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Caudal Vertebral Body Fractures Following Lateral Interbody Fusion in Nonosteoporotic Patients

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ABSTRACT

Background: The minimally invasive lateral transpsoas approach for lumbar fusions has become increasingly popular. However, vertebral body fractures have been reported after this procedure, particularly in patients with osteoporosis and patients undergoing multilevel fusions. We evaluated the risk factors for caudal vertebral body fractures in 2 nonosteoporotic patients with single-level disease.

Case Reports: Two patients presented with several years' history of incapacitating chronic low back pain and intermittent radicular pain. Diagnostic imaging in both cases demonstrated grade 1 degenerative spondylolisthesis. The patients underwent a lateral transpsoas interbody fusion, with lateral plate fixation in 1 patient and standalone lateral fusion in the other. The operations were performed without any incidents and both patients experienced immediate symptom relief. Both patients returned several weeks later with excruciating low back pain, without any postoperative history of trauma or heavy lifting. Diagnostic imaging in both patients showed a coronal fracture of the inferior vertebral body. The patients underwent urgent revision surgery involving posterior supplementation with pedicle screw and rod constructs and posterolateral fusion.

Conclusion: Caudal vertebral body fracture in patients with normal bone quality is a major potential complication after the minimally invasive lateral approach for lumbar fusions. Risk factors may include placement of a lateral plate, the size of the smaller anteroposterior cage, endplate violation, and oblique placement of the interbody cage.

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INTRODUCTION

Lateral interbody fusion is a minimally invasive technique involving retroperitoneal transpsoas access to the lumbar discs.[1] This technique has become increasingly popular because of its low complication rate and short hospitalization.[2,3] However, major complications such as vertebral body fractures have been reported in patients with osteoporosis[4] and patients undergoing multilevel lateral fusions.[5,6] We retrospectively evaluated 2 nonosteoporotic patients who underwent a single-level lateral fusion and subsequently suffered nontraumatic vertebral body fractures and analyzed the predisposing factors leading to this complication.

CASE REPORTS

Patient 1

A 56-year-old male former athlete with a body mass index (BMI) of 29.2 (height: 5 ft 9 in; weight: 260 lb) presented with intractable low back and predominantly left leg pain of more than 5 years' duration and refractory to maximal conservative treatment, including physical therapy, epidural steroid injections, and incapacitation. The patient did not meet the criteria for a dual-energy x-ray absorptiometry (DEXA) scan. His visual analog scale (VAS) score for low back pain was 10 on a 10-point scale and his Oswestry Disability Index (ODI) score was 72 on a 100-point scale. Imaging showed grade 1 L4-L5 degenerative spondylolisthesis (Figure 1) with central and foraminal stenosis. A lumbar discogram yielded a positive concordant response at this level and the postdiscogram computed tomography (CT) scan showed a Dallas-classification grade 5 disruption of the L4-L5 disc (Figure 2).

The decision to perform an L4-L5 fusion using the lateral approach was based on the patient's large body habitus[7] and the relatively preserved disc height. A 14 × 18 × 55 mm lordotic NuVasive cage (NuVasive, Inc.) filled with allograft was inserted in the

Figure 1. Lateral x-ray demonstrating grade 1 degenerative L4-L5 spondylolisthesis.

Figure 2. Postdiscogram computed tomography imaging demonstrating the Dallas-classification grade 5 L4-L5 disc disruption.

L4-L5 interspace and a NuVasive XLP plate supplemented the fixation (Figure 3). The total operative time was 60 minutes and no intraoperative complications occurred. Postoperatively, the patient experienced significant pain relief, was ambulatory within 2 hours, and was discharged the following day. Immediate postoperative x-rays confirmed the good placement of the instrumentation (Figure 4).

