

Overview of Complications

Komplikasyonlara Genel Bakış

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ABSTRACT

Deformity of spine is the structural deformity in sagittal, coronal or both planes due to many causes. Due to the complex structure of deformity, complications of deformity surgery are different from other surgeries performed for the spine. Being aware of the complications that can cause balance problems in the sagittal and coronal planes may help surgeons avoid them.

KEYWORDS: Complication, Deformity, Kyphosis, Scoliosis

ÖZ

Omurga deformitesi değişik nedenlere bağlı olarak sagittal, koronal veya her iki planda gelişen şekil bozukluğudur. Deformitenin kompleks yapısından dolayı deformiteye yönelik yapılan cerrahi girişimlerin omurganın diğer hastalıklarına yönelik yapılan cerrahi girişimlerden farklı komplikasyonları vardır. Özellikle omurganın sagittal ve koronal planda denge sorunlarına yol açabilecek bu komplikasyonların bilinmesi deformite cerrahisi ile uğraşan omurga cerrahlerinin gelişebilecek komplikasyonlardan korunmasına katkı sağlar.

ANAHTAR SÖZCÜKLER: Deformite, Kifoz, Komplikasyon, Skolyoz

INTRODUCTION

Deformity is the structural anomaly of the spine in the sagittal or coronal planes. Deformity of the spine occupies an important place in spine surgery together with tumoral, degenerative and infectious diseases of the spine. Balance disorders due to structural anomaly of the spine, development of neurological deficit or structural anomalies of the body due to shoulder and hip asymmetry are surgical indications.

The amount of complications reported in spine surgery is variable. Independent of the type of the deformity and complications, the rate of complications can be seen to be between 0% and 89% when we evaluate the previous and new reports (31). Although the kinds of complications are many and their number variable in deformity surgery, the rate of mortality is very low and is usually related to reasons other than surgery (25).

All kinds of intra operative or post operative complications seen during degenerative, tumoral and infectious diseases of the spine can also be seen during deformity surgery at various rates. Complications can be due to the surgical procedure or correction maneuvers. Being aware of these complications and notifying the patients about these is important. Being aware of surgical risks and late complications may help the patient and doctor choose the least risky method.

We can classify these complications as follows:

Intra operative complications

- Blood loss
- Neurological injury
- Dural tear
- Complications related to instrumentation
- Disorder of spinal balance or inappropriate correction
- Major vascular injury
- Post operative complications

Medical complications

- Pulmonary complications
- GIS complications

Surgical complications

Early post operative

- Hematoma
- Wound infection
- Complications related to the instrumentation system
- Disorder of sagittal balance

Late postoperative complications

- Pseudoarthrosis
- Adjacent segment degeneration

- Crankshaft phenomenon
- Junctional deformity

In this article we will discuss special complications of deformity surgery other than pulmonary complications or wound infection problems that may be seen in all kinds of spinal surgery.

INTRA OPERATIVE COMPLICATIONS

Blood Loss

Performing surgery on a longer area will lead to increased blood loss. Some procedures like hemivertebrectomy and osteotomy or anterior or posterior combined procedures may also increase blood loss.

Complications Related to the Instrumentation System

The procedures performed during scoliosis surgery can be divided into three groups after positioning the patient: placement of screws or hooks, releasing the spine, and correction maneuvers. It is more difficult to place pedicle screws to the thoracic vertebra than the lumbar vertebra in a normal patient. In a deformity patient, the structure anomaly of the pedicle, altering of angulation, and thinning of especially the concave side can be seen. Malposition rate of the pedicle screw is higher especially due to the transverse rotation that accompanies the coronal plane deformity (Figure 1). To be able to release the spine facet, resection, osteotomies or resection of hemi vertebra in congenital scoliosis can be performed. Dural tear or neurological injury are mainly seen in these first two stages and are mainly due to direct trauma to the spinal cord. Organ or major vessel injury can also be seen during screw placement or correction maneuvers.

Neurological Injury

Injury of neurological structures is the most frightening and worst complication during deformity surgery. Neurological deficit may develop due to direct trauma to spinal cord or ischemia. Neurological deficit developing due to direct trauma can recover in time. The risk of neurological deficit developing because of ischemia being permanent is higher.

