Case Report

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Effect of decompressive surgery on spine balance in congenital lumbar kyphoscoliosis: anatomical aspect with a case report

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Abstract

The lumbar vertebral column is a complex structure formed by the fusion of intervertebral joints. It protects the spinal cord by wrapping around it, carries most of the body's weight and creates a flexible structure for the body. As individuals with congenital deformities of the lumbar vertebral column age, they develop some changes in the anatomy of the spine and with some consequences. In this case, a 35-year-old male patient had a deteriorated posture together with back pain since childhood. He had walking difficulty and numbness in two legs during walking for the last three years. He fell due to a sudden brake while he was travelling afoot by bus in 2015. He was admitted to the emergency service with loss of strength in two legs. Lumbar CT and MRI showed a severe narrowing of the spinal canal due to lumbar kyphoscoliosis. The patient had neurological deficits after hyperflexion trauma. The patient underwent emergency decompressive surgery due to marked paraparesis and narrow spinal canal. At the end of the first post-operative month, his clinical complaints were almost completely resolved, and his biomechanical balance did not show radiological deterioration. While the anatomical change that occurred during the natural course of congenital kyphoscoliosis increased the stability of the lumbar spine, it severely narrowed the spinal canal and affected the spinal nerves and thereby caused severe neurological deficits.

Keywords: balance, congenital deformity, kyphoscoliosis, lumbar, narrow spinal canal

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Introduction

The lumbar vertebral column is a complex structure formed by the fusion of five vertebrae that create a robust and flexible anatomical structure for the body.[1] The lumbar functional unit is mainly divided into two parts. The anterior part consists of two vertebral corpuses and one intervertebral disc between them that bears weight and absorbs compressive loading. The posterior part consists of the facet joints that do not bear weight and provide ease of movement. The movement of the spine is greatly reduced in parallel to the increase of top-down static loading.[1,2] The lower lumbar levels need to be more stable. Therefore, connective tissue support plays an important role in the control of spinal movements. Naturally, the lower part of the vertebral column is firmly supported by abundant connective tissues to create a robust base.[3] In cases with congenital deformities, this anatomy is redesigned to the extent allowed by nature.[2–5]

The development of the spine in the embryo occurs early during the first six weeks of intrauterine life, as the complete anatomical pattern of the vertebrae is formed in mesenchyme.[5,6] The basic organization of the vertebral column is well established at the beginning of the fetal period in day 57. Vertebral body hypoplasia and aplasia represent a wide spectrum of centrum growth deficits that occur during the last seven months of pregnancy when the rapid increase in vertebral size occurs.[5,6] During this period, centrum development is independent of neural arch growth. The complete absence of the vertebral body, centrum aplasia, is the most severe form of anterior deficits.

Posterior hemicentrum and centrum aplasia produces a purely kyphotic deformity. Furthermore, lateral hemicentrum aplasia leads to scoliotic deformities.[5,6]

Congenital lumbar kyphoscoliotic deformity is a very rare spinal problem that biomechanically changes particularly the sagittal balance of the spine by causing severe deterioration of the spinal alignment. During development, the spinal column undergoes changes to protect and maintain its biomechanical balance. The deformed spinal column tries to maintain its balance at two plans. The spinal canal gradually narrows due to excessive kyphotic angulation of the spine and hypertrophy in supportive connective tissue.[4,5] The aim of this case report to present the anatomical and biomechanical changes following surgical treatment in a case of congenital kyphoscoliosis, a pathology we rarely encounter.

Case Report

A 35-year-old male patient had a deteriorated posture together with back pain since childhood. He had walking difficulty and numbness in two legs during walking for the last three years. He fell down due to a sudden brake while travelling afoot by bus in Rize province in 2015. He was admitted to the emergency service with loss of strength in two legs. Lumbar computed tomography (CT) and magnetic resonance imaging (MRI) showed severe narrowing of the spinal canal due to lumbar kyphoscoliosis (**Figure 1**). It was found that the neural tissue was crushed after