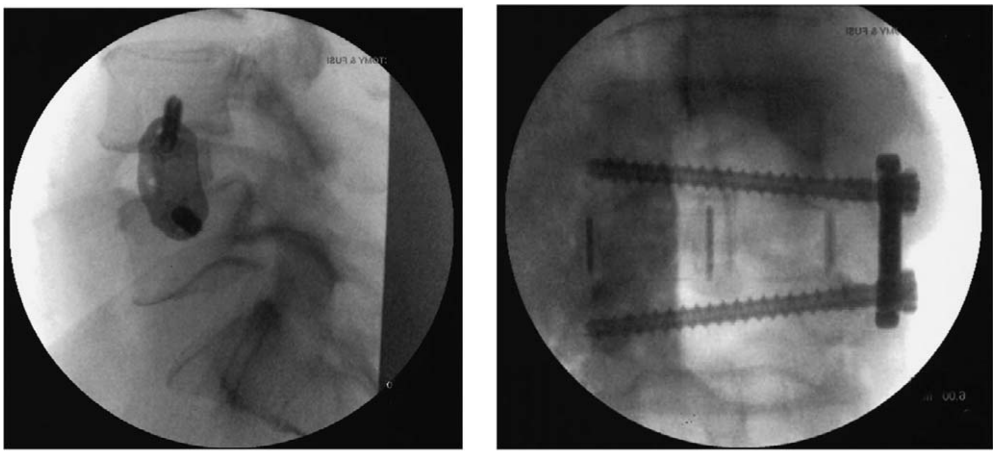
The patient returned to the emergency room 2 weeks after surgery. He described excruciating pain in his lower back with any attempt to sit or stand; the pain had started suddenly without any incidence of trauma or heavy lifting. Repeat x-rays showed the caudal screw had dislodged from the plate and migrated through the L5 vertebral body and partially into the opposite psoas muscle (Figure 5). A lumbar CT scan showed the coronal fracture of L5 through the caudal screw and collapse of the interbody cage into the L5 vertebral body (Figure 6).

The patient was taken urgently to the operating room and after removal of the lateral plate and screws underwent a posterior approach placement of pedicle screws in L4-L5 (the caudal part) and S1 (Figure 7) and extensive grafting of the facet joints and intertransverse processes (ie, a posterolateral fusion). The pain level decreased postoperatively and the patient was discharged with home physical therapy.

At 4 months postoperatively, the patient developed a deep wound infection with *Acinetobacter baumannii, Enterobacter*, and *Enterococcus faecium D* (Figure 8). He underwent reexploration of the posterior wound, removal of titanium hardware, washout, and placement of a vacuum-assisted closure**.** Fortunately, the L4-L5 level was already fused posteriorly (Figure 9). After a long course of intravenous antibiotic therapy, the infection was controlled and the pain decreased to tolerable levels. At 18-month follow-up, the patient was able to perform all his daily activities with no signs of ongoing infection and no neurological deficits. At the patient's last follow-up visit, his VAS score for low back pain was 5 and his ODI score was 56.

Patient 2

A 78-year-old man with a BMI of 21.9 (height: 5 ft 11 in; weight: 205 lb) and a DEXA scan T-score of –1.0 presented with intractable chronic low back and right leg pain that rendered him incapacitated. His VAS score was 10 and his ODI score was 78. The neurologic examination detected a slight weakness (4 on the 5-point American Spinal Injury Association muscle grading test) in the left quadriceps muscle through a knee extension test. Imaging showed advanced degeneration at the lower 3 lumbar levels, the worst being a grade 1 L3-L4 degenerative spondylolisthesis with severe disc collapse and central and foraminal stenosis.



A. B.

Figure 3. Lateral (A) and anteroposterior (B) intraoperative x-rays of the L4-L5 extreme lateral interbody fusion construct supplemented with a lateral plate.

The decision to perform a standalone lateral fusion only at the L3-L4 level aimed to minimize operative time and morbidity in this elderly patient while still providing symptomatic relief. A $12 \times 22 \times 55$ mm NuVasive cage filled with allograft was placed in the L3-L4 interspace, with a total operative time of 45 minutes (Figure 10). Postoperatively, the patient experienced good pain relief, was ambulatory the next morning, and was discharged the second day after surgery. Postoperative x-rays showed a slightly oblique position of the cage in the L3-L4 interspace but good increase of the disc height and indirect foraminal decompression (Figure 11).