Ischemia may occur because of perfusion restriction due to straining of vessels of the spine during correction maneuvers. This is the important point of intra operative monitoring of the spine during deformity surgery. If electrophysiological findings due to of ischemia occur during correction maneuvers, the stretching of vessels decreases and perfusion of the spine can be maintained with decreasing of the correction angle. During surgery, the perfusion of spine can decrease if the patient stays hypotensive for a long time. Tethering of segmental arteries is also a reason of ischemia, especially during anterior procedures (8).

Data in the literature about development of neurological injury is not definite. The rate of spinal cord injury is between 0.5 and 3% (21). Deformities of congenital scoliosis, rigid deformities with high angulation, hyper kyphosis and

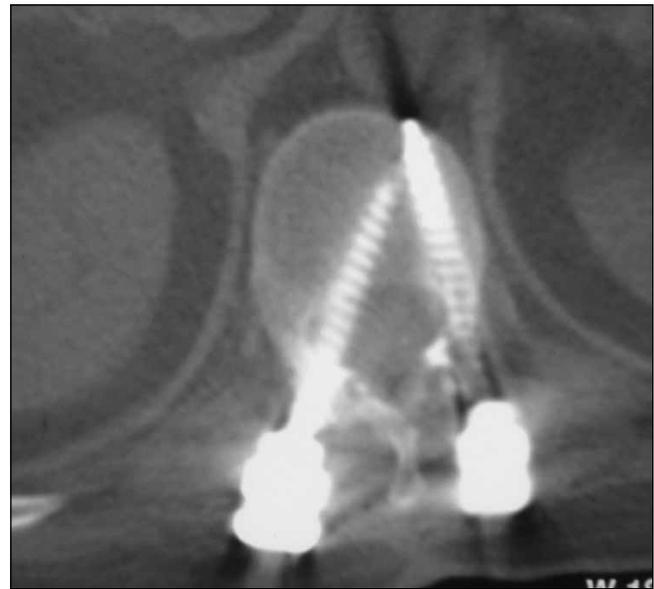


Figure 1: Pedicle screw malposition.

combined anterior and posterior surgical procedures are risk factors for neurological injury (7).

Injury of nerve root is seen at a rate of approximately 0.5% (21). Because of the difference of pedicle structures and angles between deformity patients and other patients, the risk of nerve root injury is higher than in patients with a normal vertebral structure. Neuromonitorization and navigation systems can decrease the risk of nerve root injury during pedicle screw placement.

The definite evaluation of the patients before surgery decreases the risk of neurologic deficit. We must be aware of the possibility of anomalies in the spinal channel accompanying the deformity in congenital scoliosis. Tethered cord (38 %), diastomatomyelia (9 %), and syringomyelia (9 %) are frequently seen intraspinal pathologies (6). During growing periods of deformity patients, and during correction maneuvers when performing surgery; intraspinal pathologies may cause a neurological deficit. Especially patients with a congenital deformity due to anomaly of vertebrae must therefore be definitely evaluated for intraspinal pathology. The surgeon must be aware of intraspinal pathology if there are dermal lesions such as hypertrichosis, dermal sinus or thoracic scoliosis with left concave side and mid-line closure defects. These patients must be evaluated by magnetic resonance imaging (MRI) of the entire spinal channel. In patients with atypical idiopathic scoliosis (male patient, left concave sided thoracic scoliosis), the craniovertebral junction must be evaluated by MRI if a syringomyelic cavity is determined. In this kind of patient. the Chiari malformation may be seen at high frequency. Only decompression of foramen magnum for the Chiari malformation can prevent the increase of syringomyelic cavity and scoliosis. In this way, the patient can be protected from surgical complications of scoliosis surgery.

Especially in congenital scoliosis patients; other systems must be considered as well. Cardiac and renal anomalies mainly accompany the congenital deformity. About 50% of these patients need surgery for these system pathologies before deformity surgery. If we perform surgery for deformity to these patients without evaluating other system pathologies this will increase the rate of complications (3).

One other important neurological complication is retrograde ejaculation (0.42%) and impotence in male patients due to hypogastric plexus injury during anterior transperitoneal surgery of the lumbar spine (17).

