DOES A FRACTURE OF THE ENDOCORRECTOR ROD AFFECT THE QUALITY OF LIFE OF A PATIENT WITH SPINAL DEFORMITY?

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Objective. To assess the effect of endocorrector rod fractures on the final result of treatment and the quality of life of patients operated on for spinal deformities of different etiology.

Material and Methods. The study included 3833 patients older than 10 years who were operated on for spinal deformities of various etiologies and had not been subjected to spinal surgery before admission to the clinic. In the pre- and postoperative periods, spondylograms in frontal and lateral projections in the standing position were studied using the Cobb method, the apical vertebra rotation was determined in accordance with the method of Sullivan et al. Patients answered questions of the SRS-24 questionnaire in the immediate and long-term follow-up periods.

Results. In total, fractures of metal implant rods were detected in 85 (2.2 %) patients. The average scoliotic deformity in these patients was 84.5° before surgery, 49.9° after surgery, and 53.7° at the end of the follow-up period (postoperative progression was 3.8°). Thoracic kyphosis was 61.5° before surgery, 44.3° after surgery, and 48.7° at the end of the follow-up period; lumbar lordosis — 68.4°, 54.8°, and 56.5°; and apical vertebra rotation — 55.8°, 33.2° and 35.8°, respectively. According to the questionnaire data, patients estimated their appearance after surgery and general appearance somewhat lower and pain as less intense. Indicators of activity and function of the spine after the rod remounting were slightly lower than after the primary surgery. Remounting did not significantly affect the indicator of "consent to surgical treatment under the same conditions" — 80.6 and 80.0 %.

Conclusion. Complications in the form of rod fracture do not have a significant negative effect on the treatment result from the standpoint of assessing the quality of life, provided that the corrective effect of the surgical intervention is maintained in the horizontal, frontal and sagittal planes.

Key Words: spinal deformities, surgical treatment, rod fractures.

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In spinal deformity surgery, there are a number of specific spinal complications, including those that are directly related to the metal implant: rod and screw fractures, spontaneous disassembly of the system, displacement of its elements, damage to the supporting bone structures, and protrusion of the metal implant under the skin. A number of publications [1–8] have addressed the issue of endocorrector rod fractures [1–8]; but despite the seeming multiplicity, they lack information on how complications affect the final result of treatment in terms of the quality of life. This is not only radiographic data on the loss of spinal deformity correction in three planes, but the patient's quality of life that is a priority aspect for assessing the long-term outcome. Only one publication [8] indicates that rod fracture affects the patient's quality of life. In this case, the etiology of deformity or the type of surgery is not of fundamental importance; in our opinion, the very fact of mechanical destruction of the metal implant that is designed to maintain the achieved correction effect is important.

The objective of this study was to assess the effect of endocorrector rod fractures in patients operated on for spinal deformities of different etiologies on the final result of treatment in terms of the quality of life.

Material and Methods

Study design: a monocentric retrospective non-randomized cohort study. Validity of recommendations: C. Level of evidence: 4 UK Oxford (version 2009).

The study included patients over 10 years of age who were operated on for spinal deformities of different etiologies in 1996–2018. Patients under the age of 11 years who were operated on using multi-stage treatment techniques (traditional growing rods, VEPTR) were excluded because endocorrector-associated complications, including rod fractures, were stopped during the next planned distraction and had no effect on the final result. The upper age limit of patients was 46 years.

Exclusion criteria were as follows: surgery involving a ventral endocorrector; spinal surgery before admission to the clinic.

There were 2,670 (69.63 %) patients aged 11 to 20 years, 852 (22.23 %) patients aged 20 to 30 years, 252 (6.00 %) patients aged 30 to 40 years, and 59 (1.54 %) patients aged 40 to 50 years. Various variants of modern spinal instrumentation made primarily of titanium alloys were used as endocorrectors. In the pre- and postoperative periods, frontal and lateral spinal radiographs with the patient in the upright position were

assessed. Assessment criteria included changes in the deformity magnitude by the Cobb angle, apical vertebra rotation according to the method by Sullivan et al. [9] using the formula (rotation = 0.26 × (thoracic kyphosis in degrees) + 0.54 × (main curve in degrees) – 5.38), and SRS-24 questionnaire data collected in the immediate and long-term postoperative periods [10]. The bone block was assessed visually during revision surgery. Criteria were analyzed using descriptive statistics.