The patient returned to the emergency room 3 weeks after surgery, complaining of severe back pain increased by any sudden motion; the pain started one

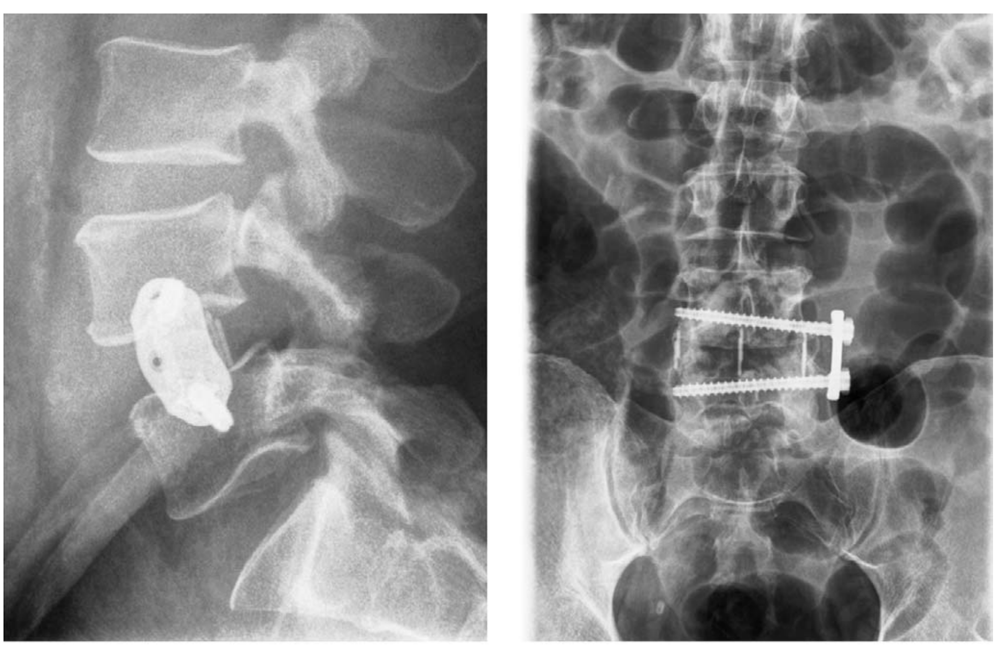


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Figure 4. Lateral (A) and anteroposterior (B) postoperative x-rays confirming the good placement of the instrumentation.

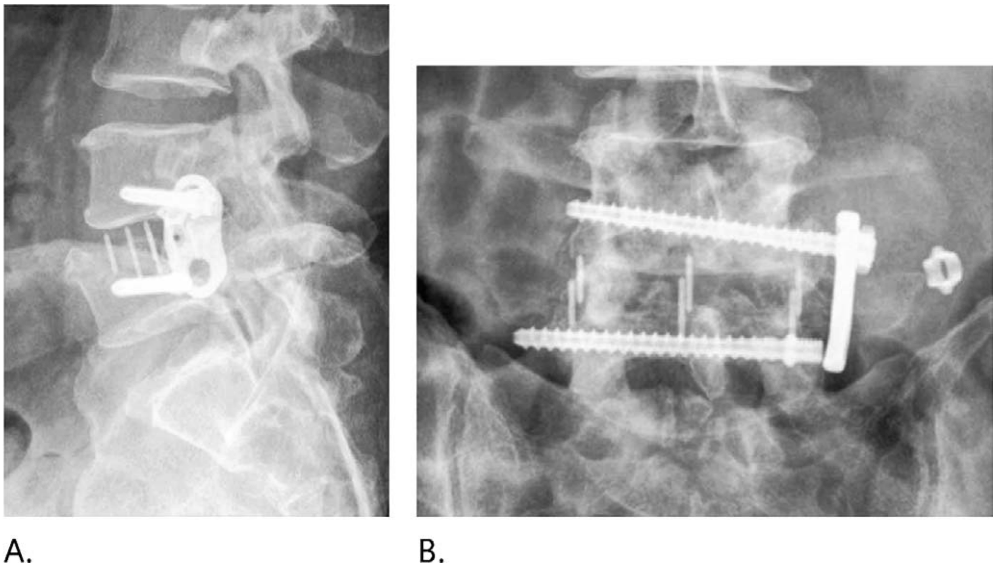

Figure 5. Lateral (A) and anteroposterior (B) x-rays at 2 weeks postoperatively showing the caudal screw dislodged from the plate and migrated through the L5 vertebral body and partially into the opposite psoas muscle.

day when he attempted to get up from a rocking chair. A lumbar CT scan showed an L4 coronal fracture extending down from the edge of the collapsed interbody cage (Figure 12). The disc height and foramina had reverted to their preoperative size.

