

Complications of Surgical Intervention in Management of Thoracolumbar Kyphosis

Mohamed Abdullah Mohamed Ibrahim, Omar Abdel Wahab Kelany, Waleed Mohamed Nafea, Mohammed Khalid Saleh

Orthopedic Surgery Department, Faculty of Medicine, Zagazig University, Egypt

Corresponding author: Mohamed Abdullah Mohamed Ibrahim

E-mail: md.esawy@gmail.com, mohamed_esawy@medicine.zu.edu.eg,
mohamedabdallahesawy2023@gmail.com

Conflict of interest: None declared

Funding: No funding sources

Abstract

Thoracolumbar kyphosis if left untreated will lead to serious complication ranging from psychological distress due to the deformity up to life-threatening conditions of improper pulmonary function and neurological deterioration over the long term. So surgical intervention when indicated is of a great importance, but this does not come without a cost. The osteotomies around the dura and the roots and behind the great vessels of the body are very risky and require high level of skill; otherwise the patient may suffer catastrophic consequences. The rate of complications increase with 3 column osteotomies as VCR and PSO represented by Schwab as (grade 3) to (grade 6) osteotomies. Complications may be intraoperative, early postoperative or late postoperative.

Keywords: Complications, Thoracolumbar Kyphosis

Tob Regul Sci. TM 2023;9(1): 4302-4311

DOI: doi.org/10.18001/TRS.9.1.300

Introduction

Thoracolumbar kyphosis if left untreated will lead to serious complication ranging from psychological distress due to the deformity up to life-threatening conditions of improper pulmonary function and neurological deterioration over the long term. So surgical intervention when indicated is of a great importance, but this does not come without a cost. The osteotomies around the dura and the roots and behind the great vessels of the body are very risky and require high level of skill; otherwise, the patient may suffer catastrophic consequences. The rate of complications increases with 3 column osteotomies as VCR and PSO represented by Schwab as (grade 3) to (grade 6) osteotomies. (1)

Complications may be intraoperative, early postoperative or late postoperative:

- Intraoperative complications are: dural tears, neurological insults, pulmonary complications and vascular injuries.
- Early postoperative complications (<30 days) as: early infection, early implant failure as screws pullout and early junctional failure as proximal and distal junctional fractures and kyphosis.
- Late postoperative complications include: late infection, implant failure in pseudoarthrosis, proximal junctional kyphosis (PJK) and distal junctional kyphosis (DJK). (2)

Intraoperative complications:

A. Dural tears:

The incidence of dural tears in spine deformity surgery can be as high as 10-14%. Tears most commonly occur due to injury by sharp instruments as osteotomes, medial breach of pedicular screws or bony spikes during reduction of a deformity. They may be type A) paracentral location, type B) lateral tears as nerve root's axilla and type C) at the ventral aspect of the dural sac. Tears can also be classified according to size and pattern into: small simple, moderate and large complex. Dural tears should be repaired once discovered either by primary repair, using a fascial graft as a tissue plug or dural patch in non-repairable complex tears. However, if the leak is first noted postoperatively then reoperation to repair the dura is recommended to prevent the formation of pseudomeningocele and decrease the opportunity of infection. (3)

B. Neural tissue injury:

Spinal cord and roots affection during deformity correction surgeries may reach up to 3 %. It may be acute or delayed. They may manifest as neuropraxia of the roots or the cord due to traction and compression intraoperatively. Sometimes recovery occurs after few minutes, but it may take days to months postoperatively to resolve. However, the injury may be more severe as a root tear with weakness of the affected muscles and hypoesthesia of corresponding dermatome, or direct trauma to the cord with subsequent paraplegia below the level of injury. Those severe injuries have unpredictable course of healing and may not recover at all. (4)

Intraoperative neuromonitoring is mandatory for early detection of insults and then early management by elevating blood pressure, decrease the performed correction and revision of any breaching screws in the hope of neural tissue recovery in the reversible insults. There is also the delayed neural injury postoperative which mainly occurs due to vascular insufficiency of the cord because of delayed spasm of the vascular structures of the cord due to the deformity correction or persistent hypotension. This condition require revision the deformity correction as soon as possible to decrease the cord stretch and putting the patient on a gradually increasing traction for a while till recovery of the neural injury and for training of the cord then taking the patient again to operating room for the definitive deformity correction. (5)