Early recognition of deficits such as nerve root injury or spinal cord injury due to instrumentation or connection maneuvers is important. The Stagnara wake-up test and methods like waking up the patient after instrumentation or correction maneuvers and checking the corticospinal tract have been used for many years in deformity surgery (10). When evoked potentials started to be used for the entire surgery, the wake up test was discontinued. With the evaluation of integrity of dorsal column medial lemniscal pathways from extremities by somatosensory evoked potentials (SSEP), neurological deficits have significantly decreased in deformity surgery (23). Because of inability to evaluate anterior cord injury, which cannot be diagnosed by SSEP; usage of motor evoked potential (MEP) that can monitorize corticospinal tract and SSEP together has become popular and this method has been a more reliable test (24).

Major Vessel Injury

Just as in other surgical procedures performed for the spine, there is risk of injury for vascular structures in deformity surgery. Just as in other surgical procedures, formation of arterio-venous fistula or pseudo aneurysm can be seen due to penetration of screws in the thoracic or abdominal part of aorta, vena cava or iliac arteries.

Thromboembolic events can occur due to rupture of atheroma plaques during dissection and retraction of aorta in anterior surgery, especially in elderly patients. Care must also be taken in elderly patients with kyphotic deformity regarding aortic calcification. During correction of the kyphotic deformity with a posterior correction maneuver, with the stretching forces acting towards the anterior part of the spinal column, there may be ruptures in the aorta that has lost its elasticity.

POST OPERATIVE COMPLICATIONS

Medical Complications

As mentioned before it must be kept in mind that systemic anomalies can accompany especially congenital scoliosis. The evaluation of all systems in these patients may prevent complications.

Pulmonary complications

Pulmonary complications are frequently seen especially in elderly patients. Smoking, chronic lung disease, long operation time, immobilization for a long time, and absence of hygiene are risk factors for pulmonary complications.

Pulmonary thromboembolism can either be due to embolic formation during deep venous thrombosis or rupture of plaques especially in elderly patients because of manipulation of vascular structures during anterior surgery.

GIS complications

Postoperative ileus is the most common complication. It can be due to manipulation of the peritoneum during anterior surgery or distraction of peritoneum during posterior surgery and generally recovers spontaneously (27).

Superior mesenteric artery syndrome is a serious complication that can result in mortality. Especially during correction of thoraco-lumbar deformities with displacement of superior mesenteric artery upwards, the angle between aorta and superior mesenteric artery decreases and compresses the third part of the duodenum, causing ischemia in the proximal part of small intestines (14).

Surgical Complications

Infection

Hematoma and wound infections are important complications as in other spine surgeries. The risk of infection increases with long operation time. Infection can be superficial or in deep tissues that can effect the instrumentation systems. The infection rate in the early period is between 0.1 and 5 % (18,22,29). The infection rate in late postoperative period is lower (0.6-1.7 %), but can be a serious problem (12,32).

Complications about instrumentation systems

In degenerative scoliosis, the pull out resistance of pedicle screws decrease with the decrease of bone mineral density (Figure 2). The resistance of pedicle screws is important because the resistance acting on instrumentation system from the spine will be high. Planning of instrumentation before surgery and strengthening the pedicle screws with hooks or sub laminar wiring are therefore important.

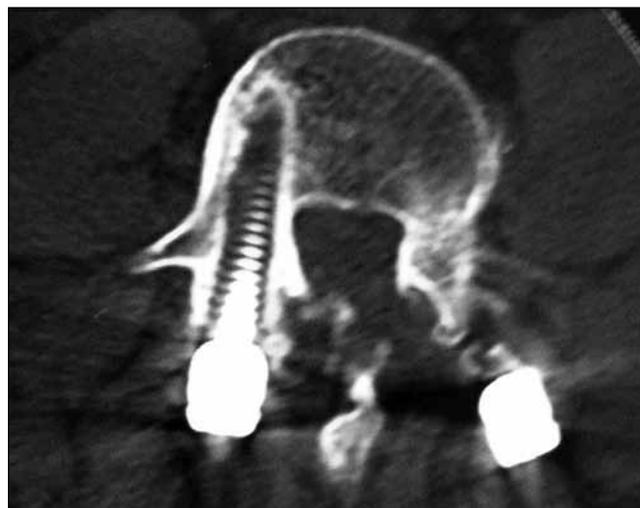


Figure 2: Pull-out of pedicle screw.

