COMPLICATIONS IN SURGERY OF EARLY-ONSET SCOLIOSIS WITH VEPTR INSTRUMENTATION: PRELIMINARY REPORT

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Objective. To analyze complications developing during multistage correction of early severe spinal deformities of various etiologies using VEPTR instrumentation.

Materials and Methods. The study included prospective group of 76 patients treated for early-onset scoliosis (EOS) with the VEPTR and VEPTR II instrumentation. Patients were classified using a randomized Classification of Early-Onset Scoliosis (C-EOS) system. In accordance with scoliosis etiology the cases were distributed as follows: 28 idiopathic, 26 congenital, 20 syndromic, and 2 neuromuscular scoliosis cases; and ratio of boys to girls was 32 : 44. The average age at the beginning of treatment was 5.4 ± 2.1 (1.6 to 9.8) years. The average follow-up period since the first stage was 2.2 (2 to 2.5) years.

Results. Twenty three complications were revealed in 15 (19.7 %) patients. According to the C-EOS system, the patients with complications were referred to normo- and hyperkyphotic groups. The most common complication was migration of the cranial point of implant fixation. Most complications were eliminated during the planned stage of deformity correction. In two cases, the complication resulted in cessation of the VEPTR technique using.

Conclusions. The use of VEPTR instrumentation for the treatment of EOS is associated with a rather high risk of complications. This is most likely in patients with normokyphotic and hyperkyphotic deformities. Most complications are eliminated during stage correction. The need to abandon the further use of the VEPTR instrumentation is rare.

Key Words: surgery of early-onset scoliosis, VEPTR, classification of scoliosis, children, spinal deformities.

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Surgical treatment of early onset scoliosis (EOS) is one of the most difficult tasks in modern vertebrology, therefore it is not surprising that there is no single solution to this problem. At present, various methods are used to treat scoliosis in the first ten years of life: VEPTR (Vertical Expandable Prosthetic Titanium Rib), Shilla Procedure, Growing Rods, Vertebral Stapling [1, 2]. In our clinics, we have been using VEPTR instrumentation to treat patients with EOS since 2008. With a rather large volume of clinical data (more than 100 patients operated on for EOS), we set out to conduct comprehensive analysis of the multiyear treatment, characterized by periodic distracting interventions on the spine.

In compliance with the experience of our foreign colleagues [4–7, 9], we quickly became convinced that VEPTR is associated with complications which, while not insurmountable, represent a major separate problem due to their high incidence.

The objective of the study is to analyze complications developing during multistage correction of severe spinal deformities of various etiologies using VEPTR instrumentation. Study design: prospective study.

Material and Methods

In 2008–2015, a total of 76 children with EOS of different etiologies were operated on using VEPTR instrumentation.

The criteria for inclusion in the study group were in accordance with generally accepted indications for surgical treatment: age up to 10 years, progressive course of scoliosis of various etiologies, curve magnitude of more than 40° (according to Cobb), minimum follow-up period (after the first distraction) of 2 years [3]. The inclusion criteria were adequate quality of bone tissue in the area of potential support points of the endocorrector, such as ribs, half-arches of lumbar vertebrae, crests of the iliac bones. The special condition was the presence of sufficient volume of soft tissues to close the VEPTR rods. For this purpose, we used a test proposed by Waldhausen et al. [9], the so-called 'pinch test', which requires at least 2 cm of soft

tissue between the thumb and forefinger of the examiner.

All patients were classified using a randomized system of Williams et al. [10] and El-Hawary et al. [6], as well as the system described by Smith et al. [8]

Patients must have been tolerant to the primary correction of deformity and to its further stages.

Based on scoliosis etiology, the patients were distributed as follows: 28 idiopathic, 26 congenital, 20 syndromic, and 2 neuromuscular scoliosis cases. The ratio of boys to girls was: 32:44. The average age at the beginning of treatment was 5.4 ± 2.1 (1.6 to 9.8) years. The average follow-up period since the first stage was 2.2 (2 to 2.5) years.

Staged surgical correction was performed at intervals of 6–8 months, the average number of stages per child was five. VEPTR I and VEPTR II instrumentation variants were used in the «rib-rib», «rib-spine», «rib-pelvis» configuration.

Results

Fifteen (19.7 %) out of 76 patients in the study group developed 23 complications. We studied the incidence and nature of postoperative complications using modern classifications, as they are the tools that allow comparing the results from different hospitals and giving them a more objective assessment. Two classifications were used.

