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Surgical management of neurologically complicated kyphoscoliosis using transposition of the spinal cord: Case report

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ABSTRACT

BACKGROUND: Transposition of the spinal cord made it possible to achieve mobilization of the fixed kyphoscoliosis, significantly increase spinal canal volume and improve spinal canal shape. This helped to eliminate spinal cord compression and achieve complete regression of the existing neurological symptoms.

METHODS AND RESULTS: We report the clinical case of surgical management of neurologically complicated kyphoscoliotic deformity of the thoracic spine by transposition of the spinal cord and correction using posterior segmental spinal instrumentation.

CONCLUSIONS: The required correction of severe kyphoscoliosis was performed; the risks of trunk imbalance, deformity progression, and instrumentation failure in the long-term postoperative period were reduced.

LEVEL OF EVIDENCE: Level IV – 1 case.

1. Introduction

Idiopathic rigid decompensated kyphoscoliosis is a severe spinal deformity tending to progress without surgical treatment.

Surgical management methods include the posterior, anterior, and combined anterior–posterior approaches [1]. Fairly good correction with short fusion level can be achieved using anterior instrumentation. However, the approaches differ in regard to some complications, such as injuries to the adjacent aorta and organs, as well as reduced pulmonary function [2]. Pedicle screws, hook or hybrid constructs are used in posterior instrumentation. The posterior approach is currently widely used as it ensures good correction outcomes and the relatively low complication rate [3,4]. The combined anterior–posterior approach implies anterior release and/or fusion with subsequent posterior instrumentation and fusion involving either one or two stages. In case of severe and rigid spinal curve, surgeons tend to choose the combination of the anterior and posterior approaches [5,6]. The reason is that the combined anterior and posterior surgery has proved to be quite safe with effective 3D curve correction being achieved [7,8]. However, it was demonstrated in some studies that the posterior-only approach is sufficient for achieving fairly good correction of the spinal curve, so the anterior approach is actually not required.

If a spinal deformity is rather long (involving 3–7 levels) and there is extensive spinal cord compression, osteoplasty after this type of resections can turn out to be inefficient. Elimination of spinal cord compression in this case may require to further increase the resection volume and the number of surgical levels. Hence, transposition of the spinal cord can be the most effective surgical intervention method [7]. Elimination of spinal stenosis by resecting bone structures that compress the spinal cord only allows one to manage the existing neurological deficit. This decompression of spinal cord makes it impossible to subsequently correct the spine deformity. The methods for single-stage radical correction of severe kyphoscoliotic deformities using vertebral instrumentation often cause neurological complications, including development of traction-ischemic myelopathy in early postoperative period [3]. The attempts to correct these deformities non-radically are often unsuccessful, since the kyphotic and scoliotic curves remain largely unchanged and the biomechanics is disturbed, resulting in pseudoarthrosis, loss of correction, trunk imbalance, and further deformity progression. Sometimes instrumentation needs to be removed because of its breakage and failure of bone fixation points [4]. This case report is given to demonstrate the method for successful single-stage decompression of the spinal cord followed by transposition. Based on their own experience, surgeons in the Clinic of Pediatric and Adolescent Vertebrology (Novosibirsk Research Institute of Traumatology and Orthopaedics) designed the method for transposition of the spinal cord in kyphoscoliotic patients [9]. Transposition of the spinal cord includes the anterior stage where transposition of the spinal cord is performed through the transthoracic approach to the anterior vertebral portions; and the posterior

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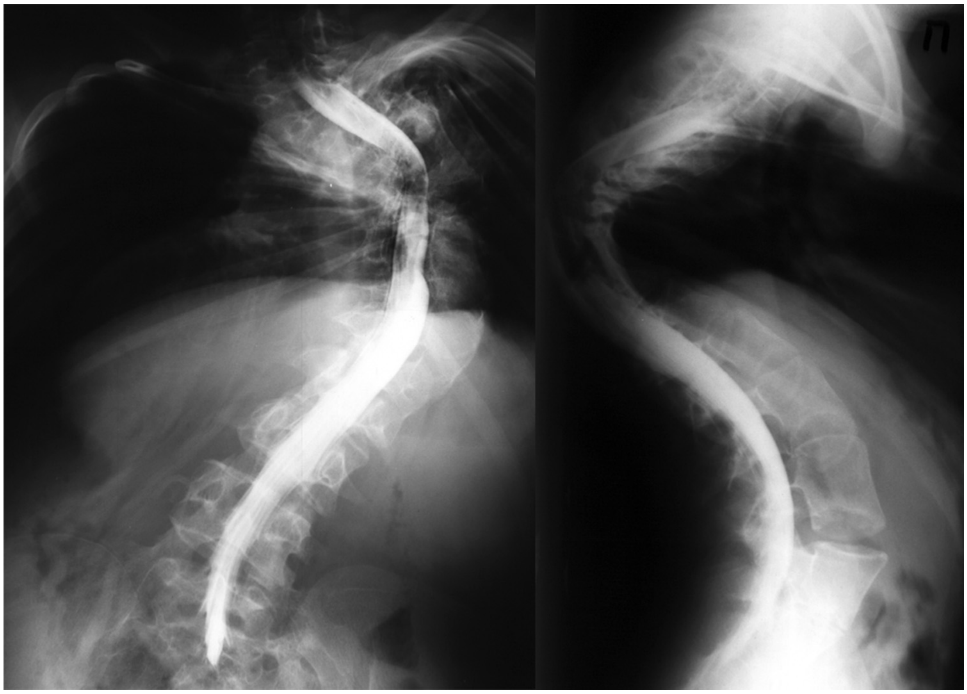

