Gh.R. Bahadorkhan MD[1]
F. Samini MD[1]
M.R. Ehsaei MD[1]
S. Nekoei MD[2]

Complications of Thoracolumbar Stabilization and Instrumentation: A Pictorial Essay

In this pictorial essay, we intend to review the imaging findings of a series of patients who underwent thoracolumbar instrumentation and showed any kind of complication. Imaging of complicated cases could help surgeons find the most frequent defects of these procedures. In this article, we present 18 images of 150 patients who underwent spinal instrumentation in a 15-year period.

Keywords: Thoracolumbar Spine, Lumbar Spine, Instrumentation, Complication

Introduction

Surgery for spinal fusion and instrumentation is performed for a wide spectrum of indications, including trauma, infections, degenerative deformities, tumors and correction of congenital anomalies such as scoliosis. The ultimate aim of spinal fusion is to restore anatomic alignment and functional biomechanics to as near normal as possible.

Internal fixation devices can preserve alignment and prevent motion to optimize graft incorporation, while allowing early mobility. Generally two of three columns must be anatomically intact for functional stability. According to the three column theory of Denis, if two of the three columns of the spine are disrupted or fractured, the spine is unstable functionally and needs stabilization and fusion. Instrumentation is therefore often necessary if more than one column is disrupted.

Commonly used methods for reconstruction of the posterior column include long rods with pedicular, lateral mass screws and sublaminar hooks. Pedicular screws and rods or plates have become the preferred method of instrumentation when multiple-column reconstruction is required.

Pedicular screw fixations have significantly improved the outcome of spinal reconstruction requiring spinal fusion by providing rigid fixation of the spine. It is a technically demanding procedure with potential complication, which includes medical complications, hardware and technical problems, long-term changes of functional motion segments and problems in balance.

The use of pedicular screw is not free of complications, but the logic for its use is fairly clear.[1,2] The complications are often related to the misuse of the device and the surgeon's decision-making skills or they are directly related to the screws themselves.[3,4] Its use has dramatically improved the union after spinal fusion.

Pedicular screw has facilitated shorter segment instrumentation for fractures, spondylolisthesis and many other spinal pathologies ranging from neoplasms to congenital malformations with a good predictable outcome.[4]

1. Associate Professor, Department of Neurosurgery, Mashhad University of Medical Sciences, Mashhad, Iran.
2. Associate Professor, Department of Radiology, Mashhad University of Medical Sciences, Mashhad, Iran.

Corresponding Author:
Fariborz Samini
Address: Department of Neurosurgery, Ghaem Medical Center, Ahmadabad St. Mashhad, Iran.
Tel: +98511-8592-180
Fax: +98511-8012-613
Email: saminif@mums.ac.ir

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In spite of the widespread use of pedicular fixation systems, there are not many studies on problems, complications and outcomes in this group of patients in the literatures.[5,6] Yuan et al. reported a higher infection rate (3%-6%), neurologic injury (1%-5%), instrumental failure (6%-10%), and reoperation (20%) with the use of spinal instrumentation in comparison with in situ arthrodesis.[7] West et al. reported a 26% to 29% complication rate for pedicle system fixation, most of which were minor complications, with the exception of two misplaced screws causing no neurologic impairment or pain.[8] Cook et al. reported an overall 45% complication rate, which was mostly minor. In this study, the complication rate increased to 63% in patients with previous lumbar surgery.[9]

Before operation, imaging is indicated for the decision about operation, the kind of operation and the degree of instability. Plain radiography (AP, lateral and oblique), CT scan and/or MRI are required.

In order to see the trajectory of the screws in the vertebral pedicle and body, during operation, C-arms scopy is necessary.

After operation, radiography is indicated one, two and three months later. If there is a good and complete fusion and arthrodesis at the level of fracture, orthosis is removed. If there is a new neurological problem or disorder, we have to follow up by plain radiography, axial CT scan and MRI with and without contrast in proper indications.

Complications

From March, 1996 to April, 2006, our patients were reviewed for their complications after thoracolumbar and lumbar spinal instrumentation and arthrodesis. They were classified as hardware related problems (Figs. 1, 3-8, 13 & 17), instrumented segment associated problems (Figs. 2, 9,10, 11, 13, 15 & 16), junction level problems (Fig. 12), balance-related problems (Figs. 14 & 17) and general problems (Fig. 18).

Problems not directly related to instrumentation which develop during and after surgery were considered as general complications (Figs. 1 & 2). Those problems related to the positional change of metal and screw, such as fatigue fracture or pulling out of instrument were defined as hardware-related problems (Fig. 3). Disc space narrowing greater than 3 mm, pseudarthrosis and loss of reduction in the instrumented segments were considered as problems in the instrumented segments .These problems were caused by severe degenerative joint disease (DJD), metabolic disorders, aging and inappropriate graft or arthrodesis (Figs.17 & 18). Junctional problems were those pathologic changes observed in adjacent motion segments, just above or below the instrumented and fused segments because of excessive loading (adjacent level syndromes). Scoliosis greater than 5 degrees or a trunk shift greater than 5 mm on the AP radiograph, taken in the standing position were defined as a problem of balance in the coronal plane. We had to rule out spinal malalignment during the fusion period and arthrodesis. Failure to obtain or maintain lumbar lordosis as seen on the lateral radiograph in the standing position was considered as a problem of balance in the sagittal plane.

