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ANTERIOR DYNAMIC SCOLIOSIS CORRECTION IN A PATIENT WITH CONGENITAL LEFT-SIDED FALSE DIAPHRAGMATIC BOHDALEK HERNIA: ONE-STAGE SURGICAL SOLUTION

S.V. Kolesov[1], V.S. Pereverzev[1], D.V. Khaspekov[2]
[1]National Medical Research Center of Traumatology and Orthopedics n.a. N.N. Priorov, Moscow, Russia
[2]Children`s State Hospital of St. Vladimir, Moscow, Russia

A clinical case of treatment of lumbar scoliotic deformity combined with false congenital diaphragmatic hernia in a 17-year-old patient is presented. Stage surgical solution to the problem was achieved using dynamic scoliosis correction system installed through the anterior approach.

Key Words: scoliotic deformity, dynamic scoliosis correction system, diaphragmatic hernia.

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A congenital diaphragmatic hernia (Bochdalek hernia) is formed as a result of incomplete atresia of the embryonic pleuroperitoneal membrane. Surgical is the only possible treatment method of such conditions [1]. Patients operated for diaphragmatic hernia tend to have an increased risk of chest distortion and scoliosis, as well as a connection between musculoskeletal deformity and diaphragmatic hernia [2, 3].

The spinal deformity development after surgeries on the diaphragm has been reported in several papers [4]. Frequently, chest distortions and scoliosis arise after surgeries due to agenesis of the diaphragm. Nonoperative treatment is usually enough. In some cases, however, follow-up of patients is required until they reach adulthood [5]. The combination of diaphragmatic hernia and spinal deformities is uncommon [6]. This article describes a clinical case of scoliotic deformity of the lumbar spine in association with a false congenital diaphragmatic hernia in a 17-year-old patient. This paper also presents a simultaneous surgical solution of these problems using an anterior dynamic scoliosis correction (ASC).

According to the mother, a three-year-old child was diagnosed with a false diaphragmatic Bohdalek hernia in the Moscow children's hospital. Meanwhile, the parents were proposed a surgery. However, the parents refused it, taking into account the risks of intervention. Later, as the child grew, the patient was constantly offered surgery due to a congenital diaphragmatic hernia. An idiopathic lumbar scoliosis was diagnosed in the girl at the age of 12. She was under conservative treatment with the use of a corset Chenault. Nevertheless, spinal deformity has steadily progressed. It was probably due to improper use of the corset. The patient became concerned about the pain, lumbar spine deformity, and balance disorder. At the age of 17, the patient applied to the Department of Spinal Pathology of the National Medical Research Center for Traumatology and Orthopedics named after N.N. Priorov. During the examination, the left-sided hernia of the diaphragm and left-sided lumbar scoliosis (Lenke V) (N; 55° according to Cobb) were diagnosed by the plain radiography of the spine. The patient also complained of gaseous eructation, retrosternal pain, epigastric burning after eating, and breathing difficulties. Following consultation of a pediatric thoracic surgeon, considering the localization of the diaphragmatic hernia and the convex side of the scoliotic deformity on the left, a group decision was made to perform a simultaneous surgery: 1) a plastic surgery of the left hemidiaphragm; 2) an anterior dynamic scoliosis correction (ASC).

The patient was laid down in the position on the right side. The thoracotomy was performed at the level of the X rib on the left, the incision was extended in the direction of the external abdominal oblique muscle by 3 cm anteriorly. During the exploration of the pleural cavity, the left lung was significantly compressed. It fitted in the area of the apex of the hemothorax and was small in size. The whole small intestine, large intestine and part of the stomach were in the chest. The defect of the diaphragm was 8 × 7 × 4 cm (Fig. 1).

Due to a moderate adhesive process, viscerolisis was first performed to mobilize the diaphragm, reposition of the prolapsed organs into the pleural cavity and perform retroperitoneal approach to the lumbar spine. The displacement of the

hernia contents was significantly complicated by the fact that the patient was of adolescent age, and the abdominal cavity was underdeveloped and small in size. After the repositioning (with minor technical difficulties) of the abdominal organs, the peritoneal defect area was sutured, several interrupted stitches were inserted on the diaphragm from the anteromedial edge (Fig. 2).

The diaphragm was dissected at a spacing of 1 cm from the origin; the peritoneum was separated from the posterior lateral abdominal wall and the diaphragm. Then a standard anterior approach to the spine was performed at the level of T11–L4 with pleura dissection, mobilization of the psoas muscle and coagulation of segmental vessels. The vertebral bodies were identified under image converter control. The staples and 2 pedicle screws were mounted at each level transcorporally. Then, a flexible cord was performed in the direction from the bottom up through the screw heads. Following that, a T-handle tensioner was alternately mounted on them and a segmental transmission was made on both sides, finally fixed with nuts. In order to control the correction at each level, fluoroscopy was done. An extra cord length was cut off with a scalpel (Fig. 3).

