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THE USE OF ORTHOTICS IN A PATIENT WITH CONGENITAL BACKBONE DEFORMATION AFTER SURGICAL TREATMENT

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Introduction. New questions of indications and methods of surgical treatment of children with congenital spinal deformity are covered in detail. However, straightening deformed segment of the spine and fixing with metal construction is not sufficient, and conditions for its retention and prevention of migration must be created. The expediency of the study is relevant because of lack of systematic review of the results of orthotic support as complex treatment of this group of patients, both in Russia and abroad. The problems faced by vertebral surgeons are the following: the tendency of deformation relapse as the child grows, tendency of deformation of unfixed (lower and upper) segments of the vertebral column.

Clinical case. For observation, we selected an 11-year-old patient. The diagnosis was congenital scoliosis on posterolateral hemivertebra Th_4, dysplastic course of congenital spinal deformity. The surgical treatment performed was extirpation of hemivertebra Th_4(S) and the correction of local congenital deformity with multicore corrective system in combination with bone grafting. We achieved complete correction of congenital local curve at the level of the posterior lateral hemivertebra and reduction of compensatory curves in the thoracic and lumbar spine. In the postoperative period, the patient was provided with corrective brace, with the aim of influencing on the compensatory curve.

Discussion. This clinical observation aimed to determine the different approaches to treatment of children with congenital deformities of the thoracic spine, which consists of surgical correction of local congenital curvature curve with subsequent correction of compensatory curves by using a correcting brace.

Conclusion. As a result of the surgical intervention, correction of congenital spinal deformity was achieved, and the use of a corrective brace in the postoperative period allowed the correction of compensatory curves and maintained the achieved result until the end of the patient's growth.

Keywords: children; congenital malformation of the spine; surgical treatment; orthotics.

ОРТЕЗИРОВАНИЕ ПАЦИЕНТА С ВРОЖДЕННОЙ ДЕФОРМАЦИЕЙ ПОЗВОНОЧНИКА ПОСЛЕ ХИРУРГИЧЕСКОГО ЛЕЧЕНИЯ

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Введение. В настоящее время достаточно подробно освещены вопросы показаний и методик хирургического лечения детей с врожденной деформацией позвоночника на фоне нарушения формирования позвонков. Известно, что при врожденных пороках развития позвоночника далеко не во всех случаях однократное хирургическое вмешательство способно избавить ребенка от болезни. Недостаточно только выпрямить деформированный сегмент позвоночника и зафиксировать его металлоконструкцией, нужно создать условия для ее удержания, предотвращения миграции. Остается открытым вопрос целесообразности ортезирования данной категории пациентов в послеоперационном периоде. Исследование актуально вследствие отсутствия системного анализа результатов ортезирования в качестве комплексного лечения данного контингента пациентов

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как в России, так и за рубежом. Проблемы, с которыми сталкиваются хирурги-вертебрологи, следующие: тенденция к рецидиву деформации по мере роста ребенка, тенденция к деформации незафиксированных (нижеи вышележащих) сегментов позвоночного столба.

Клиническое наблюдение. Для наблюдения была выбрана пациентка 11 лет, поступившая в ФГБУ «НИДОИ им. Г.И. Турнера» Минздрава России с диагнозом: «Врожденный сколиоз на фоне нарушения формирования позвонков, заднебоковой полупозвонок Th_4, диспластическое течение врожденной деформации позвоночника». Проведено хирургическое лечение — экстирпация заднебокового полупозвонка $Th_4(S)$, коррекция локальной врожденной деформации позвоночника многоопорной корригирующей системой в сочетании с костной пластикой; отмечена полная коррекция врожденной локальной дуги искривления на уровне заднебокового полупозвонка и уменьшение сколиотических дуг деформации в грудном и поясничном отделах. В послеоперационном периоде пациентка снабжена функционально-корригирующим корсетом с целью воздействия на сколиотическую противодугу.

Обсуждение. Целью клинического наблюдения явилось определение иного подхода к лечению детей с врожденной деформацией грудного отдела позвоночника, заключающегося в хирургической коррекции локальной врожденной дуги искривления с последующей коррекцией компенсаторных дуг противоискривления при помощи функционально-корригирующего корсета.

Заключение. В результате оперативного вмешательства достигнута радикальная коррекция врожденной деформации позвоночника, а применение корригирующего ортеза в послеоперационном периоде позволило исправить дуги противоискривления и удержать достигнутый результат до окончания роста пациента.

Ключевые слова: дети; врожденная деформация позвоночника; хирургическое лечение; ортезирование.

Introduction

In children, the incidence of congenital scoliosis caused by abnormal vertebral development ranges from 2%–11% [1]. According to literary sources, approximately 50% of the children in the growth and development stages are prone to the progressive nature of congenital scoliosis, leading to the formation of severe and rigid spinal deformities at preschool age, which are often accompanied by neurologic impairment [2, 3].