Deformation of sagittal balance

Spinal decompensation is the deformation of alignment in the sagittal and coronal planes. It can be due to development of deformity in adjacent segment because of arthrodesis or arthrodesis with improper alignment (Figure 3A-C). One of the most important decompensation reasons is deformation of sagittal balance due to distraction forces acting during deformity surgery. The best example for deformation of

sagittal balance is the flat back syndrome determined in 1977 (15). The best way to prevent flat back syndrome is to imagine the spine in 3D and planning the correction of the deformity in 3D.

Degeneration of adjacent segment

Adjacent segment degeneration explained by persistence of degenerative period in adjacent segments due to adjacent

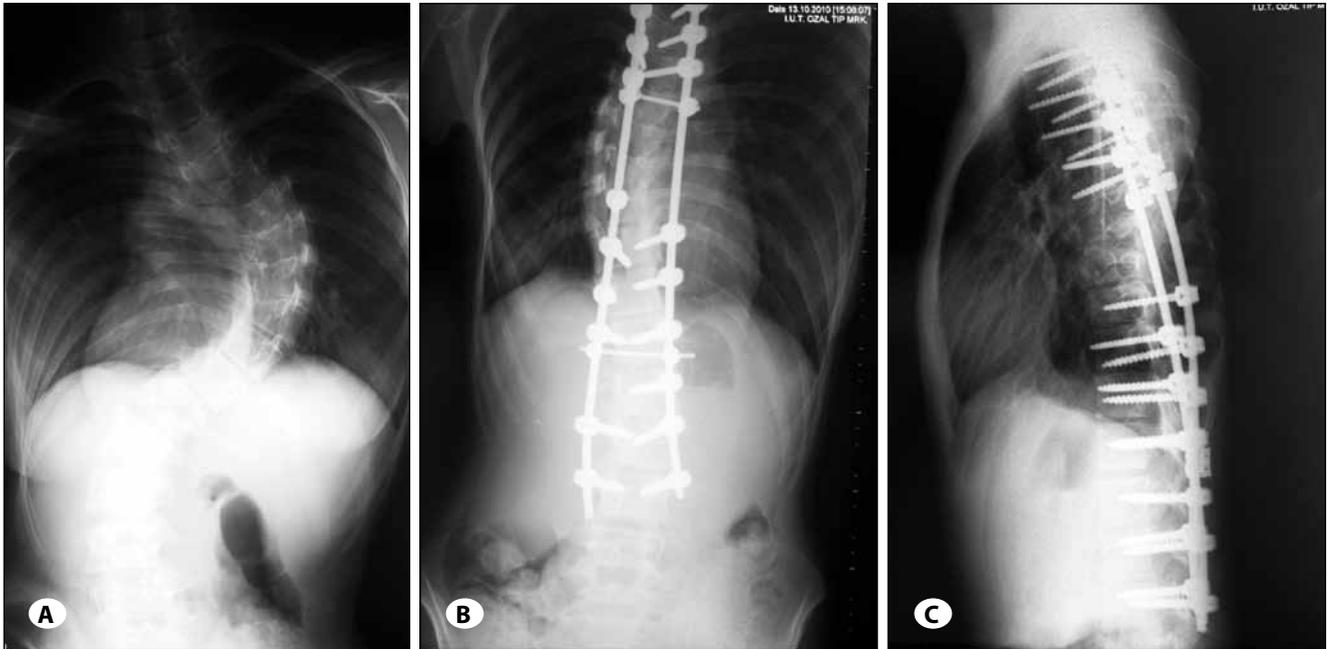


Figure 3: (A) A 13-year-old adolescent patient, (B) Significant correction in coronal plane; (C) Loss of balance in sagittal plane.