The diaphragm defect was completely sutured. The pleural cavity underwent drainage according to Bulau. Hemo- and aerostasis, layered closure of the wound. To provide adequate postoperative anesthesia, an epidural catheter was mounted. The surgery time was 3 h 05 min, blood loss was 250 ml.

During the postoperative management, it is necessary to point out that the intestines, immersed into the abdominal cavity, was in particular compression. That is why an occlusive ileus happened after the surgery. Therefore, the activities to stimulate the intestines were performed: paravertebral massage, electrical stimulation, enemas to regulate the passage. In the same way, parenteral nutrition was prescribed with the improvement of electrolytes and protein quotients. On the 4th-5th day, peristalsis and bowel movement repaired. In this regard,

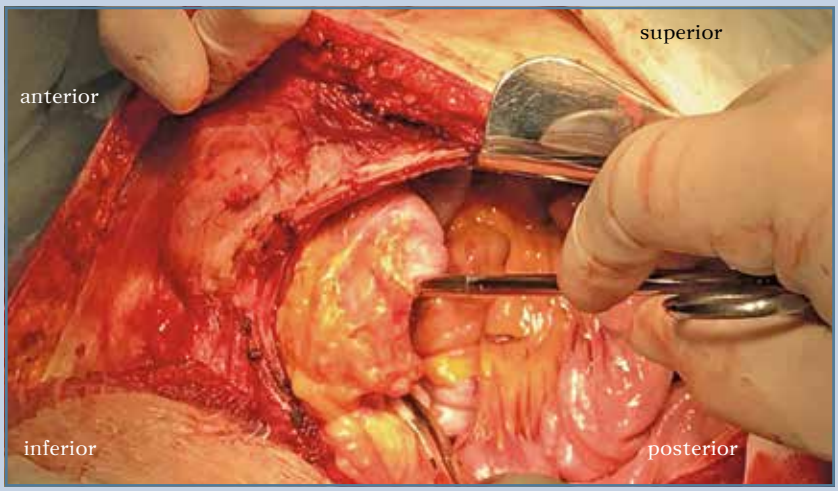

Fig. 1
Thoracotomy: defect of the Bochdalek foramen; small intestine, large intestine, part of the stomach in the pleural cavity

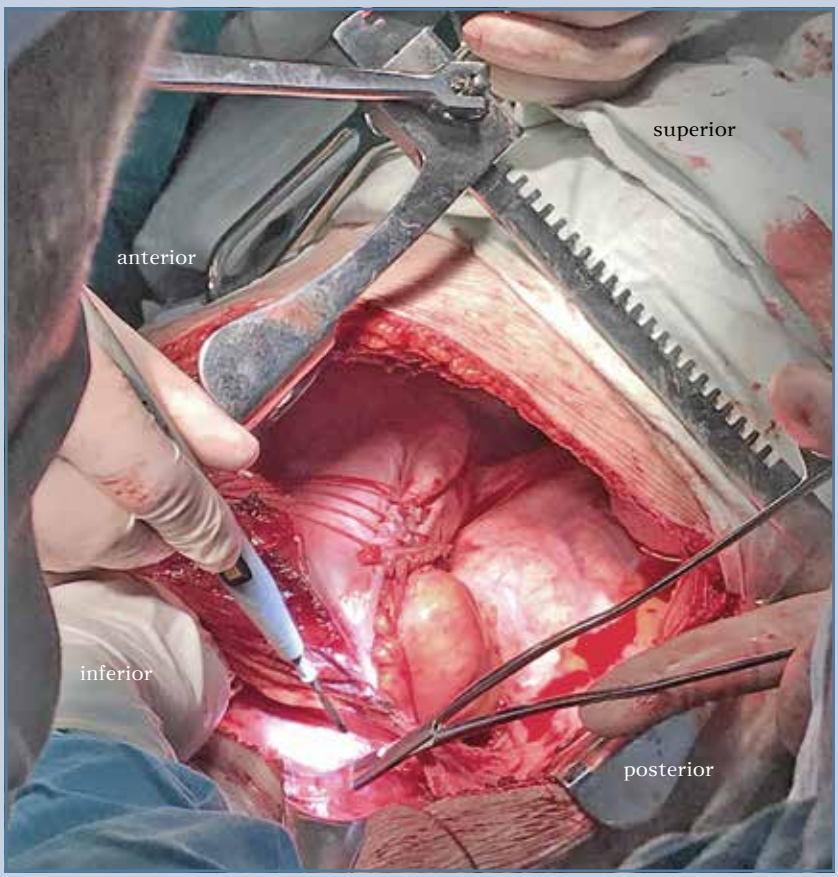

Fig. 2
Phrenotomy: the stage of performing retroperitoneal approach to the spine after the reposition of the abdominal cavity organs; partial closure of the diaphragmatic defect