The patient was taken urgently to the operating room and underwent a posterior approach bilateral L3-L4 foraminotomy, followed by L3-L4 instrumented posterolateral fusion (Figure 13). The pain level decreased gradually over the next few months. At his 1-year follow-up visit, the patient's VAS score was 3 and ODI score was 20.

DISCUSSION

This report describes 2 cases of caudal vertebral body fractures after single-level lateral interbody

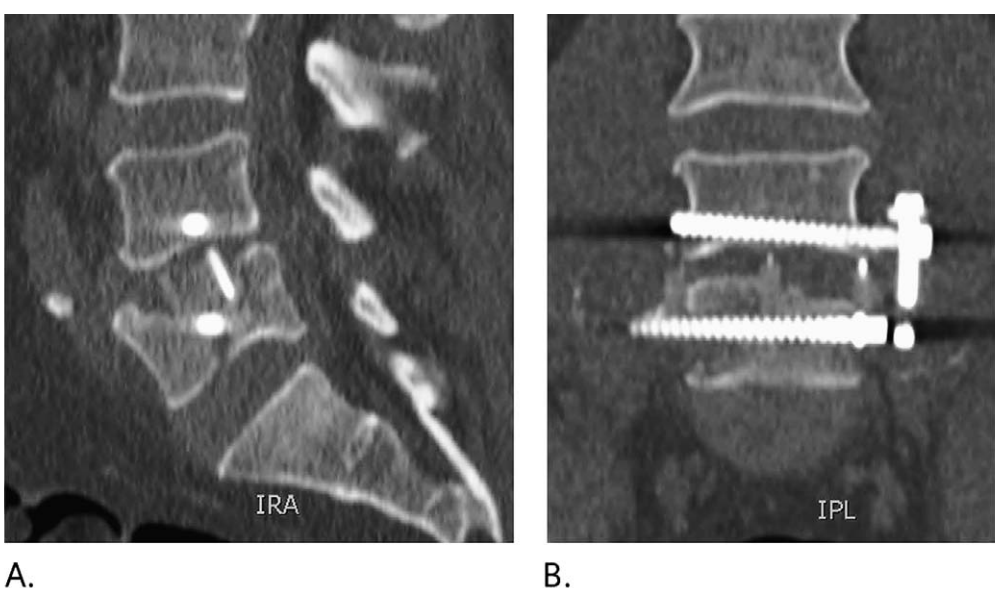

Figure 6. Sagittal (A) and coronal (B) computed tomography imaging at 2 weeks postoperatively confirming the coronal fracture of L5 through the caudal screw and collapse of the interbody cage into the L5 vertebral body.