C. Pulmonary Complications:

Etiology: Pneumothorax or haemothorax due to intraoperative pleural injury and postoperative pneumonia or lung atelectasis are serious complications that may endanger patients' lives. Pneumothorax and haemothorax occurs due to injury to the parietal pleura by sharp retractors over the chest wall, by sharp instruments during vertebral and rib osteotomy, or avulsion of the parietal pleura attachment during excision of not properly dissected ribs or vertebrae. This can lead to intraoperative decrease in the Oxygen saturation and elevation of the intrapulmonary pressure. (6)

Management: Chest tube insertion is usually needed to prevent deterioration of respiratory functions. If detected intraoperative, tears should be managed according to their size as small tears can be managed conservatively as long as there is no leakage with intraoperative Valsalva maneuver while larger ones require direct repair and insertion of a chest tube into the affected side and monitored daily to follow any occlusion of the tube. This is continued till removal of the tube after there is no more discharge into the seal. (7)

D. Vascular injuries:

They are serious complications of kyphosis deformity surgeries, especially those with three-column osteotomies. The incidence rate of vascular injuries is around 1%, but the mortality rate can be as high as 60%. Epidural vessel injuries can result in significant bleeding if not controlled, which can increase the blood loss in already bloody operations and lead to higher morbidity for the patients. However, injuries to the major blood vessels anterior to the spine, such as the aorta or inferior vena cava, are the most concerning. These injuries can result in severe bleeding and may lead to the death of the patient if not quickly controlled. Direct trauma from sharp instruments or bone spikes, as well as indirect traction during deformity correction can result in these types of injuries. (8)

Management: Epidural vessels injuries can be managed by local haemostasis by direct compression by a gauze or ligation of the bleeding vessel and addition of gelatin based sponges as Gelfoam or oxidized regenerated cellulose as surgicell to induce local haemostasis. On the other hand, dealing with the large vessels as Aorta and IVC requires specialized vascular surgeons with either stent application in minor tears or direct repair or even grafts in larger injuries. (9).

Early postoperative complications:

A. Early infection:

Surgical site infection after kyphotic deformity surgeries is not uncommon complication and results in increased morbidity and mortality later on if the condition got beyond control due to wound dehiscence and septicemia. Spine deformity surgeries are generally long surgeries, working on multiple spinal levels with larger blood loss than typical spinal procedures. Infection is classified to superficial or deep in relation to the fascia. There are several risk factors for infection as: obesity, connective tissue disorders, medical conditions as Diabetes and renal failure and bad general

condition as in syndromatic patients, cerebral palsy. Precautions should be taken with those patients to minimize the incidence of infection. Other than the general protocols for any surgery to decrease infection rates as keeping the good sterilization of the operating theatre, personnel and instruments there are specific consideration for the spine deformity procedures as: preoperative antibiotics and repeated dose every 4 hours intraoperative, decrease muscle trauma during the operation by avoiding intramuscular approach, good debridement of soft tissue and irrigation by povidine-iodine wash just before closure of the surgical wound to decrease any bacterial load and decrease the incidence of postoperative anemia by minimizing the blood loss by good intraoperative homeostasis with postoperative compensation either medically or by blood transfusion.(10)

However, if the infection has already occurred and discharge comes out of the wound then culture and sensitivity of the discharge and antibiotics coverage according to the culture is given. If this failed to control the infection then open wide debridement and removal of the necrotic tissue and all the bone graft is done. This debridement can be repeated a couple of times, but if there are continuous discharge, persistent elevated inflammatory markers (WBCs count, ESR & CRP), radiolucent signals around the screws then either a single staged screws exchange after screw tract debridement or two stage screws extraction and tracts debridement at first then after few weeks on antibiotics coverage, with the patient on traction or not according to the stability of the spine, and after decrease of the inflammatory markers then reoperation is done with new instrumentation of the spine.(11)