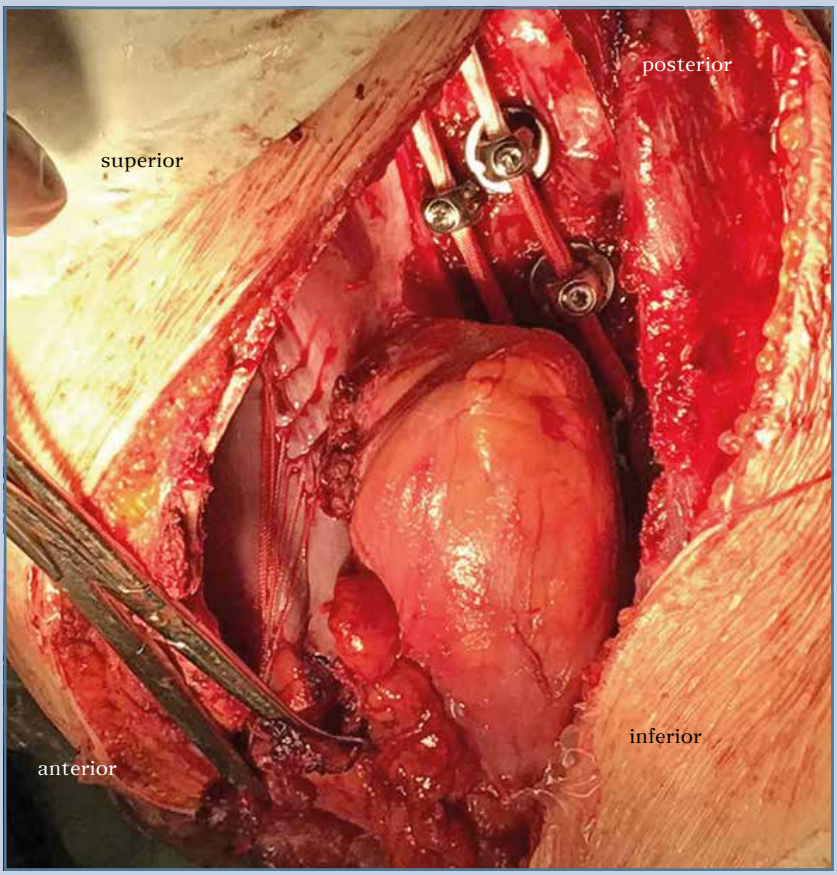

Fig. 3
Intraoperative wound after the placement of the instrumentation system for anterior dynamic scoliosis correction: an alleviation of the deformity is observed

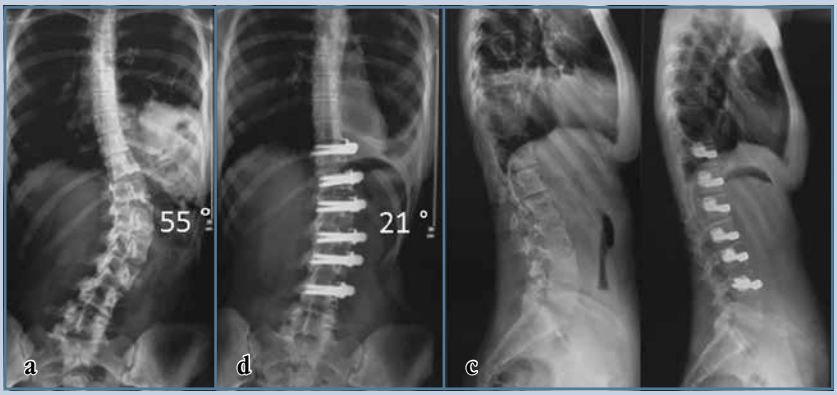

Fig. 4
X-rays of the patient's spine: in the frontal view before the surgery **(a)** a pronounced deformity of the lumbar spine is observed; **(b)** satisfactory correction is achieved after the surgery; in the lateral view before and after the surgery **(c)** the position of the system for ASC is correct

the patient's diet and feeding regimen were immediately changed. On the 5th day, the patient was verticalized. During 10 days, the patient had a subfebrile temperature, since the left lung was compressed for a long time and could not immediately fill the entire pleural cavity, the free volume of which was of a hematoma. It was not possible to drain the hemorrhagic discharge completely since a clotted hemothorax had been formed and abated within 10 days. This was verified by ultrasound and multi-layer spiral CT. This condition was followed by a subfebrile temperature. On the 2nd–3rd day after the surgery, breathing exercises and physical therapy with a specialist were performed for the patient. A satisfactory correction of the deformity was reached on the control X-rays (Fig. 4). Clinically, an improvement in the back profile was observed (Fig. 5). The total hospital stay was 17 days.