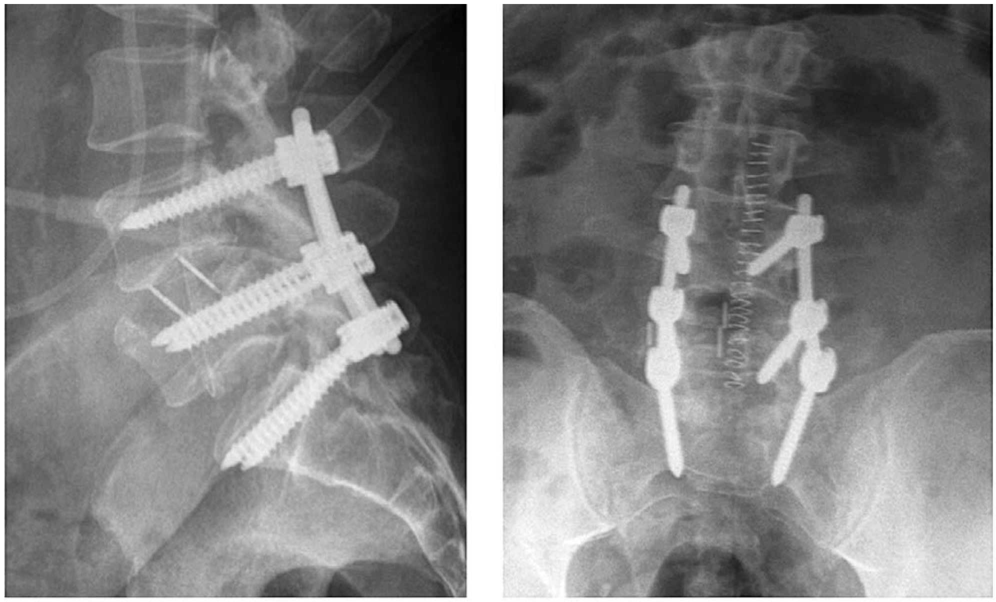

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Figure 7. Lateral (A) and anteroposterior (B) x-rays after the first revision surgery showing the posterior construct with pedicle screws in L4-L5 (the caudal part) and S1.

fusion procedures in nonosteoporotic patients. We analyzed the possible factors playing a role in these dramatic complications.

In the first patient, the placement of the interbody cage was perfectly parallel to the endplates and the screws for the lateral plate were close to the adjacent endplates, as recommended. However, several possible explanations exist for the caudal vertebral body fracture.

First, the presence of the plate and inferior screw likely played a major role. The fracture line extended through the screw trajectory, and the screw itself migrated laterally towards the opposite psoas. Several authors have described vertebral body fractures in association with lateral plating,[4-7] particularly in multilevel fusions, and biomechanical studies suggest that the lateral plate and cage constructs have a high range of motion in the sagittal plane.[8] One proposed mechanism of failure suggests the screw altered the subchondral trabecular support, thus setting the stage for the collapse of the cage through the vertebral body during flexion.

The second potential contributing factor was the anteroposterior (AP) size of the cage. Because $P=F/A$**,** where $P=$pressure (the pressure on the caudal vertebral body at the cage-endplate interface), $F=$force (the upper body weight), and $A=$area (the cage-endplate contact surface), obviously the smaller the AP size of the cage (and thus its area), the higher the pressure exerted on the caudal vertebral body.

Figure 8. Sagittal T1-weighted postcontrast magnetic resonance imaging demonstrating the deep wound infection.