B. Proximal Junctional Kyphosis (PJK):

PJK is confirmed radiologically when the angle between the lower end plate of the upper instrumented vertebra (UIV) and the upper endplate of the vertebra above becomes more than 11 degrees. It has a radiological prevalence of 20.4 %, but not every case with a radiological PJK will be a case of proximal junctional failure (PJF) which has a significant clinical impact and needs revision surgery. There are many risk factors for it as: osteoporosis, hypercorrection of the deformity beyond its normal parameters, disruption of the posterior soft tissue ligamentous structure, violating facets at the top of the construct and incorrect UIV selection. Multiple rods construct is accused of causing more junctional screws loosening than two-rods construct in osteoporotic patients so, the choice of multiple rod construct in osteoporotic patient to decrease pseudoarthrosis must be with caution. (12)

Proximal junctional failure (PJF) starts to manifest clinically usually in the first few weeks by gradually increasing kyphotic deformity above the construct due to either ligamentous failure or bony failure, mainly in osteoporosis, like screws pullout of the upper construct or vertebral fractures especially in the porotic patients. This increasing deformity may be complicated by neurological symptoms of cord compression. There are many ways to decrease the incidence of PJK like: preservation of the posterior ligamentous complex of the upper construct, preservation of the facet

on the top of the construct and soft landing technique by using hooks in the upper instrumented vertebra of a long fusion and kyphotic focal bending of the top of the rod. (13)

Proximal junctional kyphosis can be managed conservatively if it is 11- 15 degrees without progression on serial radiographs, while those which are increasing on serial radiographs should be managed operatively by extension of the fusion to upper thoracic levels. This includes just facetectomies of the fused levels with no need to more extensive osteotomies as long as the intervention has been made before establishment of any structural changes that need extensive osteotomy to correct.(14)