Discussion

According to the World Health Organization, up to 20–30 % of patients with surgical pathology need simultaneous surgical intervention. However, not all patients receive such medical care. The reason for this is the lack of a consensus among surgeons on this or that pathology [7, 8]. There is data on the joint work of surgeons and obstetricians in the treatment of a pregnant patient with a diaphragmatic hernia which resulted in saving the life of both the mother and the child [7]. The FAST TRACK concept is a highly effective tool for achieving high quality standards of treatment in association with a hospital stay reduction during spinal surgery [9]. Typically, the FAST TRACK principle is not used in pediatric surgery. Nevertheless, the recent studies have revealed the high efficiency of this technique for medical, psychological, economic and ethical characteristics. An early recovery is proved to increase the satisfaction of patients and their parents, without the development of a large number of complications, and a shorter hospital stay reduces the costs [10–12].

The goals of the surgery for a diaphragmatic hernia are the elimination of the nerve root syndrome (the return of the abdominal organs to their natural anatomical conditions) as well as the elimination of the diaphragm defect [13]. Prolonged expectant management may result in severe complications associated with the infringement of the abdominal organs in the hernial orifice. There is no data on the reasons for the combination of such disorders. In multiple congenital malformations, including severe hydrocephalus, Chiari type II malformation, renal agenesis, rib synostosis, general skeletal deformities, Bohdalek hernia, severe pulmonary hypoplasia, etc., the chromosomal micromatrix analysis shows a normal karyotype. However, genetic analysis with exome sequencing may not reveal abnormalities [14].

A fundamentally new technique in scoliosis surgery using dynamic equipment enables to preserve mobility in a fixed segment of the spine [15]. Moreover, Lenke type V deformity is well suited for anterior scoliosis correction [16]. Therefore, the approach to the spine for the placement of instrumentation requires a thoracophrenolumbotomy when the primary curve of the deformity is situated in the lumbar segment. Our patient's left-sided location of the diaphragmatic hernia and the convex side of the deformity on the left provided an opportunity for simultaneous correction of scoliosis and elimination of the diaphragm defect.

In the approach selection, endoscopic methods were omitted, since it was very difficult to fit the intestines into the small volume of the thoracic cavity. It is almost impossible to perform such a restoration thoracoscopically. Also, an open approach is specified by the fact that for large sizes of diaphragmatic hernias, the existence of a pronounced adhesive process is typical. Therefore, it can cause a significant collapse of the lower segments of the lungs, and this requires a thorough dissection of the adhesions, which may be possible only by thoracotomy performance. Instrumentation placement for dynamic correction at the lumbar and thoracolumbar levels requires open approach. Undoubtedly, the gold standard of surgical treatment of idiopathic scoliosis, which has proven its effectiveness, is the formation of a bone block through both anterior and posterior approach using transpedicular systems. In the above-mentioned patient, it was possible to consider two different surgeries: posterior correction and scoliosis fixation after intervention for a diaphragmatic hernia. However, firstly, this method has a number of disadvantages. The first is a total restriction of movements in the fixed segment. The second is that it requires repeated surgical treatment, which significantly lengthens the treatment duration. The anterior approach to the spine is anatomical and associated with less blood loss. It also allows the patient to become physically active and faster return to a habitual lifestyle. This fact is important in young patients.