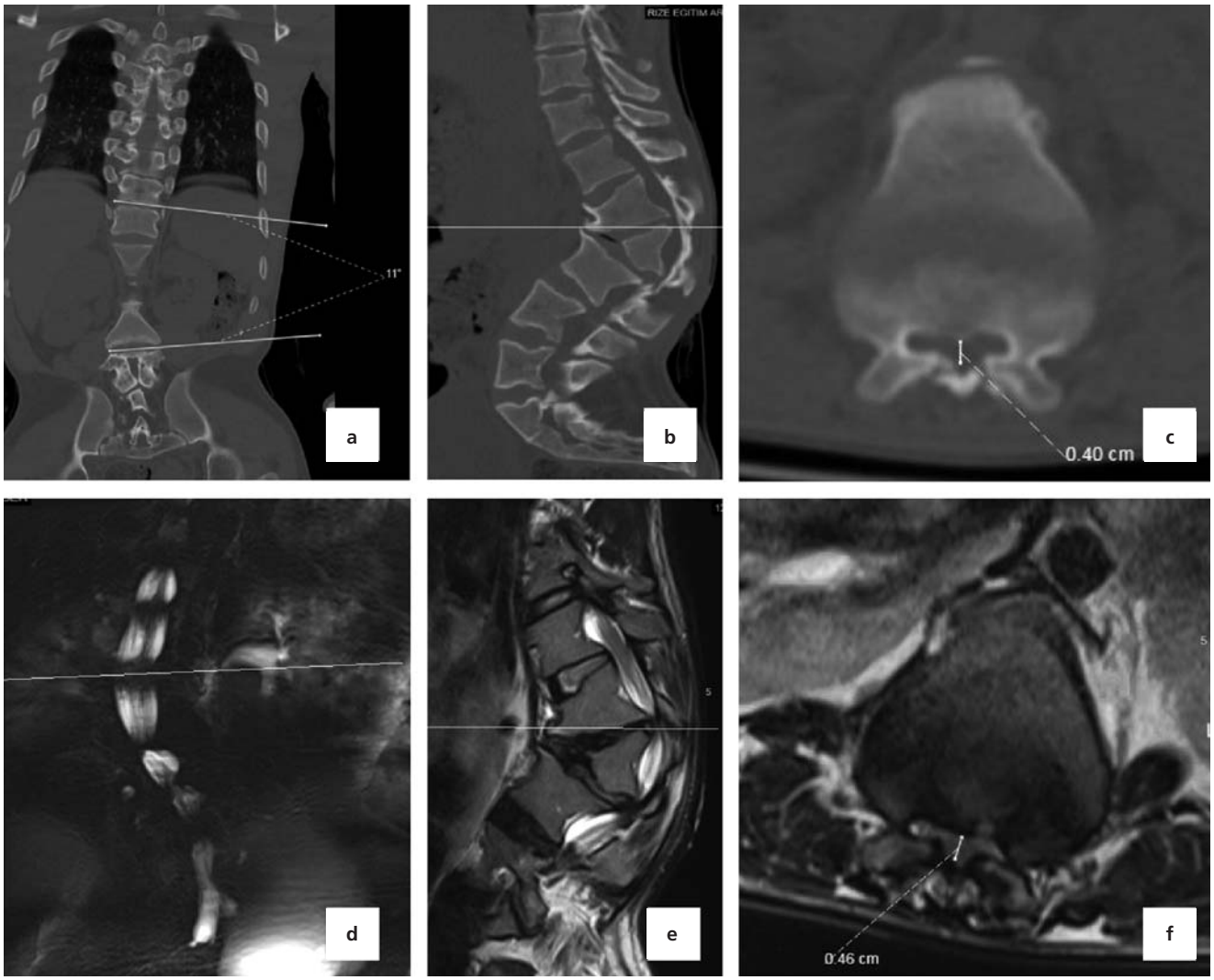

Figure 1. (**a**-**d**) Scoliosis is observed in myelo MR and CT section. (**b**-**e**) Anterior wedged vertebra on level L2 of the lumbar vertebrae is observed in sagittal CT and MR sections in the 35-year-old male patient (Type 1 deformity). (**f**) The diameter of the spinal canal decreased to 4 mm at the kyphosis segment in axial CT and MR sections.

hyperflexion trauma. The patient underwent emergency decompressive surgery due to marked paraparesis and narrow spinal canal. The posterior wall of the vertebral canal was opened with total laminectomy in level of lumbar kyphotic deformity, preserving the posterior facet joints (**Figure 2**). Neurological deficits of the patient gradually improved after surgery. Angular changes in coronal and sagittal planes were calculated using pre-operative and post-operative (1st month and 1st year) radiological images (**Table 1**). The posture of the patient became more erect when he was standing. At the end of the one-year follow-up, he had no back pain and posture deterioration. His anterior column was very strong and sagittal and coronal planes were stabilized.