Conclusion

Evaluation of fusion construct and integrity of hardware infused segments is primarily performed by different radiological techniques. Complications of spinal instrumentation are not uncommon. In the use of this effective but demanding method in treating various spinal disorders, the benefits must outweigh the risks and the experienced surgeon should judiciously use instrumentations. Detailed knowledge of vertebral pedicle anatomy, the routine use of image intensification during screw placement by attention to the trajectory of the screws, adequate fusion and blunt identification of the isthmus of the pedicle are essential for proper use of the pedicle screw system.[10-13]

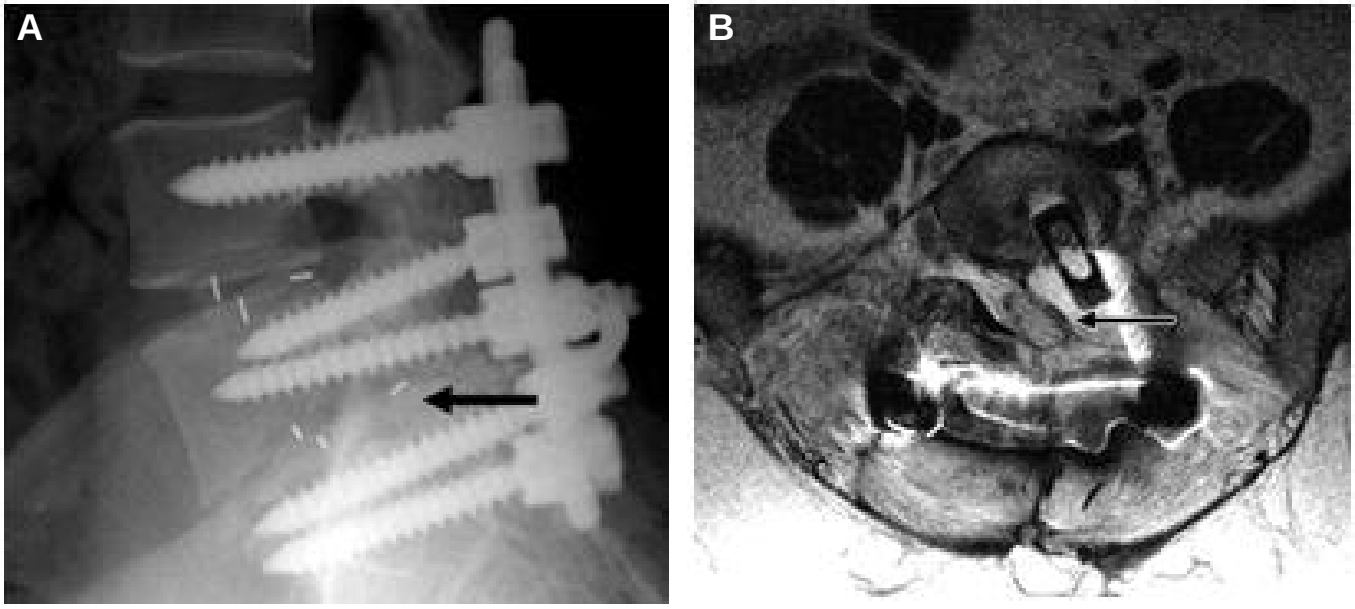

Fig. 1. Posterior herniation of an intervertebral bone graft cage in a 52-year-old man with acute neuropathy.

A. Lateral radiograph depicts posterior interbody fusion at L4–5 and L5-S1 and posterior displacement of the L5-S1 bone graft cage into the spinal canal (arrow). The patient was experiencing worsening low back pain and a left L5 radiculopathy.

B. T2-weighted MR image demonstrates ventral and lateral effacement of the thecal sac (arrow) by the cage.

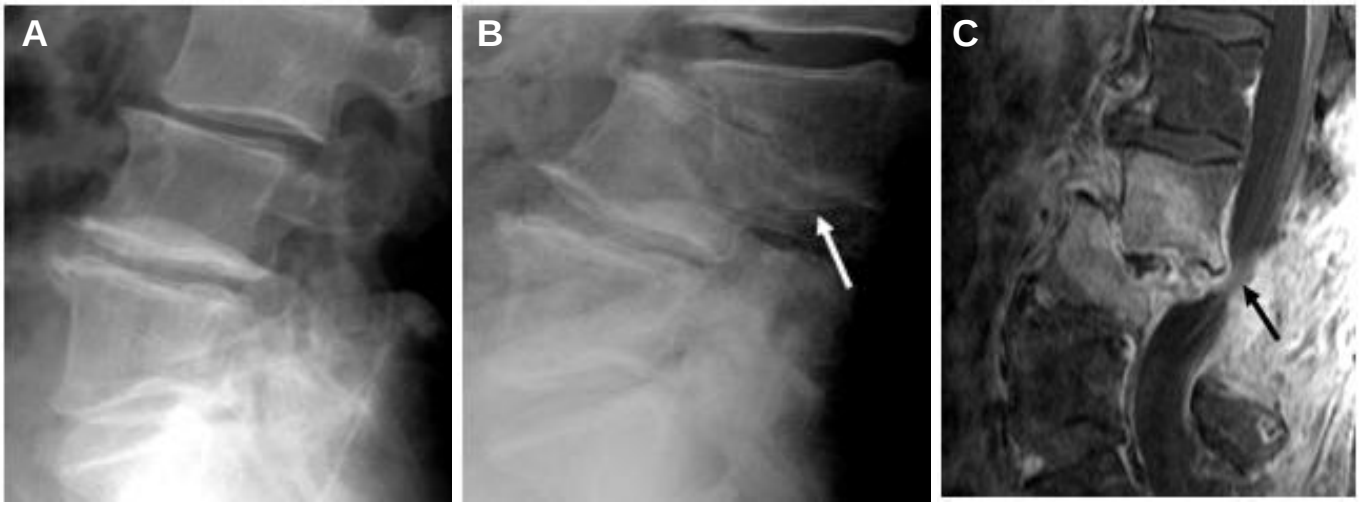

Fig. 2. Post-operative diskitis and osteomyelitis.
A & B. Lateral radiographs in a patient who underwent diskectomy, partial laminectomy, and lumbar fusion with instrumentation, after the instrument was removed. Initial postoperative image (A) and 6-month follow-up image (B) show progressive endplate destruction, collapse of the disk space, and osteopenia in the adjacent vertebral bodies (arrow in B), findings indicative of diskitis and osteomyelitis.
C. Sagittal T1-weighted contrast-enhanced MR image demonstrates intense enhancement in the vertebral bodies and the remaining disk—a finding that helped confirm the diagnosis—as well as ventral compression of the thecal sac (arrow).