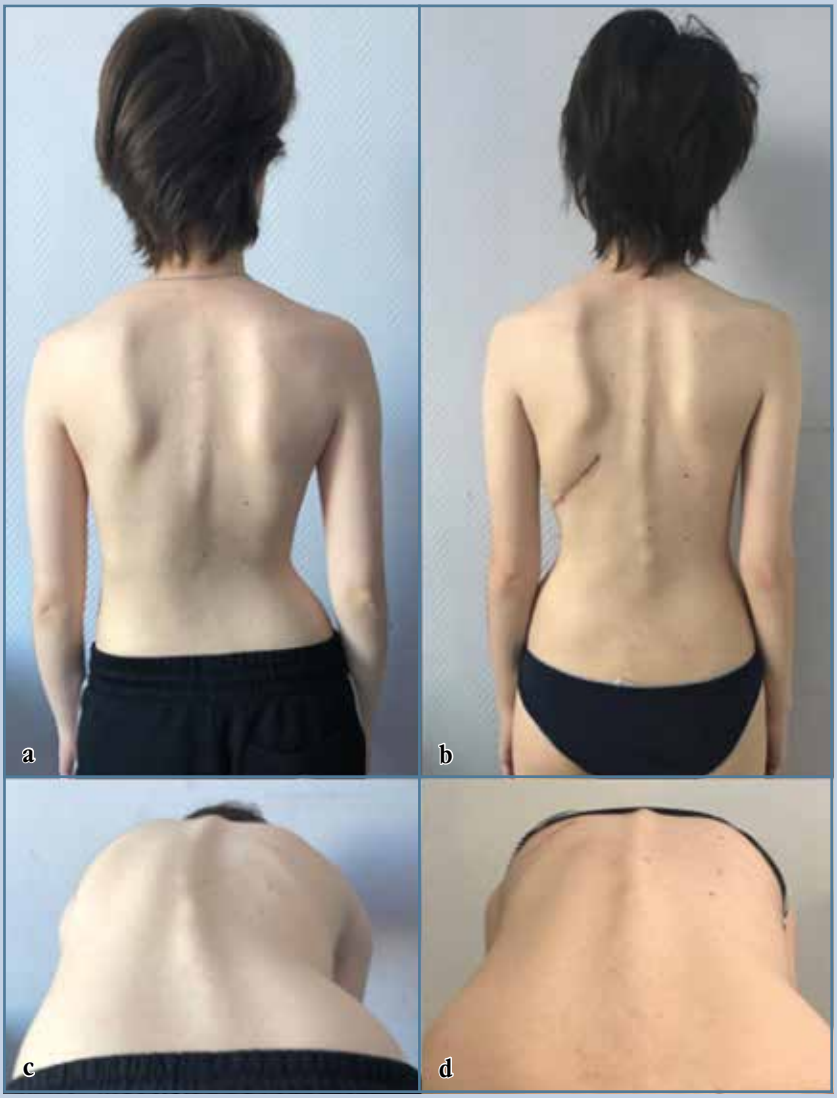

Fig. 5
General appearance of the patient before **(a)** and after **(b)** the surgery: there is an improvement in the back profile, the symmetry of the triangles of the waist, shoulder pads and shoulder blade angles; **c, d** – an example of the possibility of derotation in the use of an anterior dynamic scoliosis correction

Since the ASC (anterior scoliosis correction) method has emerged recently, there is a problem of limited data associated with it. However, the immediate results are very promising.

Therefore, a multidisciplinary approach in the treatment of patients with combined pathology and the participation of specialists from different medicine areas provide the best results, even in rare and extremely complex cases.

Conclusion

A proficient knowledge of an anterior spine approach among surgeons, advanced skills in anterior scoliosis surgery, as well as cooperation with a thoracic surgeon in a rare case of a combination of idiopathic scoliosis and congenital diaphragmatic Bohdalek hernia give us the opportunity to successfully and simalteneously solve two complex challenges: surgical and orthopedic ones.

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Address correspondence to:
Pereverzev Vladimir Sergeyevich
National Medical Research Center of Traumatology and Orthopedics n.a. N.N. Priorov
10 Priorova str., Moscow, 127299, Russia,
vcpereverz@gmail.com

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Sergey Vasilyevich Kolesov, DMSc, Prof., orthopedic trauma surgeon, Head of the Spinal Pathology Department, National Medical Research Center of Traumatology and Orthopedics n.a. N.N. Priorov, 10 Priorova str., Moscow, 127299, Russia, ORCID: 0000-0001-9657-8584, dr-kolesov@yandex.ru;
Vladimir Sergeyevich Pereverzev, orthopedic trauma surgeon, Department of Spinal Pathology, National Medical Research Center of Traumatology and Orthopedics n.a. N.N. Priorov, 10 Priorova str., Moscow, 127299, Russia, ORCID: 0000-0002-6895-8288, vcpereverz@gmail.com;
Dmitry Viktorovich Khaspekov, pediatric thoracic surgeon, Head of the Department of Thoracic Surgery, Children`s State Hospital of St. Vladimir, 1/3 Rubtsovsko-Dvortsovaya str., Moscow, 107014, Russia, ORCID: 0000-0002-6808-7670, rkhaspecov@mail.ru.