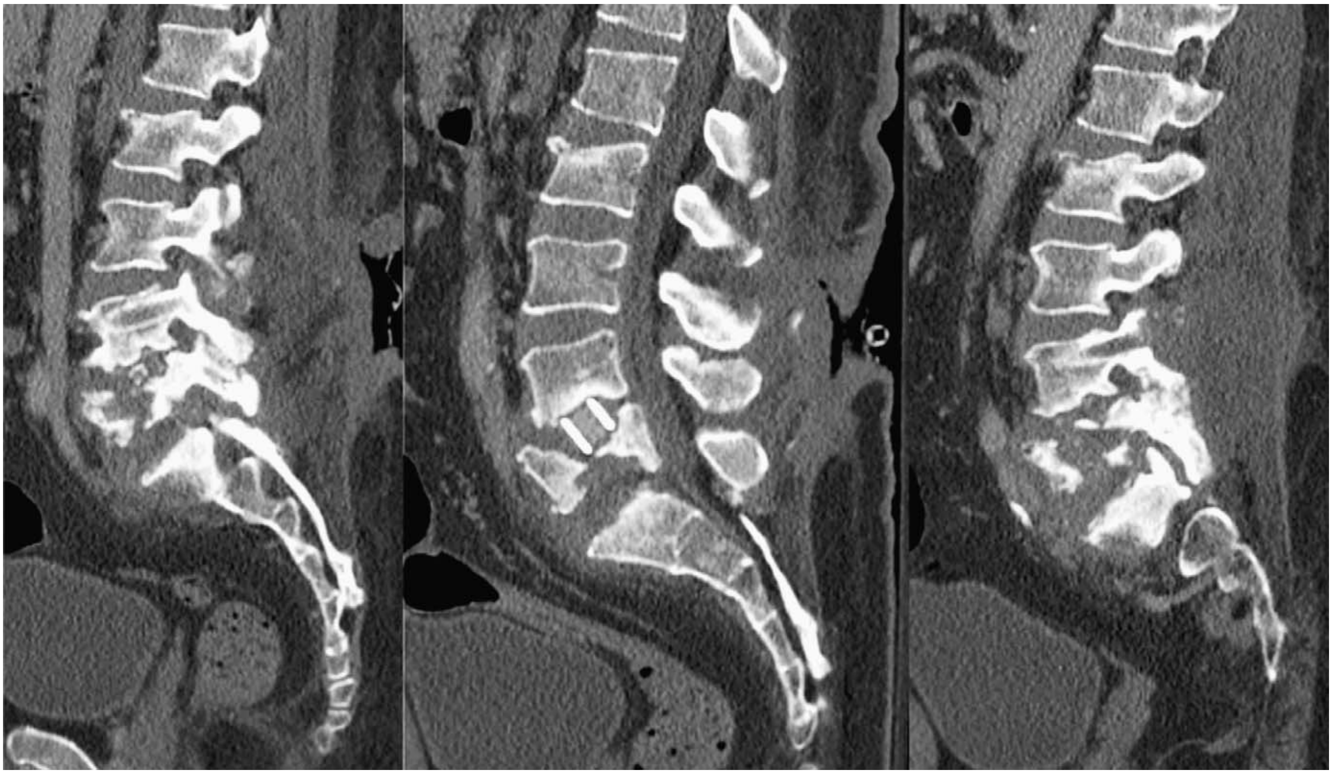

Figure 9. Sagittal computed tomography imaging after removal of the instrumentation showing bone bridging between the inferior L4 and superior L5 facet.

Figure 10. Lateral intraoperative x-ray showing the placement of the standalone interbody cage in the L3-L4 interspace. The disc space height was restored and the foramina decompressed.

We used an 18-mm cage in this patient; if we had used a 22-mm or even a 26-mm cage, the lower pressure on the L5 vertebral body possibly would not have caused a fracture.

The length of the cage also might have played a role. Many spine surgeons advocate the use of long cages that engage the outer cortical ring and thus rest on the strongest part of the vertebral endplate. However, this positioning also means that if the pressure exerted by the cage is sufficiently high, the entire vertebral body will fracture. Conversely, under the same pressure, a shorter cage might just subside into the endplate without causing a fracture. A recent study showed an inverse correlation between the AP size but not the length of the cage and the rate of subsidence.[9]

Finally, the bone quality of this patient could have been poor, despite his relatively young age and lack of comorbidities.

In the second patient, we used a 22-mm cage, but it was inserted at a slightly oblique angle and not supplemented with posterior pedicle screws. The usage of standalone lateral cages in patients with low-grade spondylolisthesis has been previously described[10,11] and we have also experienced success with this type of approach.

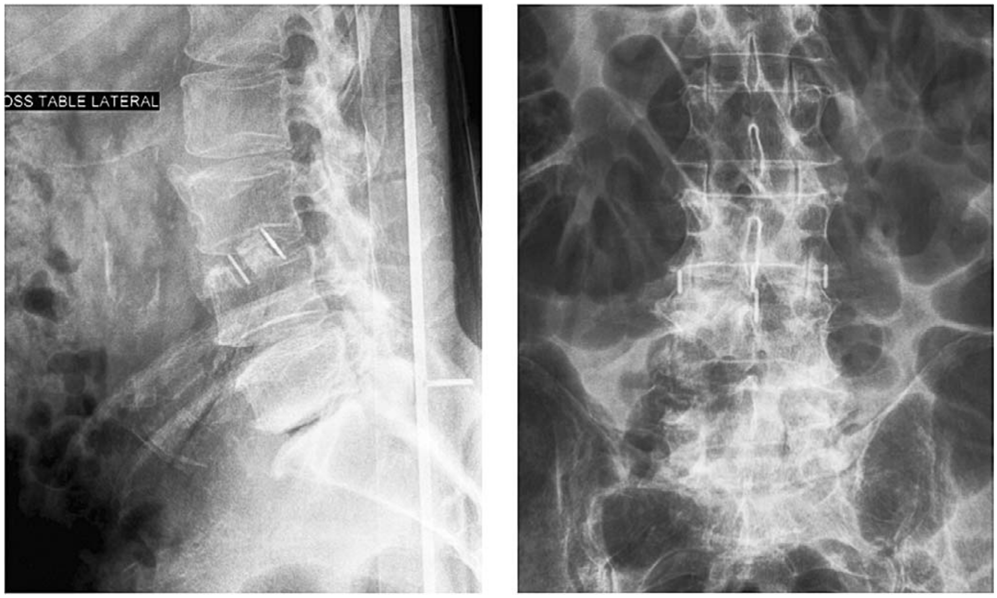

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Figure 11. Lateral (A) and anteroposterior (B) postoperative x-rays showing the slightly oblique position of the cage in the L3-L4 interspace with indentation of the L4 endplate.