In the studies by Russian and foreign experts, the issues of indications and methods of surgical treatment of pediatric congenital spinal deformities with vertebral anomalies have been sufficiently discussed. The authors have indicated that surgical treatment with fixation of a minimal number of vertebral motor segments should be given to the patients with congenital spinal deformity at an early age. Besides, it is advisable to provide spinal support by surgical hardware elements on the vertebrae adjacent to the abnormal one [4, 5].

However, the issue of orthotics has been encountered in pediatric congenital scoliosis during the postoperative period. A panel of researchers argues the use of spinal support following the correction of congenital spinal deformity. Further, the stabilization of the result achieved with the use of a surgical hardware is not indicated because it could lead to back muscle weakness. In addition, they believe that the patient should practice proper posture by keeping the torso in the correct position, thereby allowing his own pectoral muscle sling [6]. Besides, other experts believe that after surgical correction of congenital curvature, it is necessary to use semi-rigid fixation spinal supports to maintain the postoperative result, ensuring an optimal condition for the formation of bone block in the vertebral motor segment [7]. A number of authors recommend the use of hard (plastic) spinal supports, after the intervention. They believe that only with the use of this type of additional external fixation of the spine, it is possible to maintain the achieved correction of congenital deformity and obtain a stable bone block in the area of surgery. However, the aforementioned studies do not comprise the versions of postoperative orthoses (fixing or corrective) that are necessary to be used in children with congenital scoliosis [8–10].

Finding orthotic solution for patients with congenital spinal deformity associated with compensatory curve, in contrast to the main arch with an abnormal vertebra, remains the most challenging, and it is yet to be fully resolved. To date, there is no comprehensive study on the postoperative orthotics for pediatric patients.

The present clinical observation shows approaches to the treatment of an 11-year-old child with congenital deformity of the thoracic spine. Corrective spinal surgery was performed to correct the local congenital arch of curvature. Postoperatively, spinal support was implemented to correct the compensatory anti-curvature arches throughout the patient's growth phase.

Clinical case

Patient F., born in 2003, was admitted to the Turner Scientific Research Institute for Children's Orthopedics with a diagnosis of congenital scoliosis with a vertebral anomaly, posterolateral hemivertebra Th_4, and a dysplastic course of congenital deformity of the spine. Based on the anamnesis of the patient, spinal deformity was revealed at the age of 11 during a routine examination at a clinic in a primary health care facility. After undergoing a radiological examination of the spine in two views, the patient was subsequently referred to the Turner Scientific Research Institute for Children's Orthopedics for consultation.

Upon admission, the patient was comprehensively examined and consulted by experts.

The anamnesis comprised the data that the parents of this patient had noticed clinical manifestations of spinal deformity at the age of 7, as evidenced by the asymmetry of the shoulder girdles and the different heights of the angles of shoulder blades. When referring to the specialists, the situation of patient was regarded as a postural disorder. Conservative treatment was prescribed, and no radiological examination was performed. Despite the treatment, the deformity continued to gradually progress. At the age of 10, a curvature was evident in the lower part of the spine. One year later, radiological examination was performed. The orthopedic status revealed that the patient did not limp and could independently walk. However, there was a head tilt to the right, marked asymmetry of the shoulder girdles, waist triangles, multiplanar deformity of the spine and chest, and pelvic distortion to the left. In addition, deviations of the spinal axis to the left in the upper thoracic region, to the right in the thoracic region, and to the left in the lumbar region were observed. Orthopedic status of the upper and lower extremities did not show any abnormality.

Upon examination by a neurologist, no focal neurological symptoms were revealed.

Laboratory data were within the normal age limits.

ECG showed sinus rhythm with a heart rate of 78 beats per minute.

Ultrasound examination of the abdominal organs and kidneys revealed no echo structural changes.

A pediatrician did not identify any acute somatic or infectious disease. Further, there were no contraindications to elective spinal surgery.

Radiographs of the spinal column revealed the existence of a hemivertebra at Th_4 vertebral level with deformity angles, where the upper thoracic left-sided local scoliotic arch at the level of the hemivertebra was 30°, and the local kyphosis was 31°. Moreover, right-sided scoliotic chest arch was 36°, and the thoracolumbar scoliotic left-sided arch was 22°, according to Cobb. The size of the thoracic kyphosis was 36°, and the value of lumbar lordosis was 39°, according to Cobb.

MSCT and MRI studies did not reveal any intracanal pathology.