Table 1
The changes before and after surgery in angles calculated by the Dicom Software related to lumbar spinal stability.

	Pre-operative	Post-operative 1st month	Post-operative 1st year
Local kyphosis angle	56°	56°	56°
Sagittal Cobb angle	65°	65°	64°
Coronal Cobb angle	11°	5°	6°
Lumbar lordosis angle	30°	26°	24°

Discussion

Congenital kyphosis and kyphoscoliosis are uncommon deformities in which there is an abnormal posterior convex angulation of a segment of the spine due to developmental vertebral anomalies.[2,4,5] These congenital anomalies are present at birth, but may not be clinically apparent except for slight changes in general posture until childhood. The development of kyphosis due to vertebral anomalies is fully established at birth and thought to develop during the later stages of chondrification and ossification.[6] Congenital kyphosis and kyphoscoliosis are less common than pure congenital scoliosis. However, these problems can lead to more serious clinical consequences such as paraplegia and spinal cord compression.[5,7]

Congenital kyphosis was first described by von Rokitansky in 1844.[5] Van Schrick (1932) differentiated a failure of vertebral-body formation from a failure of vertebral-body segmentation as a cause of congenital kyphosis.[5,8] We have our current knowledge of congenital kyphosis mainly from Winter et al. in 1973 who followed 130 patients for more than one year without treatment, and were able to make further assessments.[5] They reported that spinal deformities usually progress rapidly during

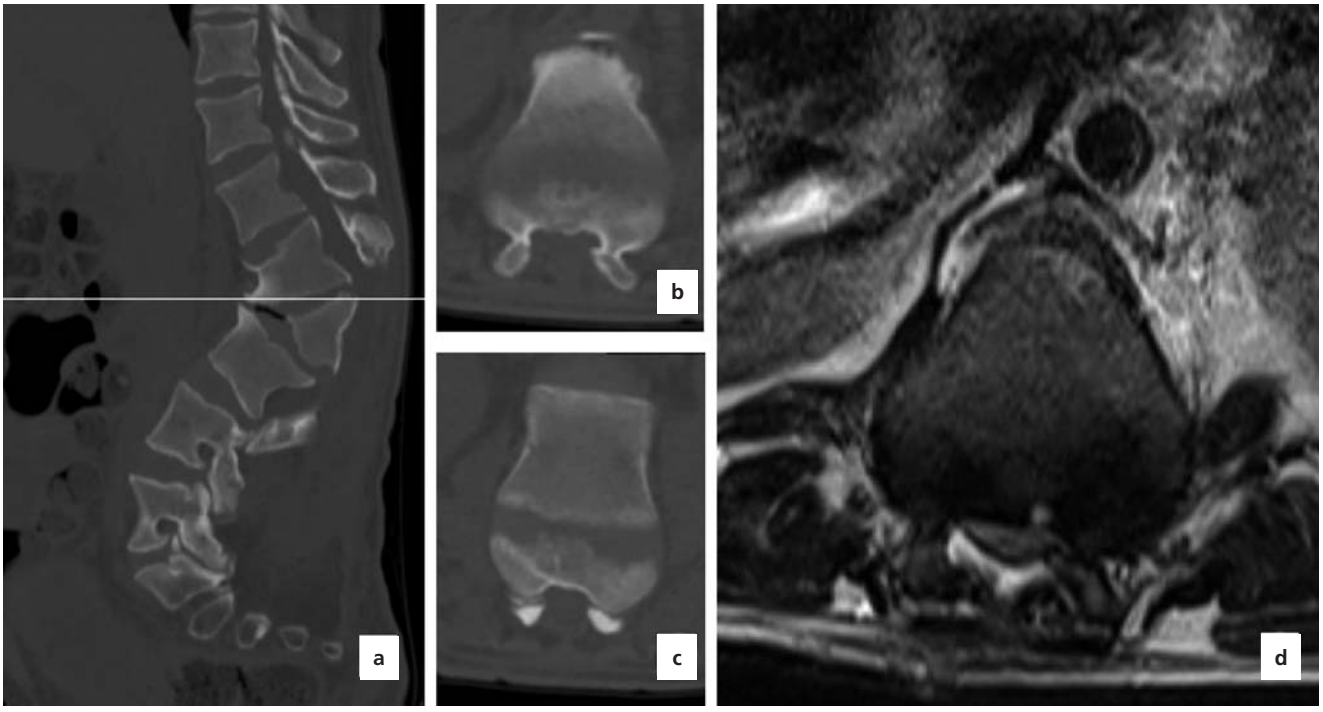

Figure 2. There are post operative changes in the spine. (**a-c**) Changes in sagittal and axial CT sections were observed after decompressive surgery. (**d**) Spinal canal enlargement at kyphosis level on axial MR section.