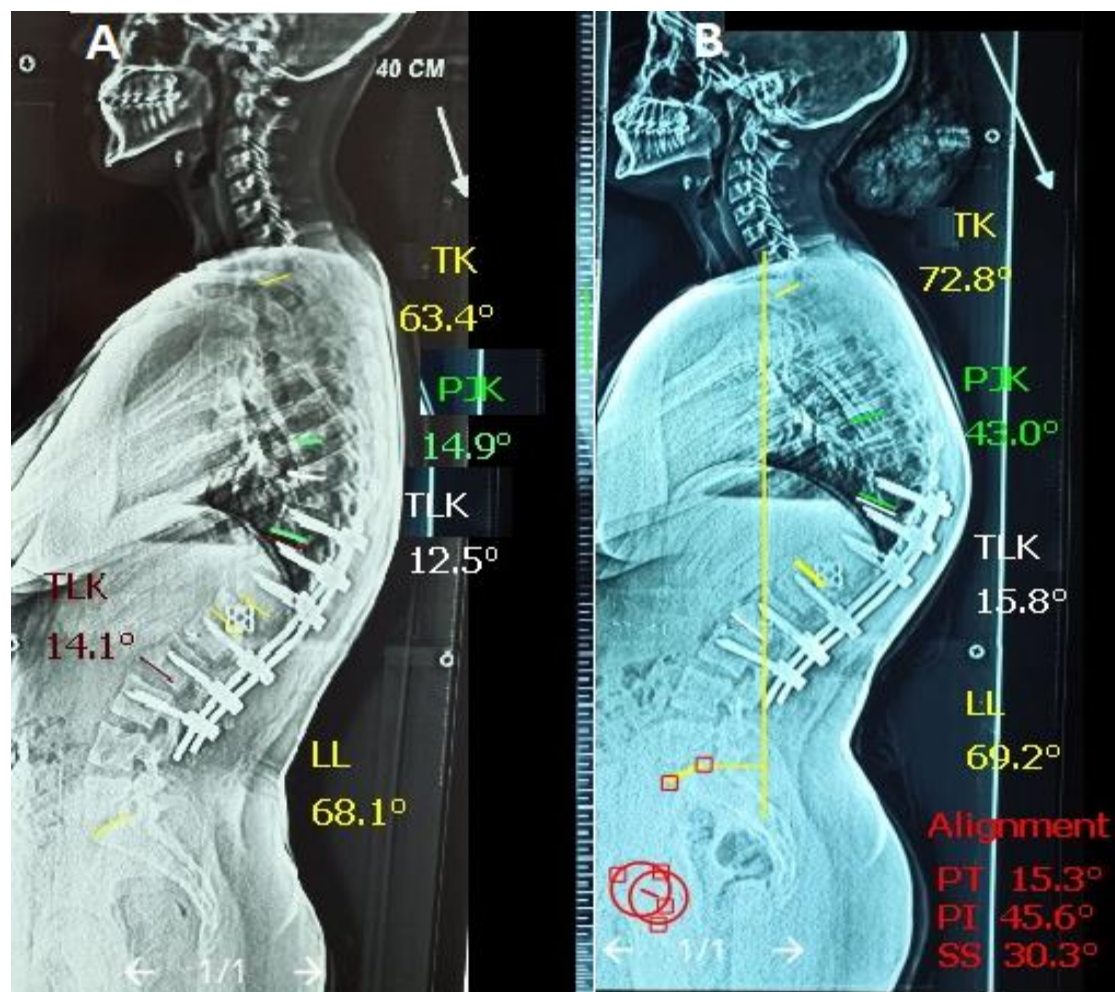


Figure (1): Longstanding Xray lateral view of A) 2 months after VCR of posttraumatic kyphosis of T12 B) 7 months postoperative of the same patient with increasing of PJK angle to 45°.

C. Distal Junctional Kyphosis (DJK):

DJK is confirmed radiologically when the angle measured from the lower endplate of the LIV and the caudal endplate of one vertebra below becomes more than 11 degrees. It may be only a radiological finding or it progress with time and becomes a clinically disturbing condition known as distal junctional failure (DJF). DJF may be ligamentous or bony with screws pullout, vertebral fractures, spondylolisthesis, and stenosis at the lowest instrumented fused level. In kyphotic

deformities, it is most commonly seen in Scheurmann's kyphosis due to wrong choice of lower instrumented vertebra or long fusion in osteoporotic bone. The selection of LIV in Scheuermann's kyphosis has always been a concern for deformity surgeons. Nowadays, it is more accepted the most proximal vertebra touched by the perpendicular line from the postero-superior corner of the sacrum is considered a sagittal stable vertebra (SSV) and can be the LIV. This has much lower rates of DJK compared to selecting the first lordotic vertebra below the first lordotic disc space in the sagittal view. (15)



Figure (2): longstanding X-ray sagittal view showing the SSV to be L3, and L2 to be the first lordotic vertebra.

Late postoperative complications:

A. Pseudarthrosis:

In spine fusion surgery, nonunion is referred to as pseudarthrosis. It is detected clinically by constant pain or broken rods more than 9 months postoperative, and radiologically by absence of fusion which is mainly detected in the CT scan. However, surgical exploration remains the gold standard for its detection. It negatively affects the health related quality of life of the patient due to pain and the mechanical troubles of broken rods. In most cases it requires revision surgery accounting for 25 % of all revision surgeries of kyphotic spine deformities correction. There are

several risk factors for it as: smoking, osteoporosis, debilitating diseases with bad general condition, dural tears, increased number of fusion levels (>4 levels), high mechanical loads and shear forces at lumbosacral junction in extended fusions to the pelvis and in sagittal malaligned spine and sometimes shortage of bone graft especially in revision surgeries and in long fusions requiring adding synthetic grafts to using autogenous pelvic graft. (15)

On the other hand, there are several ways to reduce pseudarthrosis incidence especially in patients with multiple risk factors as: rigid instrumentations with multiple rods technique, cobalt chromium rods, combined approaches mainly in debilitating conditions affecting bone healing to increase chance of fusion, interbody fusion with removal of all intervertebral disc material as possible and increasing the bone graft amount by the use of synthetic bone graft. (16)