Fig. 3. Penetration of the anterior sacral cortex in a 46-year-old man after lumbosacral fusion. Sagittal reconstruction CT image shows that the inferior pedicle screw has exited the anterior cortex of the S1 segment and is impinging on the hypogastric vein (arrow).

Fig. 4. Plain radiograph of pedicular screw fracture in a 51-year-old woman with anterior wedge fracture of the spine, 8 months after operation.

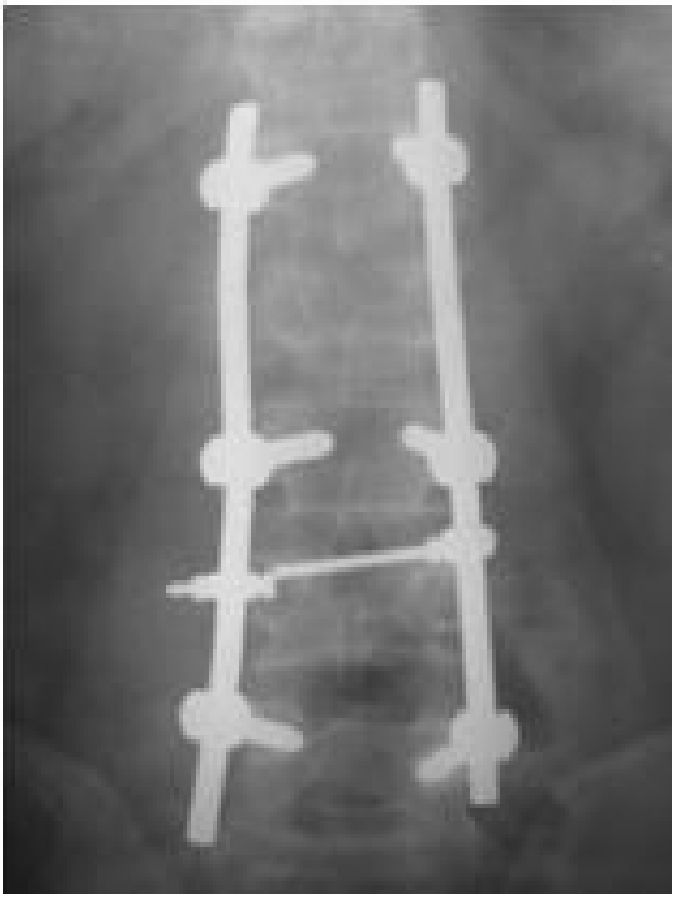

Fig. 5. Plain AP radiograph of fracture of the transverse rod in a 28-year-old man, about 6 months after operation.