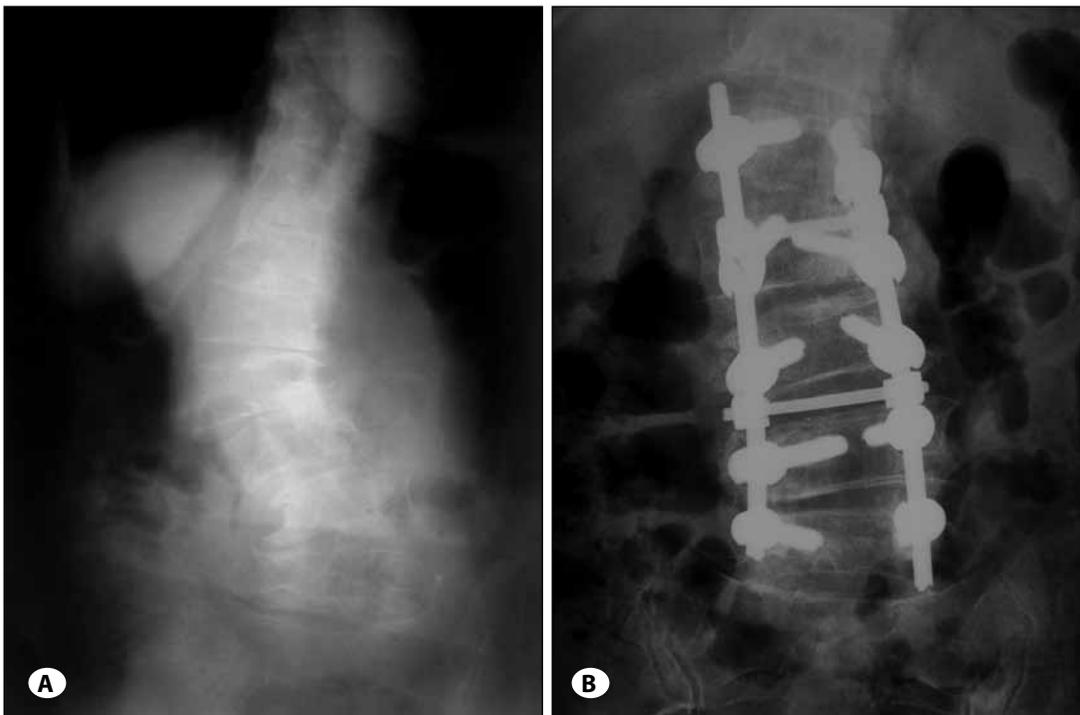


Figure 4A,B: Degenerative scoliosis. Development of decompensation at T12 in coronal plane 6 months after surgery.

segment deformation or increasing stress on adjacent segment is a well-known entity. Decompensation of lower or upper tips in the coronal plane may occur during deformity surgery (Figure 4A,B). Planning of upper and lower tips in the coronal plane is therefore important for arthrodesis.

Pseudoarthrosis

One of the most important complications of spine surgery is pseudoarthrosis and complications due to this entity. Pseudoarthrosis is known as absence of solid bone formation one year after arthrodesis. The rate of pseudoarthrosis in deformity surgery is between 0% and 2.2% (2,28,30).



Figure 5: Breakage of instrumentation and development of deformity 5 years after surgery due to pseudoarthrosis.

Pseudoarthrosis signs are increasing of deformity and failure of instrumentation (Figure 5). Just as in other spine surgeries for the formation of ideal fusion development, some rules must be followed. Positive factors like preparation of fusion area properly, usage of a sufficient amount of bone graft, usage of a suitable implant, and negative factors like infection, and smoking are important factors affecting the development of fusion. Older age (over 55 years) is one of the most important factors causing pseudoarthrosis. It is frequently seen in the thoracolumbar or lumbosacral part. Especially in these areas, interbody fusion techniques or combined performance of anterior and posterior surgery may be done to increase development of fusion (4,5,9,13).

Crankshaft phenomenon

The name is derived from the similarity to a crankshaft in automobiles (26). It is especially seen due to growth from the epiphysis plate which still has growth potential in children who have undergone arthrodesis for deformity surgery. A more definite explanation is that it is the structural deformity of the spine developing due to disproportionate growth from the anterior part of the spine due to healthy epiphysis plates in patients who have undergone posterior stabilization and fusion. If there is an increase of Cobb angle more than 10 degrees and rotation of apical vertebra more than 5 degrees, this is accepted as the crankshaft phenomenon. The rate of occurrence of the crankshaft phenomenon in Risser 0 children who are in the rapid growth period is about 37-43% (16,19).

Junctional deformities

These are deformities that may develop at proximal or distal parts of instrumentation system in all patients operated for deformity. They are mainly seen due to incorrect choice of stable vertebra or stopping instrumentation at transition areas like the thoracolumbar junction. This deformity can be named with the name of the place it is seen (junctional deformity, proximal junction kyphosis, distal junction kyphosis). Osteoporosis and presence of kyphosis (>5-10 degrees) are important risk factors for this complication. To avoid this complication while choosing the upper and lower vertebra of instrumentation, the 3 D structure of the spine and the deformity must be kept in mind. Instrumentation must not be stopped at the top of kyphosis. Choosing the correct stable vertebra prevents development of junctional deformity (1,11).