Results

In total, fractures of metal implant rods were detected in 85 (2.2 %) of 3,833 patients. The nosological picture of spinal deformities of different etiologies was as follows: 64 (2.1 %) fractures in 3,068 patients with idiopathic scoliosis, 15 (4.0 %) fractures in 374 patients with congenital deformities, and 6 (1.5 %) fractures in 391 patients with deformities of different etiologies (neurofibromatosis – 4 cases, Scheuermann's disease – 1 case, and neuromuscular scoliosis – 1 case).

A fracture of one rod was found in 51 patients, and fractures of two rods were detected in 34 cases. The level of rod breakage varied significantly: T6–T10 in 16 patients, T11–L4 in 65 patients, and L5–S1 in 1 patient. The risk of skin perforation occurred in few cases. In 62 out of 85 patients, the rod fracture was as a cause for repeated intervention — restoration of the rod integrity using a connector or complete rod replacement. Indications for this operation included loss of achieved correction and pain. In 18 of these 62 patients, there was recurrent fracture, which required 2 to 4 revision interventions. The exact time of rod fracture was not identified in most cases, although some patients indicated injury that might be a cause of the complication. Repeated intervention was performed 38.4 (4–126) months, on average, after correction surgery.

The mean scoliotic deformity in the entire group of 85 patients was 84.5° (36–140°) before surgery, 49.9° (7–123°) after surgery, and 53.7° (7–125°) at the end of the follow-up period (including rod fracture and repeated intervention). Therefore, the mean postoperative progression of scoliotic deformity was 3.8° (10.9 % of the achieved correction). Changes in the thoracic kyphosis were as follows: 61.5° (10–150°) before surgery, 44.3° (10–138°) immediately after surgery, and 48.7° (16–144°) at the end of the follow-up period. Changes in the lumbar lordosis were as follows: 68.4° (32–130°) before surgery, 54.8° (31–94°) after surgery, and 56.5° (27–107°) at the end of the follow-up period (Fig. 1–4). On average, apical vertebra rotation amounted to 55.8° (17–138°) before surgery, 33.2° (3.5–123°) immediately after surgery, and 35.8° (2.5–92°) at the end of the follow-up period. Frontal imbalance (the distance between the T1 vertebral body centroid and the central sacral vertical line) was 18.0 mm before surgery, 20.7 mm immediately after surgery, and 14.2 mm at the end of the follow-up period. Changes in the Cobb angle of the main curve, thoracic kyphosis, lumbar lordosis, apical vertebra rotation, and frontal imbalance in different etiological subgroups (idiopathic scoliosis, congenital deformities, other deformities) are presented in Table 1.

Self-assessment of the surgical treatment results in the study group was examined using the SRS-24 questionnaire. The questionnaire was completed after the main surgical intervention and at the end of the follow-up period after surgery for endocorrector replacement due to rod fractures (Table 2).

Patients after a device replacement operation assessed the appearance after surgery and the general appearance slightly poorer, while pain after replacement was assessed as less intense. The indicators of activity (general and professional) and spinal function after replacement were slightly poorer than after primary surgery, which may be explained by a more cautious attitude of the patient to activation in the postoperative period. In this case, the replacement had no significant effect on the indicator "consent to surgical treatment on the same terms" – 80.6 and 80 %, respectively.

Discussion

Information on the topic under discussion was searched through international databases Scopus, Medline, and Google-Scholar. Also, we additionally searched for publications from references.

We found only one publication whose authors addressed the issue of rod fractures in spinal deformity surgery and examined the quality of life of patients in the long-term postoperative period.