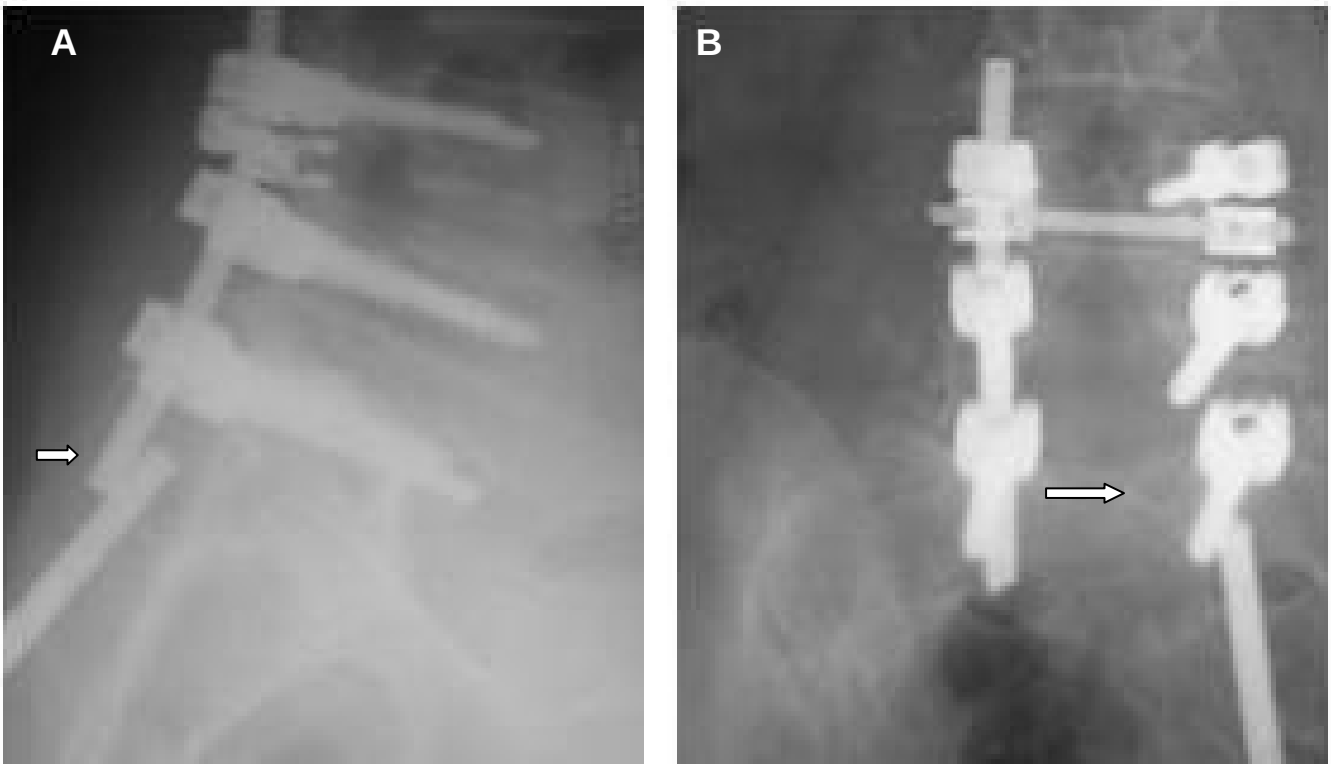

Fig. 6. Distal rod dislodgement in a 56-year-old woman who had undergone pedicular screw fixation and fusion of L4, L5, and S1 for L4, L5 spondylolisthesis one year earlier.

A. Lateral view

B. Anteroposterior view

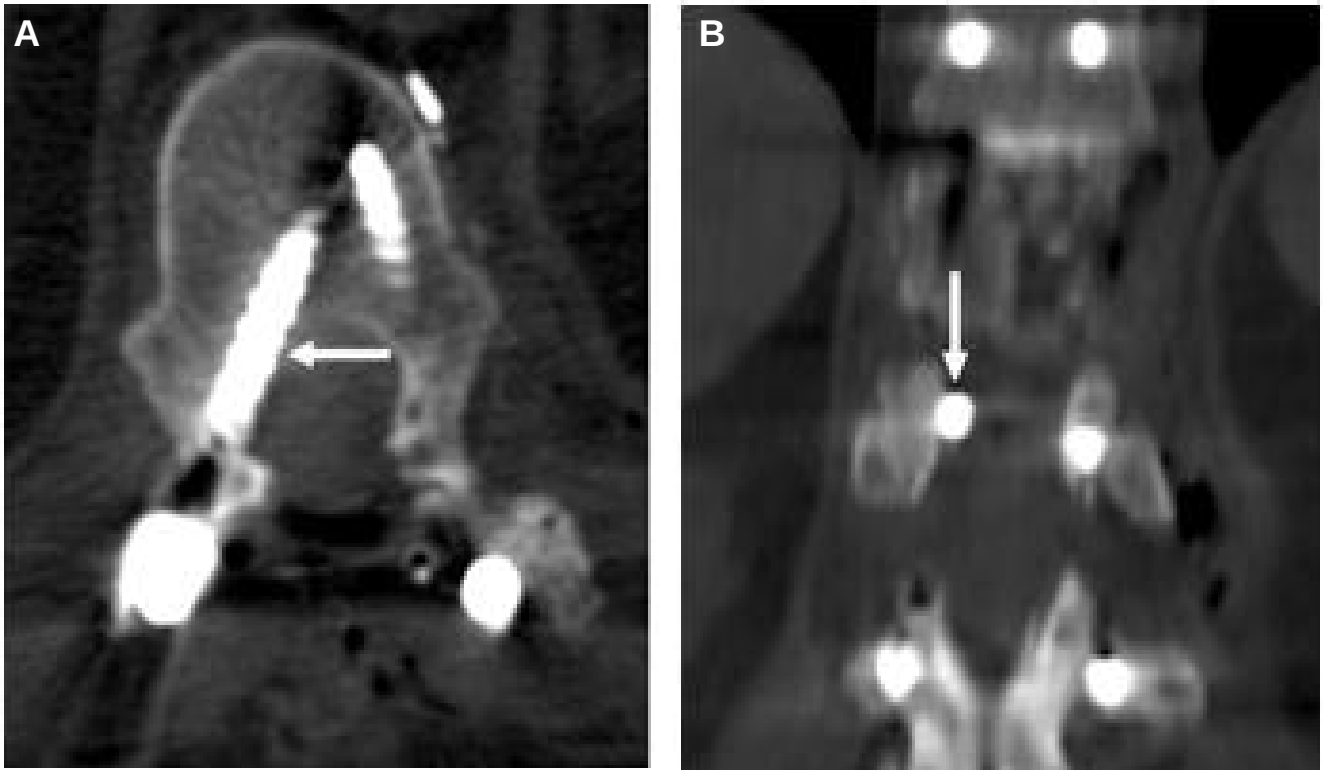

Fig. 7. CT imaging of medial deviation of a pedicle screw that had traversed the medial cortex of the pedicle and had penetrated the dural sac (arrow), causing a cerebrospinal fluid leak. The leak was repaired when the errant screw was removed and a new screw was replaced correctly.

A. Axial view

B. Coronal view

Fig. 8. Lateral pedicle screw deviation in a 65-year-old man with neuropathy at L5. The axial CT image shows deviation of the right pedicle screw, which exits the lateral cortex and traverses the right neural foramen at the L5-S1 level (arrow). Neuropathy resolved after the screw was removed.