periods of rapid growth seen in adolescence and thereby clinical manifestations occur after childhood.[5]

Congenital kyphoscoliotic spinal deformities are classified into four types according to the shape of the vertebral column anatomy. In Type 1 deformities, there is deterioration in the anterior segment of the vertebral body. These patients are also divided into four subgroups within themselves: posterolateral quadrant vertebra, posterior hemivertebra, butterfly (sagittal cleft) vertebra, and anterior or anterolateral wedged vertebra. Posterolateral quadrant vertebra and butterfly (sagittal cleft) vertebrae affect the posture of the vertebral column in the coronal plane and cause more severe scoliotic deformities.[5] The other two problems cause more severe kyphotic deformities, because they affect the posture of the vertebral column mostly in the sagittal plane. In Type 2 deformities, vertebral segmentation is impaired, and intervertebral discs are absent or unclear. There is a long, unsegmented bony bar in the anterior or anterolateral side. The bony bar can cause a kyphotic deformity if it is in the anterior side.[5,6] Type 3 deformities are mixed-type anomalies. They consist of a combination of segmentation and vertebral body anomalies. Very severe deformities that do not fit all these classifications are typified as Type 4 (unclassified deformities). Our case had anterior wedging of the L2 vertebral body, Type 1 deformity causing kyphotic angle of 56 degrees, and mild scoliosis with a Cobb's angle of 11 degrees (**Figure 3**).