Lertudomphonwanit et al. [7] analyzed the rate of rod fractures in adult patients after posterior fusion extending up to the sacrum. Totally, there were 526 patients aged 18–80 years (mean, 56.8 years); the mean follow-up period was 57 months. Rod fractures were detected in 97 (18.4 %) patients: one rod was broken in 61 patients, and two rods were broken in 36 cases. Rods made of stainless steel are more reliable. Rod fractures reduce the quality of life in patients, which is confirmed by questionnaire data (ODI, SRS). The authors define rod fracture as a rod breakage at least in one site after primary surgery. Rod fracture was detected, on average, after 39.6 months after surgery: in 51 patients at the age under 3 years, in 23 patients at the age of 3 to 5 years, in 22 patients at the age of 5 to 10 years, and in 1 patient at the age of over 10 years. In 36 patients with a unilateral fracture, there were 79 breakage sites; in one of them the rod was broken at four sites. Most often, rods were broken at the L5–S1 and L3–L4 levels. At the latest examination, there was no pain and loss of correction in 57 patients; another 40 patients underwent revision surgery due to pain, loss of correction, and implant protrusion. Patients with fractures of both rods were operated on more often; the time interval between the diagnosis of fracture and revision surgery was 3 months.

As far as we can judge, the analyzed clinical material is the largest of the published studies – 3,833 patients, with 85 of them having broken rods. In this case, changes in the main curve magnitude, apical vertebra torsion, thoracic kyphosis, and lumbar lordosis in patients with complications differ very little from the

usual course of the postoperative period [11]. For example, the mean postoperative progression of the main curve was only 3.8°, which does not exceed the measurement error for the Cobb method. In the literature, we could not find the results of analysis of spinal deformity parameters after endocorrector rod fracture.

We consider the results of questioning patients who had complications and resurgery (rod replacement) to be equally important because they demonstrate that the quality of life associated with health in these patients is not significantly reduced. Our data differ from the results of Lertudomphonwanit et al. [7], and we are inclined to explain this difference by the fact that the mean age of patients in their study e was almost 58 years, while most patients in our cohort were operated on at the age of 10–30 years. It is logical to suppose that young patients easily adapt to more difficult living conditions, including complication effects.

Conclusion

Surgical correction of spinal deformities is designed primarily to improve the quality of life of the patient. A complication in the form of an endocorrector rod fracture developed in the postoperative period was shown to have no significant negative effect on the outcome in terms of the quality of life, provided that the corrective effect of surgery has persisted in the horizontal, frontal, and sagittal planes.

The study was conducted without financial support.
The authors declare no conflict of interest.

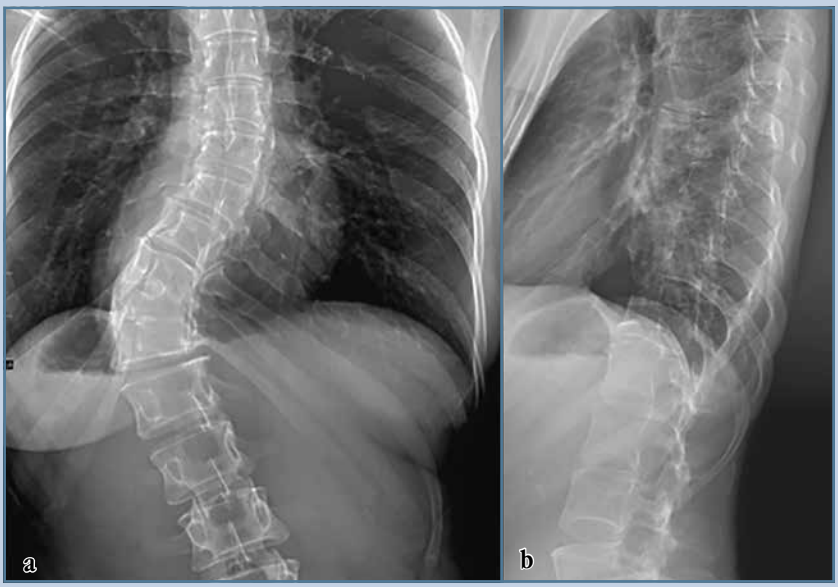

Fig. 1
Spine radiographs of a 34-year-old female patient M. before surgery: **a** – anteroposterior spine radiograph: congenital (due to multiple developmental abnormalities) left-sided uncomplicated non-progressive lower thoracic scoliosis, grade IV, the Cobb angle of the main curve is 52° (2011); **b** – lateral spine radiograph: thoracic kyphosis – 27°, lumbar lordosis – 50°