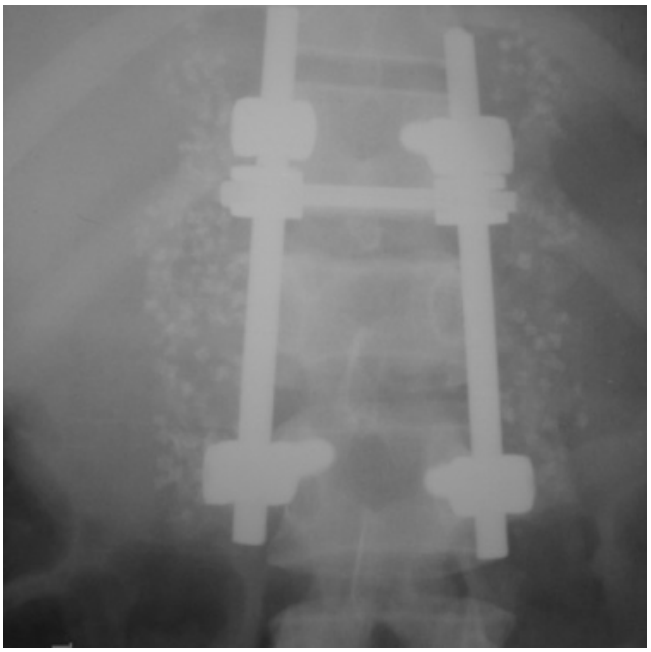

Fig. 9. Plain AP radiograph of the thoracolumbar spine with solid bony fusion in a 27-year-old man, 9 months after operation.

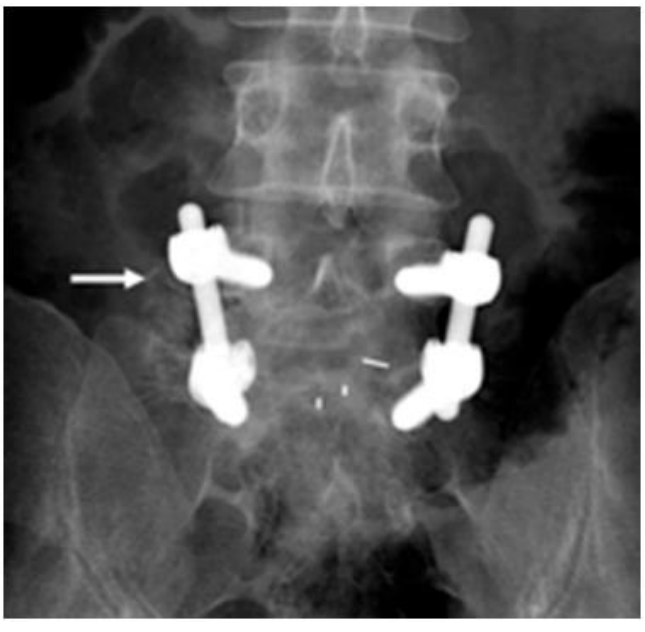

Fig. 10. Early pseudarthrosis in a 43-year-old man. The anteroposterior radiograph demonstrates a linear lucency in the lateral bone graft material on the right (arrow), a finding indicative of early pseudarthrosis.

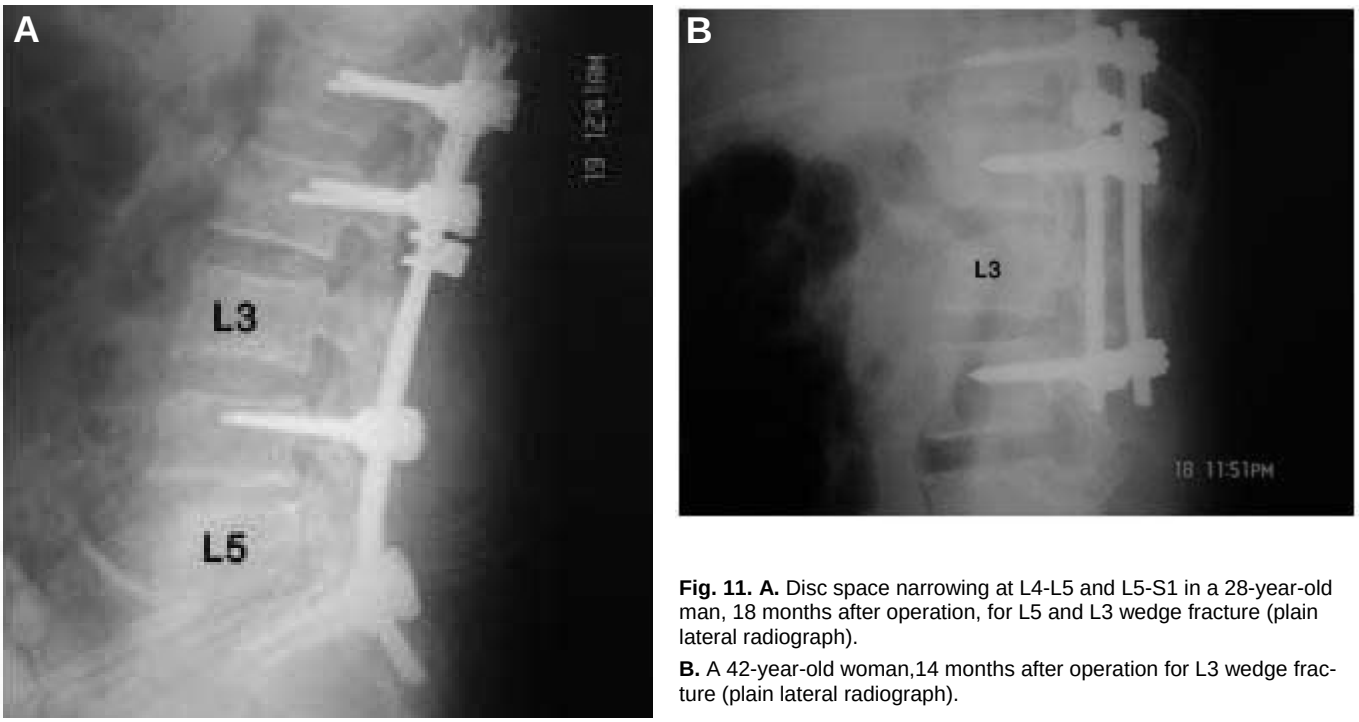

Fig. 11. A. Disc space narrowing at L4-L5 and L5-S1 in a 28-year-old man, 18 months after operation, for L5 and L3 wedge fracture (plain lateral radiograph).

