External halo traction has the advantage that it can be applied in a lying, sitting or standing position, noting that the positional transition of the patient might be risky and requires assistance. A retrospective study of 19 patients, who underwent spinal fusion following halo traction, showed that 2 patients developed pin loosening and

Abstract · Zusammenfassung

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Magnetically controlled growing rods for rigid scoliosis. An alternative to halo-gravity traction in preparing for definitive correction?

Abstract

The treatment concept for severe rigid idiopathic scoliosis is a short-term application of halo-gravity traction to enable maximum correction and subsequent dorsal fusion. The method has already been mentioned in the literature as an effective procedure. This case report demonstrates the use of a new treatment concept using magnetically controlled distraction rods as a possible alternative to the halo-gravity traction device. To our knowledge the use of this technique in severe rigid idiopathic scoliosis has not yet been published.

Keywords

Idiopathic scoliosis · Adolescent · Spinal fusion · Radiography · Kyphoscoliosis

Einsatz eines magnetisch-kontrollierten Wachstumsstabs bei rigider Skoliose. Eine Alternative zur Halotraktion als Vorbereitung auf die definitive Korrekturspondylodese?

Zusammenfassung

Das Versorgungskonzept bei einer ausgeprägten rigiden idiopathischen Skoliose besteht in einer kurzfristigen Applikation der Halotraktions, um eine maximale Korrektur sowie anschließend eine dorsale Fusion zu ermöglichen. Es ist bereits als effektives Verfahren in der Literatur beschrieben. In dieser Kasuistik berichten wir über ein neues Versorgungskonzept mit einem magnetisch kontrollierten Wachstumsstabsystem als mögliche Alternative zur Halotraktion. Nach unserem Wissen ist die Anwendung dieser Technik bei schweren rigiden idiopathischen Skoliosen noch nicht in der Literatur dokumentiert.

Schlüsselwörter

Idiopathische Skoliose · Jugendliche · Spondylodese · Röntgendiagnostik · Kyphoskoliose

3 patients suffered from superficial pin site infections during traction [10]. Cranial nerve (CN) palsy has been also reported as a complication after applying halo traction, with a relatively higher incidence of sixth CN palsy. A combined fourth and sixth CN injury was detected in two children [6]. A retrospective analysis of 300 patients with severe congenital, idiopathic or neuromyopathic scoliosis, who underwent halo traction followed by posterior correction, reported that 7 patients developed brachial plexus injury after halo traction [7].

Costs of treatment

The cost of a rod is four times higher than the cost of a halo ring and its pins, also taking into account that the halo traction wheelchair can be used for further patients and the cost would not be counted in this comparison.

Limitations

This technique is limited by the severity of the spinal deformity. For instance, pronounced kyphoscoliosis could be prohibitive for initial magnetic rod implantation. Hence, halo traction remains the first-line treatment in the setting of severe kyphoscoliosis.

Conclusion

To our knowledge this case report is the first to describe magnetically controlled distraction rods as an alternative to the halo traction device and traditional growing rods in the setting of severe rigid idiopathic scoliosis. The use of a single magnetically controlled distraction rod seems to be an excellent alternative to halo traction. Further investigations are indicated to prove the efficacy and safety of this technique.

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Compliance with ethical guidelines

Conflict of interest. R. Aldeeri, H. Almansour, Y. Kentar, S. Hemmer, W. Pepke and M. Akbar declare that they have no competing interests.

This article does not contain any studies with human participants or animals performed by any of the authors. For images or other information within the manuscript which could identify the patient, consent was obtained from them and/or their legal guardians.

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