Based on the complaints, anamnesis, and clinical radiological picture, the final diagnoses were

Fig. 1. Radiographs of the spine of the patient F., 11 years old, in two views before the surgical treatment

Fig. 2. Radiographs of the spine of the patient F., 11 years old, in two views after the surgical treatment

congenital scoliosis with the impairment of the formation of vertebrae, complete posterolateral hemivertebra Th_4 on the left, and dysplastic course of congenital spinal deformity.

The radiographs of the spine of the patient upon admission to surgical treatment of congenital spinal deformity are presented in Fig. 1.

Considering the pronounced static-dynamic impairment of the spine and the progressive nature of congenital spine deformities in the pediatric patient, a corrective spinal surgery was decided to be performed. The patient showed a continuous growth in the congenital local arch of the curvature. Therefore, surgical treatment was performed in the volume of extirpation of the posterolateral hemivertebra Th_4(S), where multiple-seated corrective system combined with bone grafting were adopted to correct the local congenital spinal deformity. The entire scope of surgical intervention was performed from the posterior approach according to the standard method [4]. Postoperatively, no neurological complications were reported.

After the surgical treatment, control radiographs revealed a radical corrected local congenital spinal deformity in upper thoracic region, the multi-support surgical hardware (4 transpedicular support elements and 1 infra-laminar support hook) installed in the vertebrae Th_3, Th_5, and Th_6 were correct and stable. Right-sided scoliotic arch at the level of the vertebrae Th_7–Th_{10} was 15°, and the left-sided arch at the level of L_1–L_4 was 11° (Fig. 2).

After the surgical treatment, a completely corrected congenital local arch of curvature at the level of the posterolateral hemivertebra and reduced scoliotic deformity arches in the thoracic and lumbar regions were recorded. The size of the thoracic kyphosis was 38°, whereas that of lumbar lordosis was 42°, according to Cobb, and it was within the physiological norm. Besides, the laminar hook was installed on the concave side of the curvature at the level of the posterolateral hemivertebra due to the small size of the base of the arch of the vertebra Th_3 and Th_2, which did not allow the transpedicular screw to be inserted.

The postoperative period was uneventful and healing occurred by primary adhesion. To make a rigid spinal support for the bed-resting patient, a virtual negative image of his body was made using a portable 3D scanner without plaster casts. A special program was used to process the negative image of the orthosis, and the positive image of the patient's body was subsequently created on a machine with numerical control. Taking the residual values of spinal deformity in the thoracic and lumbar regions into account, a spinal support of low-pressure thermoplastic was made for the patient. The orthosis has pressure zones (bandages) in the region of the apexes of the curvature and unloading on the opposite side in accordance with the radiological pattern and the extent of the deformity. On postoperative day 7, the patient was put on his feet and equipped with a rigid spinal support. In addition, the patient was recommended to wear the spinal support for 18–20 h per day, massage the upper and lower extremities, and perform breathing exercises.

After 4 months, a follow-up examination reported no complaints. A control radiograph of the spine with spinal support, in standing frontal

Fig. 3. Radiographs of the spine of the patient F., 11 years old, after surgical treatment, in a spinal support

Fig. 4. Radiographs of the spine of the patient F., 12 years old, 1 year after the surgical treatment, in a spinal support

view, was performed. The position of the surgical hardware was radiologically stable and correct. There was no loss of the achieved correction. In addition, there was a right-sided scoliotic arch Th_7–Th_{10} of magnitude 9°, and a left-sided scoliotic arch L_1–L_4 of 12°, according to Cobb (Fig. 3).

During the entire follow-up period, the patient was on a spinal support for 20 h a day, received courses of conservative treatment, and underwent periodic follow-up examinations. Ten months after the surgical treatment, follow-up examination revealed that a replacement of the spinal support was necessitated because the pediatric patient had grown by 7 cm. The pressure was strengthened by the orthosis bandages to achieve a better correction of residual curvature angles in the thoracic and lumbar regions. The patient did not have any complaint. Improvement in the appearance of the patient was clinically marked. There was a decrease in the size of the costal humpback in the thoracic region, the symmetrical arrangement of the shoulder girdle and the angles of the shoulder blades were evident, and pelvic distortion was solved. Nonetheless, the asymmetry of the waist triangles demonstrated only minimal improvement. A radiograph of the spine without spinal support, in standing and frontal view, was made. The position of the surgical hardware was reported to be radiologically stable and correct. There was no loss of the achieved correction, and the residual deformity arches in the thoracic and lumbar spine were corrected (Fig. 4).