B. A 42-year-old woman,14 months after operation for L3 wedge fracture (plain lateral radiograph).

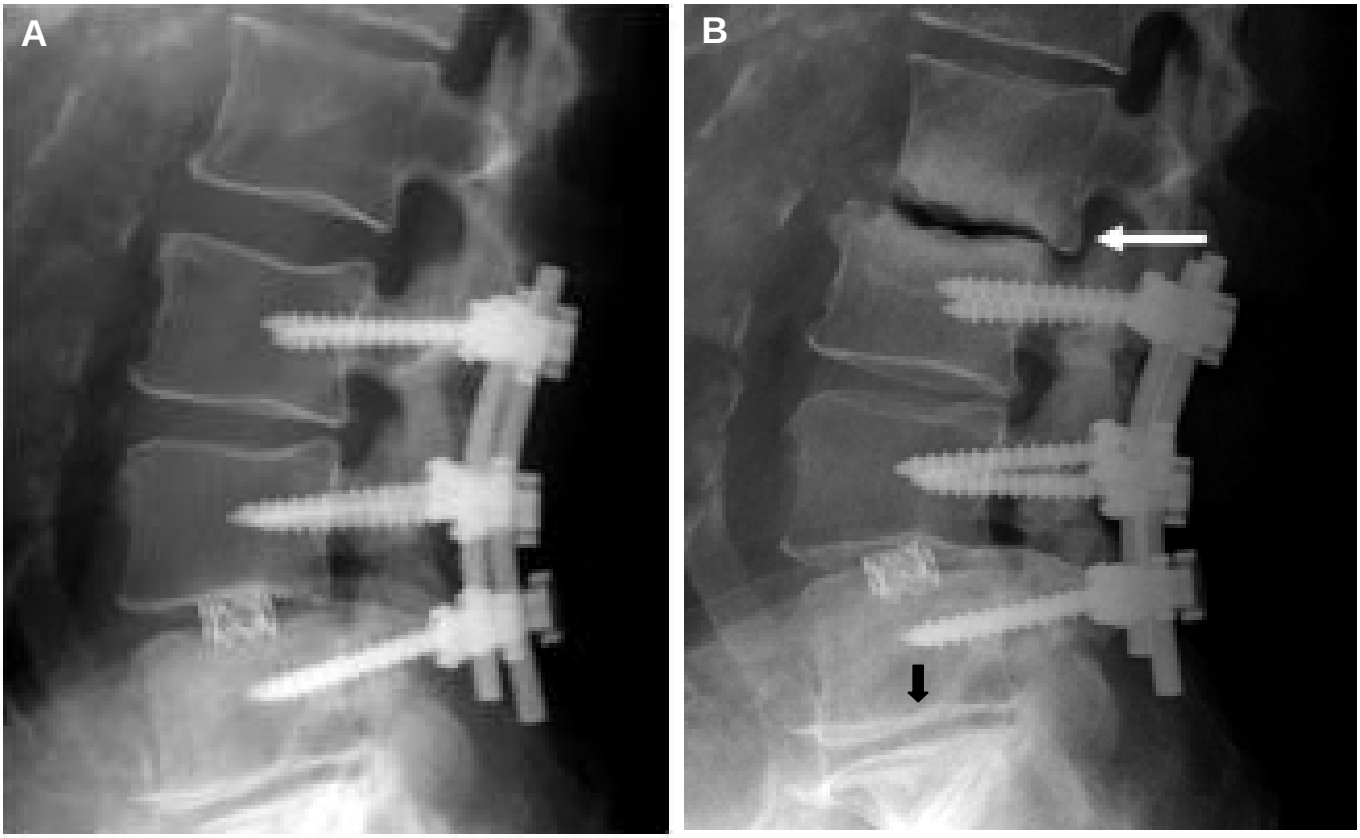

Fig. 12. Plain lateral radiographs of the lumbosacral region in a 53-year-old woman. Disc space narrowing and spondylosis at levels adjacent to instrumentation after lumbar interbody fusion with titanium mesh cage in L4-L5 and pedicular screw fixation of L3-L4-L5.

A. Two months after surgery.

B. Two years after surgery.

Fig. 13. Screw plug dislodgement and junction problems in a 23-year-old patient. This lateral plain radiograph shows this failure 9 months after the operation.