Fig. 1. Myelograms of the patient. (a) – Kink and stenosis of the dural sac in the frontal view at the T9–T10 level. (b) – Absence of reserve subdural space in the sagittal plane at the T9–T10 level.

stage where spinal deformity is corrected after performing several spine osteotomies at the apex of the curve.

2. Case report

A 15-year-old female patient S., was admitted to the Clinic of Pediatric and Adolescent Vertebrology (Novosibirsk Research Institute of Traumatology and Orthopaedics) with complicated progressive decompensated rigid right-sided thoracic kyphoscoliosis (degree IV) caused by multiple developmental anomalies of the thoracic spine. The patient also had thoracic myelopathy presenting as spastic paraparesis of the lower limbs without pelvic organ dysfunction; kyphoscoliotic heart disease; and degree II respiratory failure (vital capacity of lungs – 1000 mL). It was known from past medical history that spinal deformity had been revealed at an early age. It progressed gradually despite conservative treatment. Rapid progression was observed when the patient was 11–12 years old. Spondylograms recorded for the patient in standing position showed that the Cobb angle of the scoliotic curve at the T4–L1 level was 148°; the Cobb angle of the kyphotic curve was 155°. Multiple developmental anomalies of the thoracic spine were revealed (posterolateral wedge-shaped T9, T10, and T11 hemivertebrae; concrescence of the posterior segments at the apex of deformity on the concave side; and hypoplasia of intervertebral discs at the apex). X-ray images and myelograms of the thoracic spine showed narrowing of the free space on the concave side of the spinal deformity. The kink of the dural sac on the apex of the deformity is clearly visible (Fig. 1). Since the spine deformity was strongly pronounced, X-ray images showed overlapping of different spinal segments on the cross-sections of the vertebral arch apex. A conclusion about the location, degree, and length of spinal cord compression has been drawn based on the myelograms. The kink and compression of the dural sac were detected at the level of the T9–T10 vertebrae in myelograms. The patient was able to walk, although signs of spastic gait were observed. The knee-jerk and plantar reflexes were noticeably more brisk on both sides, being pronounced stronger on the left-hand side, with plantar and patellar clonus and pathological plantar response (Babinski's sign). Traction test involved vertical traction using a Glisson's loop with the patient's total body weight. Traction test showed aggravation of neurological deficit, emergence of bilateral plantar and patellar clonus, and aggravation of the Babinski's sign.

The patient was operated on at the Novosibirsk Research Institute of Traumatology and Orthopaedics (NVV being the operating surgeon). All the procedures were performed sequentially within the same day. The surgery involved dural sac decompression and spinal cord transposition at the T7–T11 level through the transthoracic transpleural approach with resection of the fifth rib. Only in this case sufficient reserve epidural space for subsequent correction of spinal deformity was achieved without the risk of spinal cord compression.

We used the posterior approach for laminectomy throughout the deformity, dissected the dura mater, removed the facet joints, transverse processes, and arch roots, and resected the posterior portions of the vertebral bodies compressing the spinal cord. This resulted in displacement of the spinal cord anteriorly, to a new bed. In this case, the spinal cord transposition occurred spontaneously, by moving the cord to the place of resected bone structures compressing the spinal cord. This procedure decompressed the spinal cord without damage to it.

The consecutive stages of correction included: anterolateral transposition of the spinal cord at the T7–T11 levels through the right-sided transthoracic approach; skeletal cranio-tibial traction; posterior wedge-shaped vertebrotomy at the T7–T11 levels; correction of the spine deformity using a CD Horizon instrumentation and posterior fusion with local bone autograft along the entire length of the instrumentation (T1–L4) (Fig. 2). The surgery was carried out under multicomponent total intravenous anesthesia and mechanical ventilation. Intraoperative control of the status of spinal cord was carried out by monitoring somatosensory evoked potentials; no negative dynamics were revealed. The total duration of surgical manipulations was 480 min; perioperative and postoperative blood loss volume was 2000 and 650 mL, respectively. The first stage of transposition of the spinal cord that involved its com-