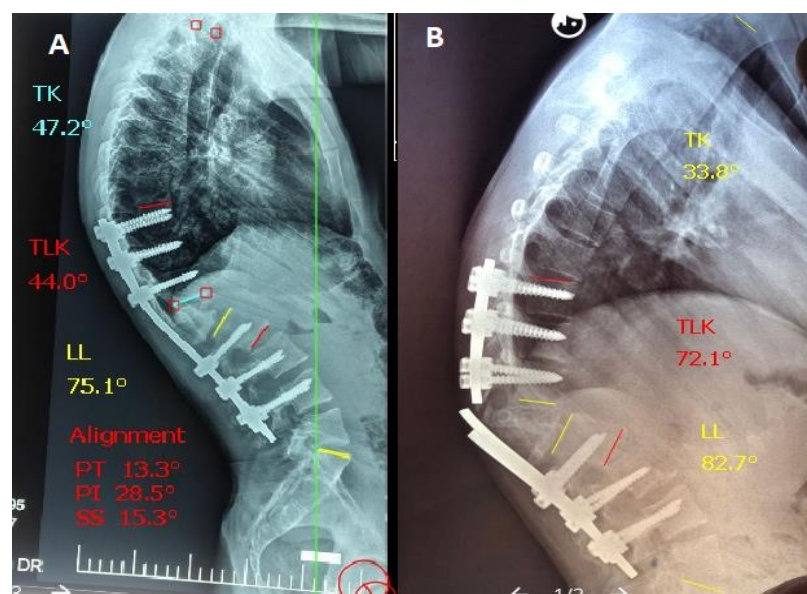


Figure (3): longstanding X-ray sagittal view: A) 2 months after under-corrected thoracolumbar congenital kyphotic deformity (TLK= 44°) with (PI-LL) mismatch. B) 6 months postoperative with broken rods.

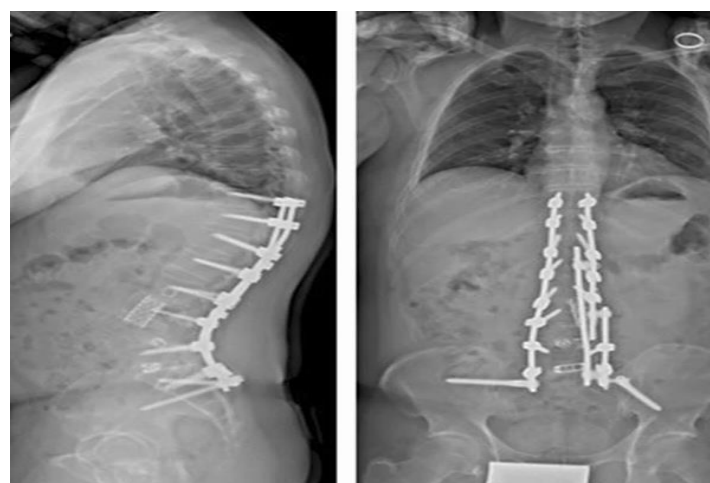


Figure (4): Longstanding X- rays showing multiple rods technique. (16)

B. Junctional failures and fractures:

In late neglected cases of proximal junctional kyphosis with large degrees, the upper instrumented vertebra or the vertebra above the construct may show fractures. This may happen early in smaller degrees of deformities in osteoporotic cases. This requires extension of the fusion to higher thoracic levels and osteotomy at the level of the fractured vertebra to correct the deformity. This osteotomy may only posterior closing wedge osteotomy or three column osteotomy according to the degree of the deformity. (12)



Figure (5): a case of proximal junctional fracture of the first instrumented vertebral body and posterior facets; A)longstanding lateral x – rays, B) CT sagittal view; C) MRI sagittal view. (14)

C. Late infection:

It describes the infection that may start to occur 6 months postoperative. This is mainly due to haematogenous spread from distant septic focus elsewhere in the body. It is more common in patients with any of those immune-compromising risk factors as connective tissue disorders, medical conditions as Diabetes and renal failure and bad general condition as in syndromatic patients, cerebral palsy. Clinically it may range from collection over the implant with redness and hotness to catastrophic complications of wound dehiscence and septicemia. (10)



Figure (6): Wound dehiscence; a late catastrophic infection complication of spine deformity correction surgeries. (10)

No Conflict of interest.

