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Clinical Study

Spinal deformity changes in children with long-term vertical expandable prosthetic titanium rib treatment

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Abstract

BACKGROUND CONTEXT: In several studies, *vertical expandable prosthetic titanium rib* (VEPTR) implants have shown good scoliosis control in children with the longest reported follow-up of 3.6 years. For *growing rods,* recent studies suggest a decreased efficiency of correction starting just after that time. To our knowledge, no long-term results of children with VEPTR treatment are available.

PURPOSE: This study aimed to evaluate spinal deformity in scoliotic children and to investigate correction potential of VEPTR implants at several time points of treatment, particularly after long-term follow-up.

STUDY DESIGN/SETTING: We performed a retrospective case series of 32 children with spinal deformity and VEPTR treatment with analysis of clinical and radiological data pre- and post-VEPTR implantation and every 2 years during the follow-up period.

PATIENT SAMPLE: Thirty-two patients with spinal deformity and VEPTR treatment comprised the patient sample.

OUTCOME MEASURES: Patients had a primary VEPTR implantation due to spinal deformity and thoracic insufficiency syndrome and repeated lengthening procedures every 6 months. Clinical data were assessed and radiological parameters were analyzed. The main thoracic scoliotic curve and associated curves as well as kyphosis, lordosis, pelvic obliquity, and spinal length were measured in all radiographs until the end of VEPTR treatment or the last available examination.

METHODS: Development of the different parameters during follow-up was evaluated and statistical analysis was performed with Statistica version 13.0. No funding was obtained for this study. The authors have no conflicts of interest to declare.

RESULTS: Directly after VEPTR implantation, thoracic and lumbar curves corrected significantly, were stable at 2.8-year follow-up, and increased at 5.5-year follow-up, whereas cervical scoliosis was not affected by the treatment. The sagittal profile was initially improved both in kyphosis and lordosis. However, at 5.5-year follow-up, hyperkyphosis had deteriorated beyond the initial deformity. Pelvic obliquity was significantly restored especially in neuromuscular patients, and increasing spinal length was achieved within the 5.5-year follow-up.

CONCLUSION: In children with spinal deformity, implantation of the VEPTR device sufficiently corrected the deformity in all planes. During long-term follow-up, scoliosis increased slightly and was rather well controlled, whereas the implant system was not able to prevent deterioration of hyperkyphosis. Pelvic obliquity was well balanced and spinal lengthening was achieved during long-term follow-up.

Keywords: Kyphosis and lordosis; Long-term; Scoliosis; Spinal deformity; Spinal length and pelvic obliquity; VEPTR

FDA device/drug status: Not applicable.

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Introduction

In children, progressive spinal deformity may lead to severe problems such as thoracic insufficiency syndrome [1]. Thus, early surgical procedures with growth preserving devices such as *growing rods*, *vertical expandable prosthetic titanium rib* (VEPTR), or magnetically controlled expansion devices (MAGEC) have been used to provide thoracic and therefore lung growth as well as an increase in spinal length and deformity correction [2–6].

During the treatment with *dual growing rods*, Sankar et al. reported on an increase of spinal stiffness and therefore reduced spinal correction potential [7], possibly due to autofusion and ossification (Fig. 1). Severe ossifications during VEPTR treatment have also been described for a great number of VEPTR patients by Groenefeld and Hell [8] as well as Zivkovic et al. [9]. However, it is unclear whether these ossifications and fusions which occur mainly between ribs affect the ability of the VEPTR implant to achieve spinal deformity correction over a longer time period. In the literature, spinal deformity analysis in VEPTR patients has been reported with the longest follow-up between 2.6 and 3.6 years [10–13].

To our knowledge, this article reports on the longest follow-up of a larger series of children with spinal deformities and VEPTR treatment.

Material and methods

After ethics committee approval, we conducted a retrospective case series on 32 children. All patients underwent implantation of VEPTR implants between ribs and pelvis (bilateral) (Fig. 2) or ribs and lumbar spine (unilateral) (Fig. 3) with repetitive expansion surgeries approximately every 6 months. Clinical data such as diagnosis, gender, age at initial VEPTR implantation, type of construct, ability to walk, and comorbidities (eg, hip dislocation) were acquired.

Imaging

Using the radiologic processing program Centricity (GE Healthcare, Chicago, IL, USA), 350 digital available radiographs were measured. Measurements of 53 conventional radiographs were performed on an x-ray image viewer with a geometry triangle and a goniometer. Anterior-posterior and lateral standing or sitting radiographs were analyzed before and after the initial VEPTR surgery as well as every 2 years after until the end of VEPTR treatment or the last available film. Measurements of the main thoracic curve and the associated cranial/cervical and caudal/lumbar curve, kyphosis, and lordosis were analyzed using the Cobb method [14]. The values for pelvic obliquity were obtained by measuring the

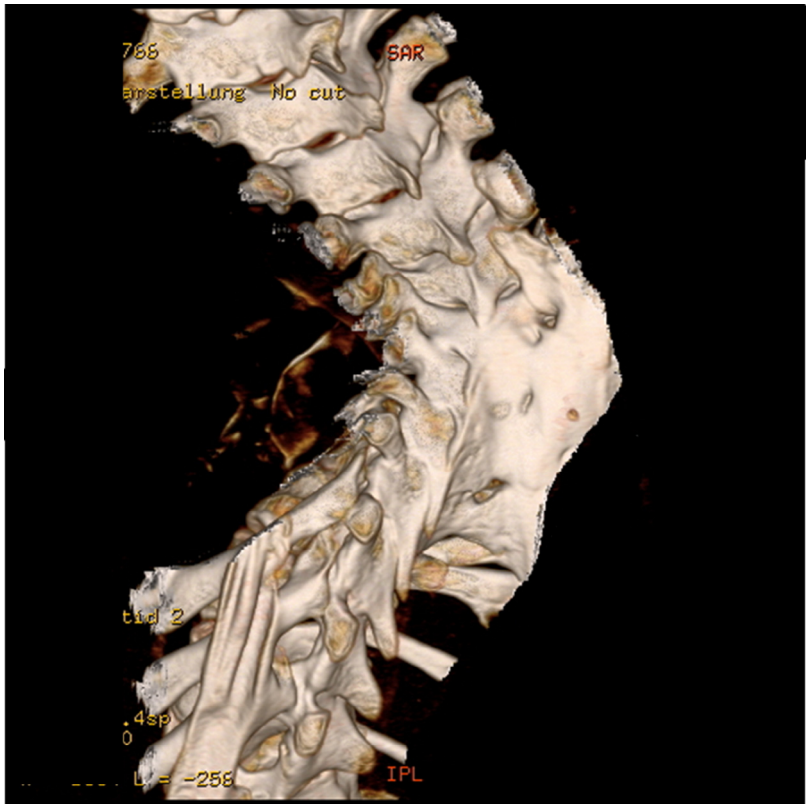

Fig. 1. Severe ossifications and autofusion of the spine in a 12-year-old girl with Pierre-Robin-syndrome. Several surgical interventions including implant infection and removal took place before the CT examination with 3D reconstruction. CT, computed tomography; 3D, three-dimensional.