Over the next 3 years, the pediatric patient was supervised with a spinal support, and the previous mode of wearing an orthosis was observed. Moreover, the patient underwent control examinations every 4 months and an imaging study every 6 months, received courses of conservative treatment, back massage (excluding the postoperative scar area), and did swimming. During this period of observation, one more replacement of the spinal support was required, and several additional corrections were performed during the follow-up period. During this period, the growth of the patient had increased by another 3 cm. At the age of 14, the patient had *menses*, and the height of the child between the ages of 14 and 15 did not change. A stable pattern was clinically observed, as manifested by a symmetrical arrangement of the shoulder girdles and angles of the shoulder blades, the absence of pelvic distortion, and the presence of slight asymmetry of the waist

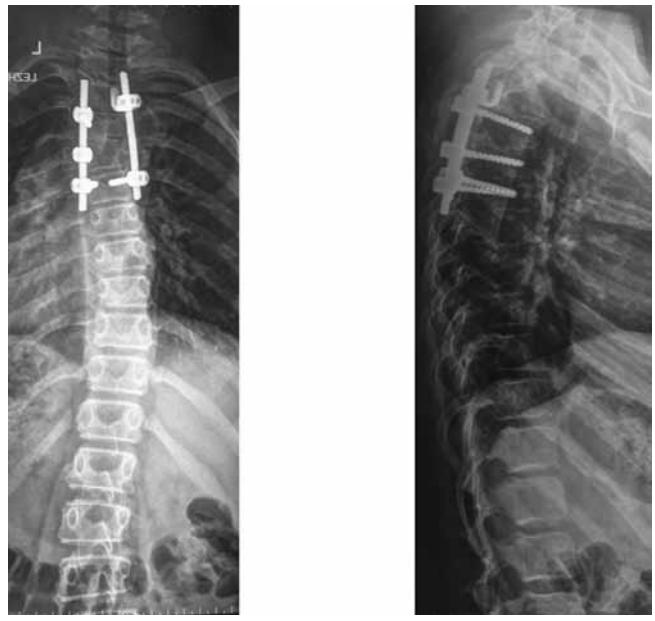

Fig. 5. Radiographs of the spine of the patient F., 15 years old, in a standing position without spinal support

triangles. At the age of 14.5, a gradual withdrawal of the spinal support had started, during which the time spent without spinal support gradually increased, starting from night period. During this time without spinal support, the patient was actively engaged in physical therapy aimed to strengthen the muscles of the back, shoulder girdle, and abdominal tension. In addition, the patient did swimming and received back massage courses. Courses of conservative therapy enabled the patient to completely exclude the spinal support for 6 months. At the age of 15, the control spinal imaging study was performed. On the radiographs, the position of the surgical hardware in the upper thoracic region was correct and stable. There was no loss of the achieved correction of the deformity as compared to that of postoperative period. There was a right-sided scoliotic arch of Th_7–Th_{10} of 5°, and a left-sided scoliotic arch of L_1–L_4 of 8° (Fig. 5).

Thus, corrective spinal surgery, followed by postoperative spinal support could produce a satisfactory result in the treatment of congenital spinal deformity.

Discussion

To date, various approaches have been used to determine the management of congenital spinal deformities in pediatric children. Some authors recommend conservative treatment, including active functional orthotics combined with physical therapy,

back massage, and hydrotherapeutic procedures, until the end phase of the growth of pediatric patient. Conversely, surgical treatments have been performed during the period of growth completion following the second growth spurt [11–13]. In the present case, the surgical hardware was installed throughout the entire deformed section or sections of the spinal column.

Furthermore, other experts recommend immediate surgical treatment upon detection and confirmation of the progressive nature of the congenital deformity. Such strategy involves the implementation of multiple-staged surgical interventions, where an extended surgical hardware can be used to correct the congenital curvature in pediatric patient in the active growth phase. Upon completion of the growth period, the final stage of treatment consists of the installation of a multi-support extended surgical hardware and bone grafting [14].

The present case devotes a practical approach to the correction of congenital spinal deformity in a pediatric patient in the active growth phase.

Conclusion

It is evident that the local congenital curvature, in the upper thoracic spine and at the level of the abnormal vertebra, can be completely corrected by instrumentally fixing a minimal number of vertebral motor segments. In addition, the surgery reduced the size of deformity arches in the thoracic and lumbar spine. The use of a corrective orthosis enabled additional correction to the anti-curvature arches in the thoracic and lumbar regions, and maintenance of the postoperative result until the growth of pediatric patient had ceased. Furthermore, fixing the minimum number of vertebral motor segments at the level of the abnormal vertebra created an optimal condition for the active growth of the spine and provided opportunities for the motor activity of the spinal column.

Additional information

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Ethical review. Patient representatives (parents) have given written consent to the processing and publication of all personal data for scientific purposes.

Contribution of the authors

V.V. Murashko, D.N. Kokushin, and S.V. Vissarionov performed surgical treatment of the patient, edited the article, and assessed the results of complex treatment.

G.A. Lein, I.V. Pavlov, and I.A. Redchenko performed postoperative orthotics with a functional correcting spinal support, wrote the text of the article, evaluated the results of the complex treatment.

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