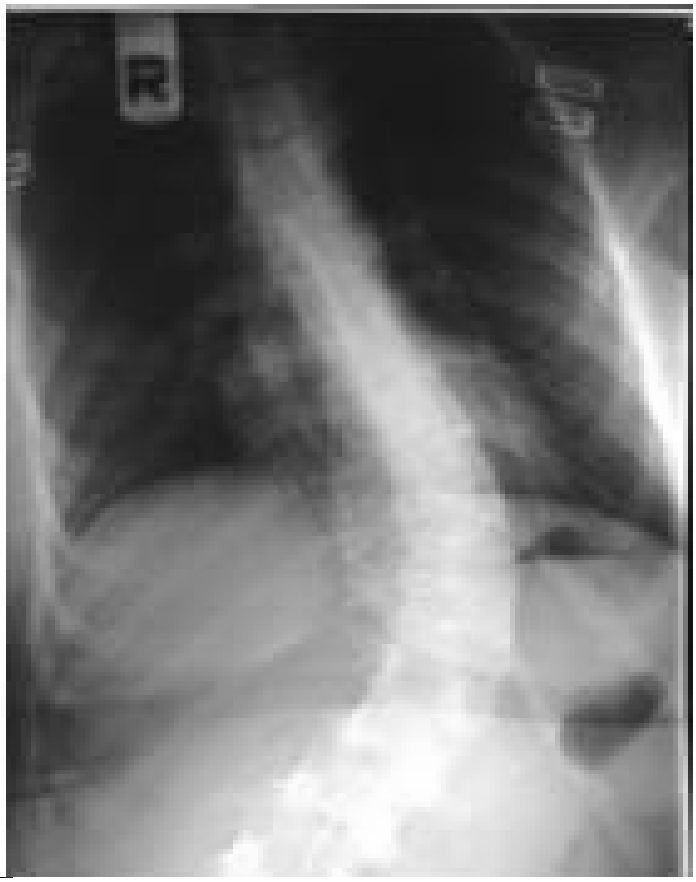

Fig. 14. Sagittal imbalance in a 32-year-old man who had initially undergone posterior spinal fusion for burst fracture of T12, two years after removing displaced pedicular screws. There is severe thoracolumbar scoliosis in the AP plain radiograph.

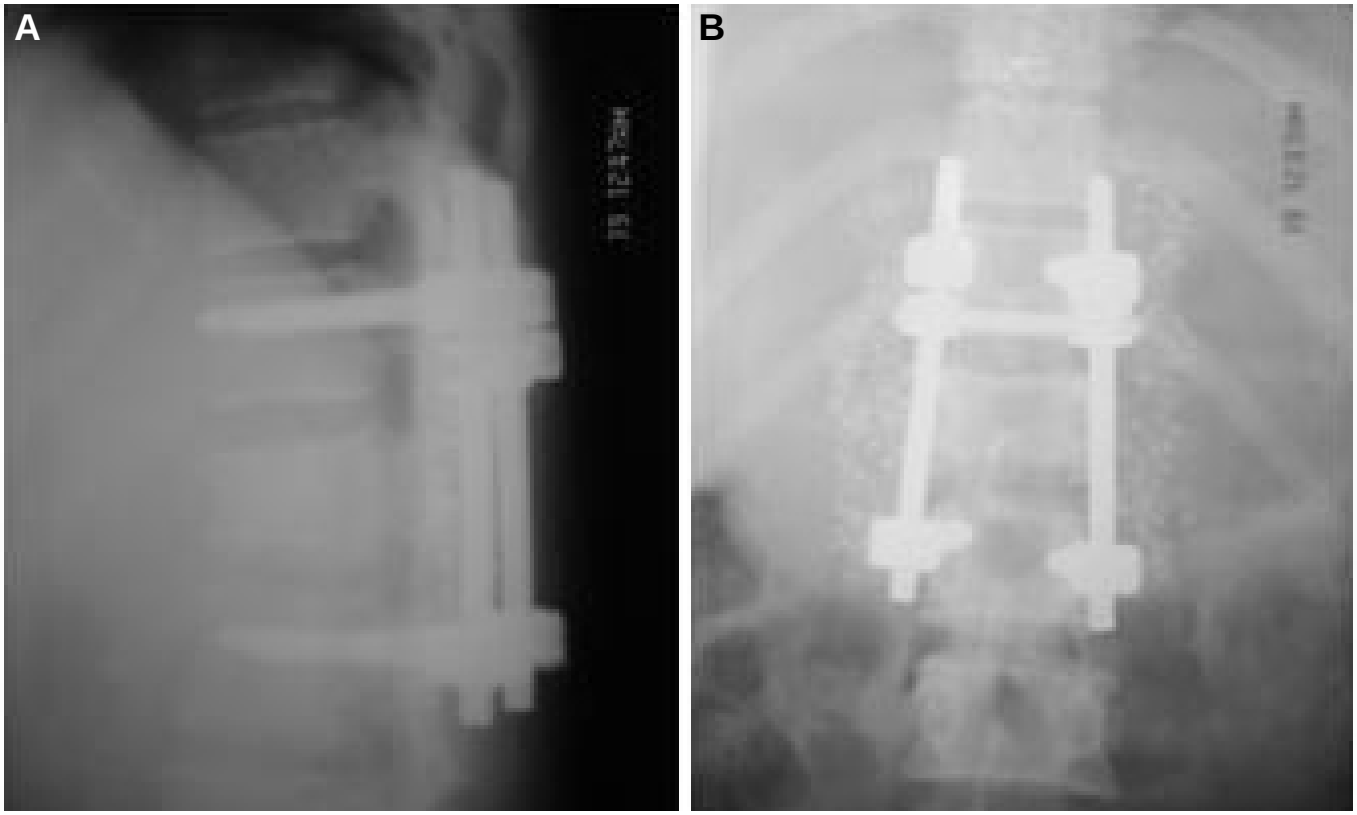

Fig. 15. Short segment pedicular screw fixation without good fusion in a 27-year-old man.with T11 compression fracture due to car accident.