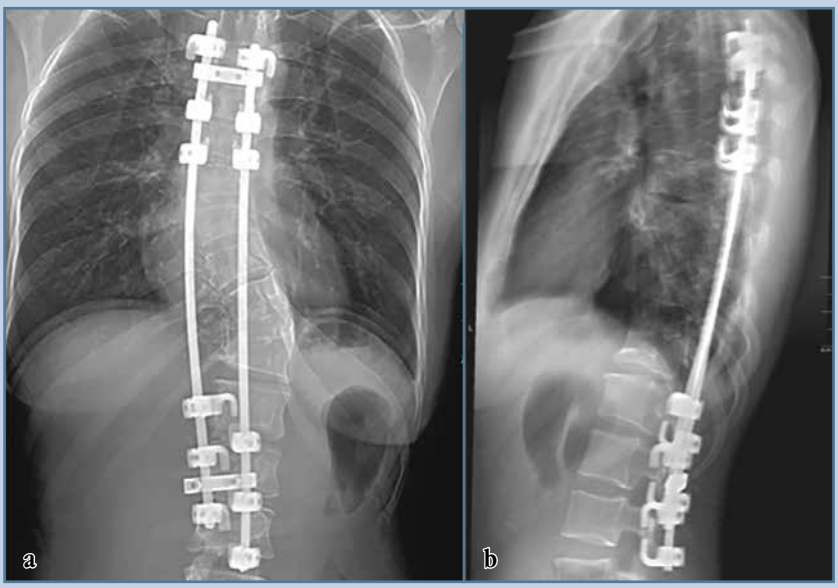

Fig. 2
Spine radiographs of the female patient M. after surgery: **a** – anteroposterior spine radiograph after deformity correction using segmental instrumentation (hook fixation) and posterior spinal fusion using autobone graft (05.10.2011); the Cobb angle of the main curve is 26°; **b** – lateral spine radiograph after surgery: thoracic kyphosis – 32°, lumbar lordosis – 38°

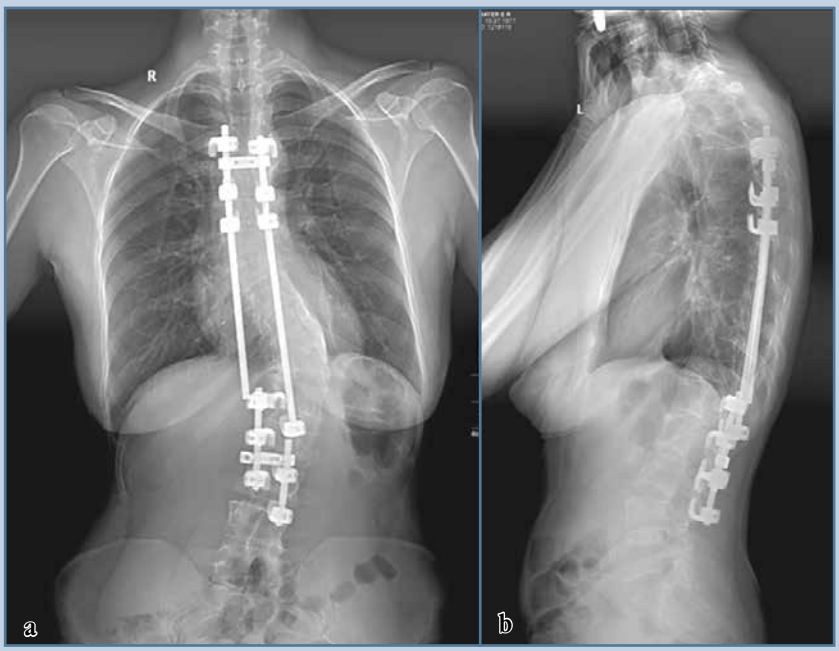

Fig. 3
Spine radiographs of the female patient M. (2017): **a** – anteroposterior spine radiograph, fractures of both endocorrector rods, the Cobb angle of the main curve is 40°; **b** – lateral spine radiograph: thoracic kyphosis – 32°, lumbar lordosis – 49°