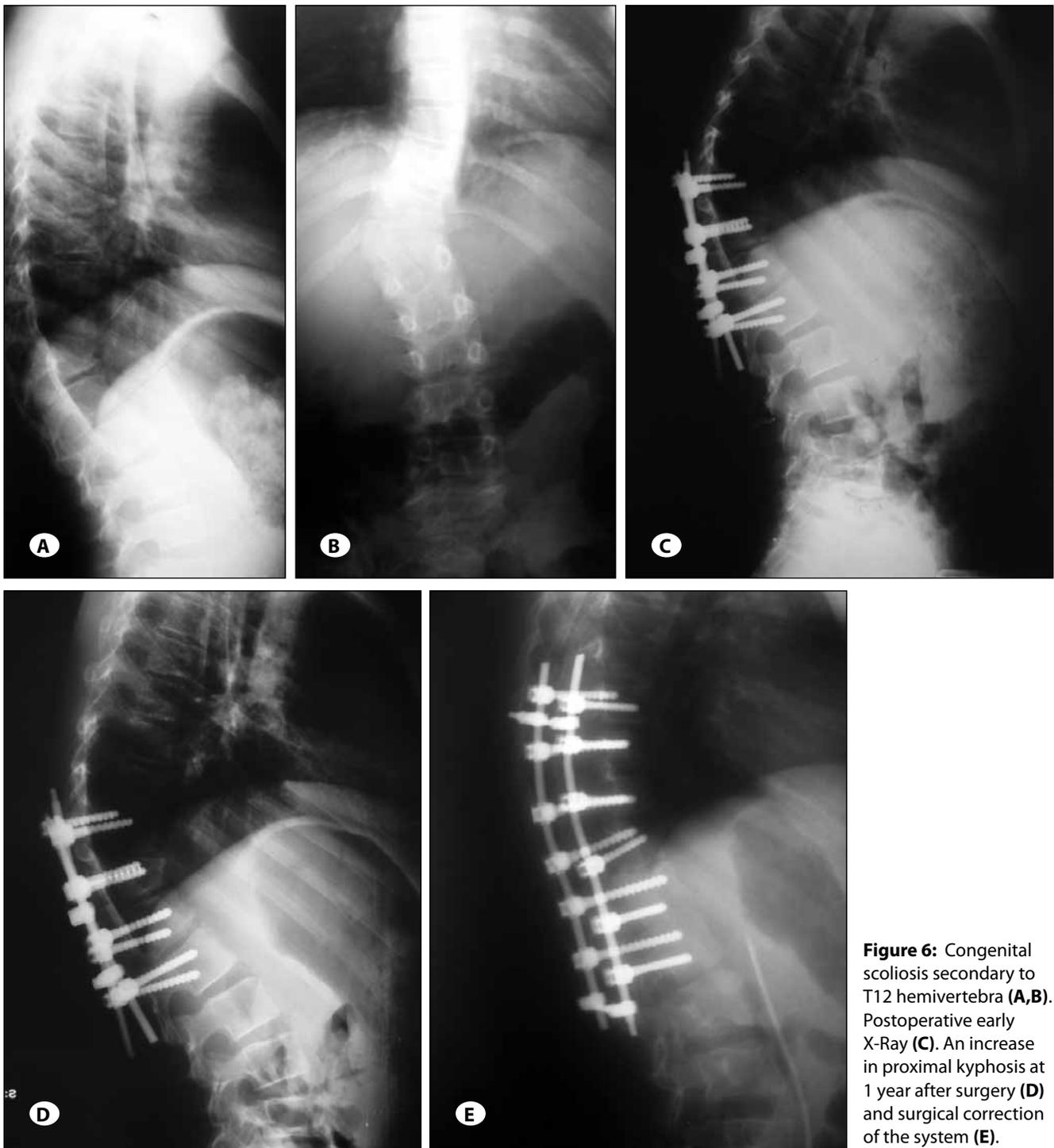


Figure 6: Congenital scoliosis secondary to T12 hemivertebra (A,B). Postoperative early X-Ray (C). An increase in proximal kyphosis at 1 year after surgery (D) and surgical correction of the system (E).

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