1. C-EOS (Classification of Early-Onset Scoliosis) classification of patients [5, 10] takes into account the etiology and magnitude of deformity, as well as the severity of the kyphotic component (Table 1). Among 76 patients in the group, complications were noted only in hyperkiphotic (+) and normokiphotic (N) deformities. In patients with congenital scoliosis (C), complications were observed in 19.2 % of cases, while neuromuscular (M), syndromic (S) and idiopathic (I) scolioses had, respectively, 0.0 %, 20.0 % and 21.4 % of complications.

2. Classification system for assessing complications by Smith et al. [8] (Table 2). In this system a complication is defined as an unplanned medical event in the treatment process, which may or may not affect the final outcome. The type of complications refers to the level of care and urgency required for its treatment and can be classified as associated with the device or associated with the disease. Type I is a complication that does not require an unplanned surgery and can be corrected at the next planned intervention; Type II is a complication requiring an unplanned operation, where IIA requires one unplanned operation, and IIB requires multiple surgical interventions; type III is a complication that leads to abandonment of the planned course of treatment. Disease-related complications are classified as type I if hospitalization is not required and as type II if hospitalization is required. Type IV is defined as death associated with the disease or the endocorrector. All 23 complications identified in our group are presented in Table 3, according to the classification of Smith et al. [8]

Complications of varying severity were identified in 15 patients; the total number of complications was 23. Nine patients had 1 complication, four had 2 complications, and two had 3 complications. Most of these complications (15) were of Type I and were related to the device: 11 cases of migration of the upper (rib) anchor (Figure), 4 cases of migration of the lower fixation point (laminar). All complications were eliminated during the planned distraction stage.

At the 4th stage of correction, one patient underwent skin plastic surgery due to a soft tissue sore over the endocorrector (type I).

Extraordinary (unplanned) intervention had to be carried out twice: one case of instability of the laminar hook (type IIA) and one case of fracture of the Dunn-McCarthy hook, which required its replacement (type IIA).

Surgical site infections (SSI) were detected In 3 (3.9 % patients. In one case (type IIA), SSI was associated with primary implantation. In this case the endocorrector was removed, and then reimplanted one year later. In the second case (type IIA), the infection occurred after stage distraction only on one of the two elements in the «rib-pelvis» and «rib-pelvis» arrangement. The infected implant was removed, and a new one was installed a year later, during this time, the stage distractions were performed on the preserved distractor. In the third case (type III), SSI developed in a patient after the 4th stage of correction with VEPTR instrumentation, which was removed; after 1 year the final stage was completed using segmental instrumentation.

One patient was forced to discontinue stage treatment with VEPTR instrumentation due to the absence of a cranial fixation point after a fracture of ribs revealed prior to repeated distraction (type III).

Table 1

Patient distribution based on C-EOS classification [10], n

Patients	C2N	C3N	C3+	C4N	C4+	M3N	S3N	S3+	S4N	S4+	I2N	I3N	I3+	I4+
Total number	5	12	4	4	4	2	6	2	3	8	2	14	4	8
With complications	1	2	3	0	0	0	0	1	1	2	1	2	1	2
By etiology: C – congenital; M – neuromuscular; S – syndromic; I – idiopathic				Based on magnitude of the main scoliotic arccurve: group 1 – <20°; group 2 – 20–50°; group 3 – 51–90°; group 4 – > 90°					By the kyphotic component of the deformity: N – normokiphotic 20–50°; (-) – hypokyphotic; (+) – hyperkyphotic					

Table 2
The classification system for complications by Smith et al. [8]

Type of the complication	Complication associated with the device	Complication associated with the disease
I	Does not require an unplanned surgery	Only outpatient treatment
II	–	Hospital treatment
IIA	Only one unplanned surgery is required	–
IIB	Multiple unplanned surgeries are required	–
III	Requires abandoning the planned course of treatment	Requires abandoning the planned course of treatment
IV	Death	Death

Table 3
Distribution of complications in the study group according to the Smith et al. classification [8], n

Type of the complication	Complication associated with the device	Complication associated with the disease
I	15	0
II	–	0
IIA	4	–
IIB	0	–
III	2	0
IV	0	2
Total	21	2

Two deaths were recorded, which are not related to the device (type IV). One patient died as a result of drowning. Strictly speaking, this case cannot be regarded as a complication, but we included it in the study group, since the patient was part of the group initially and had underwent several stages of surgical treatment. The second patient was operated for a diaphragmatic hernia in infancy, suffered from peritoneal adhesions, and died at an outpatient stage due to intestinal obstruction.

None of the patients had intraoperative blood loss requiring hemotransfusion; in most cases, blood loss was minimal. There were no neurological complications.

In three patients, the elements of the structure were replaced by longer ones during the stage distraction, since the previous ones had exhausted their capacity to extend.