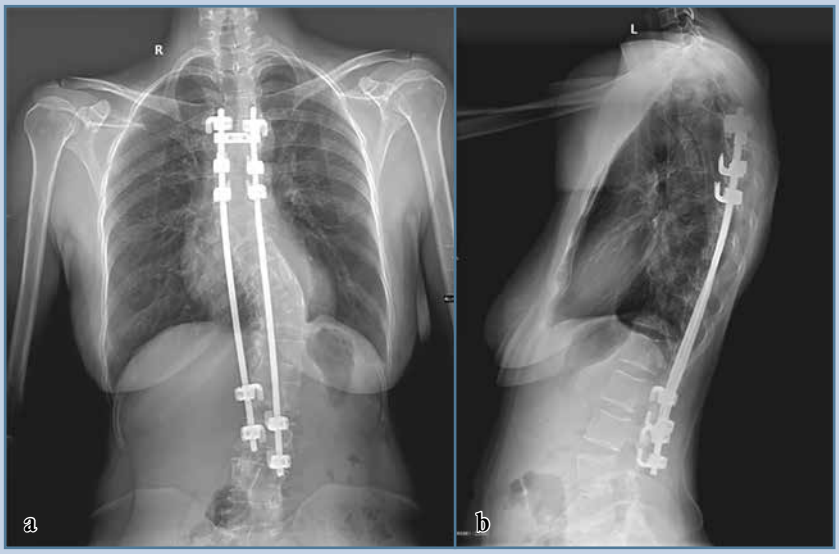

Fig. 4
Spine radiographs of the female patient M. after replacing broken rods (26.09.2017): **a** – anteroposterior spine radiograph: the Cobb angle of the main curve is 30°; **b** – lateral spine radiograph: thoracic kyphosis – 30°, lumbar lordosis – 55°; replacement of the device enabled almost complete restoration of correction in the sagittal and frontal planes, which was lost due to rod fractures

Table 1

Changes in the mean radiographic parameters of spinal deformity in patients with rod fractures, depending on the disease etiology

Parameter	Idiopathic scoliosis	Congenital spinal deformities	Other etiological forms
Scoliosis before surgery, deg.	84.0	82.4	95.2
Scoliosis immediately after surgery, deg.	46.5	60.8	61.1
Scoliosis at the end of the follow-up period, deg.	50.3 (postoperative progression – 3.8)	64.5 (postoperative progression – 3.7)	64.3 (postoperative progression – 3.2)
Thoracic kyphosis before surgery, deg.	55.4	73.9	99.2
Thoracic kyphosis immediately after surgery, deg.	40.5	53.8	57.7
Thoracic kyphosis at the end of the follow-up period, deg.	45.2	55.2	68.9
Apical vertebra rotation before surgery, deg.	53.9	58.3	71.2
Apical vertebra rotation immediately after surgery, deg.	30.3	40.8	42.6
Apical vertebra rotation at the end of the follow-up period, deg.	33.5	41.5	47.2
Lumbar lordosis before surgery, deg.	65.4	78.0	88.0
Lumbar lordosis immediately after surgery, deg.	53.1	61.4	60.2
Lumbar lordosis at the end of the follow-up period, deg.	55.3	54.8	71.8
Frontal imbalance before surgery, mm	16.9	23.3	26.5
Frontal imbalance immediately after surgery, mm	18.4	27.5	58.0
Frontal imbalance at the end of the follow-up period, mm	12.9	23.5	16.7

Table 2

Mean parameters of quality of life according to the SRS-24 questionnaire

Parameter	Before rod fracture	After endocorrector replacement
Back pain, score	3.52 ± 0.45	3.91 ± 0.54
General appearance, score	3.48 ± 0.46	3.27 ± 0.46
Appearance after surgery, score	4.38 ± 0.61	4.13 ± 0.80
Spine function after surgery, score	2.44 ± 1.39	2.17 ± 1.28
General activity, score	3.27 ± 0.84	2.97 ± 0.77
Professional activity, score	3.62 ± 0.62	3.53 ± 1.00
Satisfaction with results of surgical treatment, score	4.34 ± 0.51	4.17 ± 0.67
Consent to surgical treatment on the same terms, %	80.6	80.0

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