References:

1. **Fernandes P, Flores I, Soares do Brito J.** Complications associated with surgical treatment for pediatric spine deformities: A single center 10-years experience. *ARP Rheumatol.* (2023) Jan-Mar;2(1):22-29.
2. **Iyer S, Klineberg EO, Zebala LP, Kelly MP, Hart RA, Gupta MC, Hamilton DK, Mundis GM, Sciubba D, Ames CP, Smith JS, Lafage V, Burton D, Kim HJ;** International Spine Study Group (ISSG). Dural Tears in Adult Deformity Surgery: Incidence, Risk Factors, and Outcomes. *Global Spine J.* 2018 Feb;8(1):25-31.
3. **Sansur CA, Smith JS, Coe JD, Glassman SD, Berven SH, Polly DW Jr, Perra JH, Boachie-Adjei O, Shaffrey CI.** Scoliosis research society morbidity and mortality of adult scoliosis surgery. *Spine (Phila Pa 1976).* (2011) Apr 20;36(9):E593-7.
4. **Iorio JA, Reid P, Kim HJ.** Neurological complications in adult spinal deformity surgery. *Curr Rev Musculoskelet Med.* (2016) Sep;9(3):290-8.
5. **Wulff I, Duah HO, Osei Tutu H, Ofori-Amankwah G, Yankey KP, Owiredu MA, Bidemi Yahaya H, Akoto H, Oteng-Yeboah A, Boachie- Adjei O;** FOCOS Spine Research Group. Postoperative Pulmonary Complications in Complex Pediatric and Adult Spine Deformity: A Retrospective Review of Consecutive Patients Treated at a Single Site in West Africa. *Global Spine J.* (2021) Oct;11(8):1208-1214.
6. **Lucifero GA, Gragganiello C, Baldoncini M.** Rating the incidence of iatrogenic vascular injuries in thoracic and lumbar spine surgery as regards the approach: A PRISMA-based literature review. *Eur Spine J* 30, 3172– 3190 (2021).

7. **Chundamala J, Wright JG.** The efficacy and risks of using povidone- iodine irrigation to prevent surgical site infection: an evidence-based review. *Can J Surg.* (2007) Dec;50(6):473-81.
8. **Farah K, Lubiato A, Meyer M, Prost S, Ognard J, Blondel B, Fuentes S.** Surgical site infection following surgery for spinal deformity: About 102 patients, *Neurochirurgie*, Volume 67, Issue 2,(2021),Pages 152-156.
9. **Marques MF, Fiere V, Obeid I, Charles YP, El-Youssef K, Lahoud A, Faddoul J, Ferrero E, Riouallon G, Silvestre C, Le Huec JC, Kieser D, Boissiere L.** Pseudarthrosis in adult spine deformity surgery: risk factors and treatment options. *Eur Spine J.* (2021)(Nov;30(11):3225-3232.
10. **Akıntürk N, Zileli M, Yaman O.** Complications of adult spinal deformity surgery: A literature review. *J Craniovertebr Junction Spine.* (2022) Jan- Mar;13(1):17-26.
11. **Hostin R, McCarthy I, O'Brien M, Bess S, Line B, Boachie-Adjei O.** Incidence, mode, and location of acute proximal junctional failures after surgical treatment of adult spinal deformity. *Spine (Phila Pa 1976)* (2013);38:1008–15.
12. **Cho KJ, Lenke LG, Bridwell KH, Kamiya M, Sides B.** Selection of the optimal distal fusion level in posterior instrumentation and fusion for thoracic hyperkyphosis: the sagittal stable vertebra concept. *Spine (Phila Pa 1976).* (2009);34:765–770
13. **Li S, Li Z, Hua W:** Clinical outcome and surgical strategies for late post- traumatic kyphosis after failed thoracolumbar fracture operation, *Medicine:* (2017) - Volume 96 - Issue 49 - p e8770
14. **Audat ZA , Radaideh AM, Odat M, Bashaireh K, Mohaidat Z, Assmairan M, Alshbool O, Audat M.** Severe thoracolumbar congenital kyphosis treated with single posterior approach and gradual “in situ” correction. *Journal of Orthopaedic Surgery* 28(1) 1–7 (2020)
15. **Soliman, Hany Abdel Gawwad MD.** Health-related Quality of Life of Adolescents With Severe Untreated Congenital Kyphosis and Kyphoscoliosis in a Developing Country. *SPINE* 43(16):p E942-E948, August (2018).
16. **Atici Y, So`ku`cu` S, Uzu`mcu`gil O.** The results of closing wedge osteotomy with posterior instrumented fusion for the surgical treatment of congenital kyphosis. *Eur Spine J* 2013;22(6): 1368–1374.