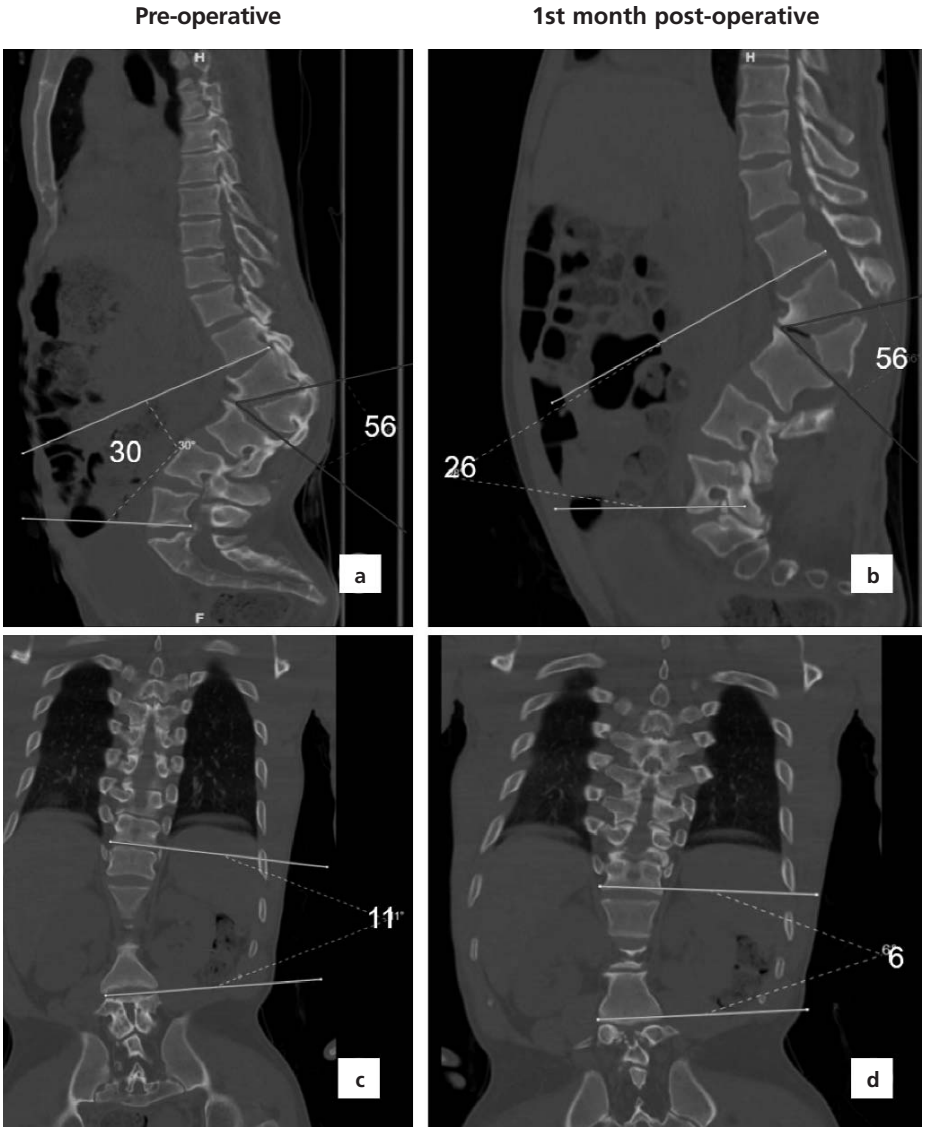

Figure 3. (**a**-**c**) The measured angles in the pre-operative sagittal and coronal planes. (**b**-**d**) Angles in the same planes after 1 month.

The occurrence of physiological kyphotic angulation of the thoracic vertebral segment in the lumbar vertebral segment is considered completely pathological.[9] The deterioration of physiological posture of the spine leads to early degeneration of the spine and other structures that provide stabilization. There is a risk of developing kyphosis following extensive laminectomies involving the facet joints during surgery in any segment of the spine. In our case, there was no increase in the kyphosis angle after surgical decompression; there was only a slight decrease in the lumbar lordosis angle (reducing from 26 degrees to 24 degrees) after one year of follow-up. In anaother study, the lumbar lordosis angle was found to be consistent with the mean angle (20.4±10.2°) measured in cases of degenerative lumbar kyphosis.[7] No additional neurological deficits were observed at the end of follow-up. There was also no evidence of back pain suggesting lumbar instability. According to the Roussouly's classification, the lumbar lordosis angle is reported to vary between 52 and 71 degrees.[10] It was observed that the lumbar lordosis angle was much smaller due to the angular effect of kyphotic deformity on the opposite direction.

Cobb's angle is often used to determine the angle of scoliosis in the coronal plane, as well as to grade sagittal plane spinal deformities. It is defined as the angle formed between a line drawn parallel to the superior endplate of one vertebra above the curve and a line drawn parallel to the inferior endplate of the vertebra one level below the curve. Cobb angle is the most important determinant of the severity of kyphoscoliosis. It was reported that Cobb angle above 60° may result in progressive pulmonary and cardiac failure.[5] In our case, the sagittal plane kyphosis angle in the lumbar segment was measured as 65°, and therefore can be considered as severe kyphosis.[5,8,10]

Anterior compression of the spinal cord at the apex of the congenital kyphosis or kyphoscoliosis occurring spontaneously in the patients, neurologically normal previously, leads to progressive spastic paraparesis of the lower limbs.[5] In this case, paraparesis was also observed with a minor trauma, because the spinal canal diameter was narrowed to 4–5 mm. Severe congenital rigid kyphoscoliosis in adults remains challenging for spine surgeons. Kyphoscoliosis is a deformity with fixed spinal vertebrae that does not allow traction, suspension, or side bending of the spine.[11] Surgery is currently the most common treatment, despite being difficult and controversial.[11,12] Vertebral column resection is a technique for correcting rigid severe kyphoscoliosis; posterior vertebral column resection is an effective alternative for moderate to severe deformities with limited flexibility. This is a technically demanding and exhausting procedure with possible major complications.[12] Spinal wedge osteotomy by single posterior approach is a reliable and safe surgical technique for correcting severe rigid angular kyphosis or kyphoscoliosis.[13] Therefore, decompressive minimally invasive surgical methods may be preferred in the presence of neurological deficits. In addition, in the spine anatomy of this patient, spinal biomechanics did not deteriorate after simple surgical decompression.

Conclusion

This case report presents positive results for anatomical and biomechanical changes following surgical treatment of congenital kyphoscoliosis. Long-term radiological follow-up in this patient as well as comparison of the results of surgical treatment in more patients is essential to support these data.

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