Discussion

Most of the complications were associated with the migration of anchor points, predominantly of cranial ones. It can be attributed to technical features of VEPTR endocorrector (which has only two anchor points) as well as to the characteristics of the patients (the strength of children's bones is low, children have difficulty observing the orthopedic regimen, despite the severity of the spine deformity).

Full healing of the operating wound is crucial for both primary correction with VEPTR instrumentation, and for subsequent stage distractions. Soft tissue sores or superficial wound infections can lead to deep infection associated with the implant, which can result in severe problems, most often leading to removal of the endocorrector. There are many predisposing factors for development of such problems, however for this cohort of patients the main ones are low body weight in relation to age and congenital aplasia or hypoplasia of the musculature. Attention to pre- and postoperation nutrition, as well as to gentle intraoperative treatment of soft tissues is the main preventive factor for development of infections. In case of infectious complications, repeated hospitalization is required as quickly as possible.

Fractures of VEPTR endocorrector are often associated with fatigue and require replacement of damaged elements of the metal structure.

We have experience in treating more than 100 patients with scoliosis within the first ten years of life. In this article, we analyzed the number and nature of complications arising at the stage of repeated distractions, provided that treatment had been started at least two years ago. Our task was not to compare the obtained data with the results of other authors. However, we plan to conduct such meta-analysis in the very near future. We have been more interested and found it more relevant to use the classification systems developed by Williams et al. [10] and Smith et al. [8]. These systems are designed to help researchers working all around the world to compare the results and develop the basis for further action. Moreover, it seems that the use of both systems will be most effective, as it will enable better understanding of the causes of developing complications and more effective control of them.

Conclusion

Speaking about our patients, it can be stated that complications related to the use of VEPTR instrumentation are quite frequent and more likely in patients with significant spinal deformities and in persons with normo- or hyperkophotic sagittal contour of the spine. Many complications require additional surgery, but most of them can be eliminated without unplanned interventions. A

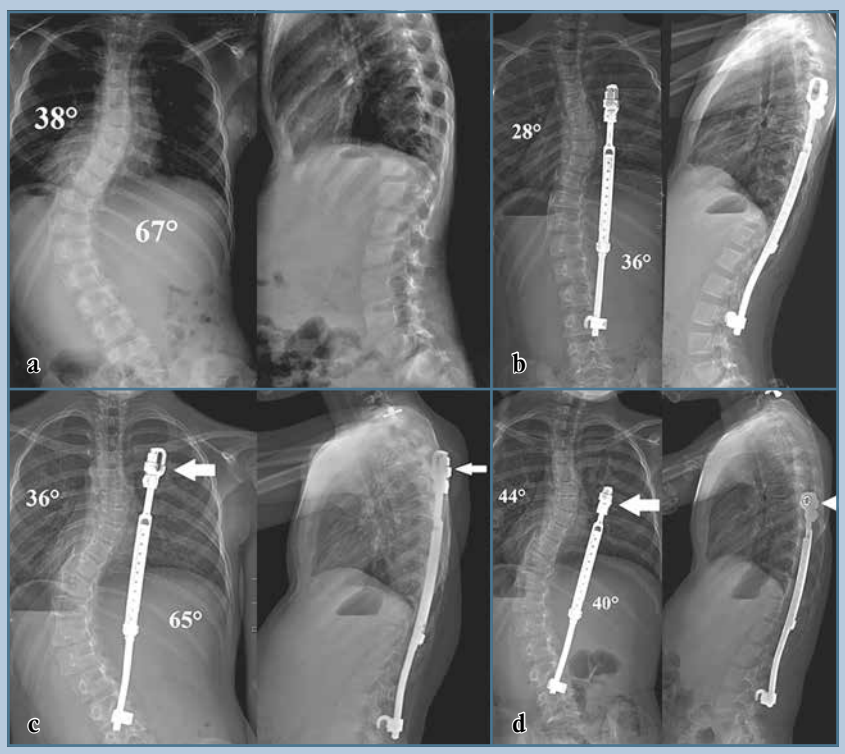

Рис.
X-rays of the patient A., 6 years old, with infantile uncomplicated progressive left-sided grade IV thoracolumbar scoliosis (67°), with thoracic counter-curve (38°), C-EOS type: I3N: **a** - at the time of the treatment initiation; **b** – after the implantation of VEPTR instrumentation (the rib fixation was performed on the ribs IV and V); **c** - before the planned 4th stage of distraction (the instability of rib fixation is identified and partially fixed for rib IV); **d** - after the remounting involving placement of rib anchor at the rib VI and the next stage of correction of the deformity of the spine

multidisciplinary approach with due regard to nutrition, quality of suturing and surgical techniques may be the best way to minimize complications. Infectious complications can potentially be reduced if stage distractions are less frequent.

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