A. Lateral view

B. Anteroposterior view

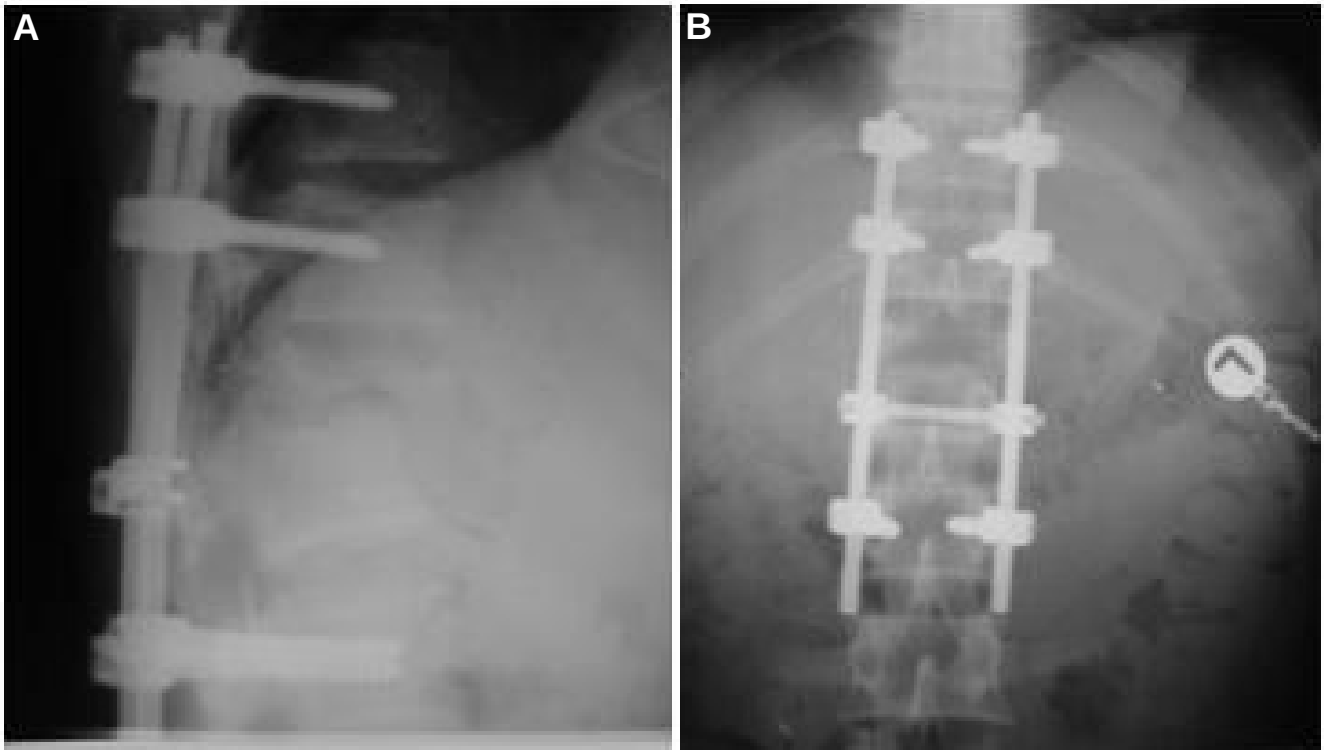

Fig. 16. Three segment pedicular screw fixation in T11 compression fracture in a 23-year-old man due to car accident. Failure of reduction and decompression with imperfect fusion are seen in these views.

A. Lateral view

B. Anteroposterior view

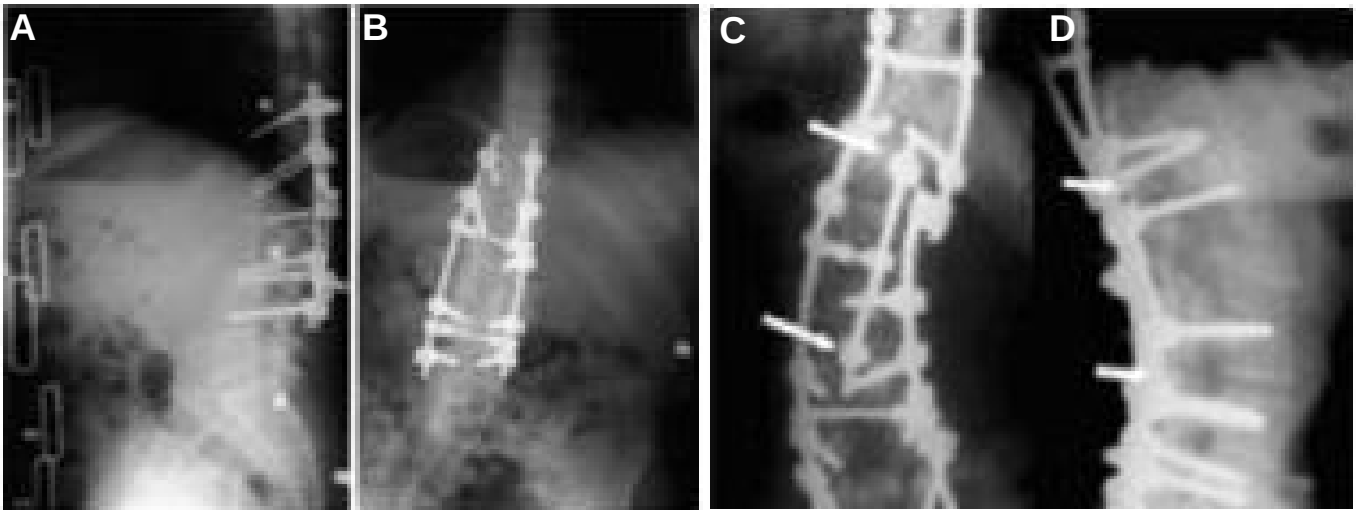

Fig. 17. Multi-level pedicular screw fixation in a patient with more than one-segment pathology. Screw misplacement and malalignment are seen in these views.

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Fig. 18. Arachnoiditis after L4 and L5 laminectomies in a 47-year-old patient. Sagittal T2-weighted MR image demonstrates an abnormal configuration of the lumbar nerve roots (arrow), a finding indicative of arachnoiditis.

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