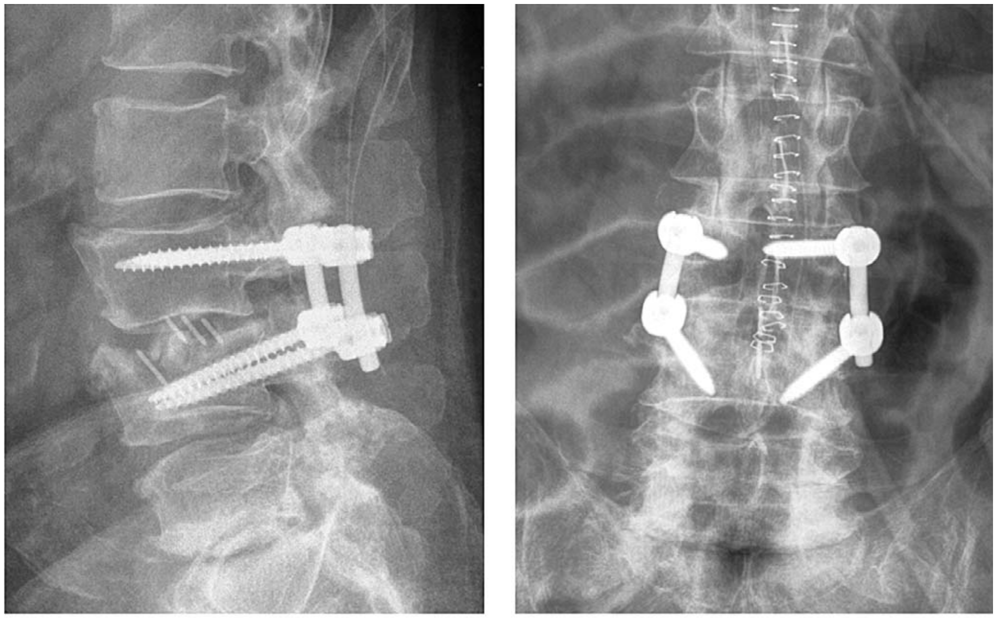
The main contributing factor to the failure, besides the patient's borderline bone quality as measured by the DEXA scan, was probably the oblique position of the cage. As previously described, the pressure exerted by the cage on the vertebral body directly depends on the surface area of contact between the cage and the endplate. Despite the larger AP footprint of the cage used in this case (22 mm), its oblique position only allowed for direct contact with the endplate over the narrow anterior edge of the cage. The increased pressure transmitted through this thin surface explains the anatomy of this coronal fracture, in direct extension with the leading edge of the implant that acted as a guillotine.

Figure 12. Sagittal computed tomography imaging at 3 weeks postoperatively showing the L4 coronal fracture extending down from the edge of the collapsed interbody cage. The disc collapsed to its preoperative height.

Another possible contributing factor was the height of the cage. We inserted a cage 22 mm high into a disc space that was previously measured at a maximum height of 8 mm. Inserting this oversized cage might have led to endplate violation and the oblique position of the implant in the interspace. Moreover, overdistraction of any interspace may induce subsidence (or possible fracture) because of the increased pressure resulting from stretching of the annulus fibrosus (even after the release of the contralateral annulus).

CONCLUSION

Caudal vertebral body fractures after lateral transpsoas interbody fusion are a major complication that can occur even in single-level fusions of nonosteoporotic patients. Besides bone quality, factors that may play a role in the fractures' pathogenesis include the placement of a lateral plate, the AP size and length of the cage, the position of the cage in the interspace, and the integrity of the vertebral endplates.



A. B.

Figure 13. Lateral (A) and anteroposterior (B) x-rays after the revision surgery showing the posterior construct with pedicle screws in L4-L5 and bilateral foraminotomy.

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