

## Bilateral L3 and L4 pedicle traumatic fracture a case report

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### Abstract

**Background:** Traumatic bilateral pedicle fractures of the lumbar spine are rare. Some pedicle stress fracture cases have been described previously; most of them associated to spinal procedures having had different stabilization or fusion techniques, osteoporosis, secondary to unilateral spondylolysis or due to certain athletic activities. In these types of fractures, fatigue fractures which occur in normal bone that is subjected to repetitive abnormal stress or insufficiency fractures which are due to normal stress on a structurally defective bone are mostly observed. Traumatic cases with L5 pedicles fracture have been previously described but these are commonly associated with facet injury and severe spondylolisthesis.

**Case Description:** We present a case of a previously healthy young male who suffered a bilateral pedicle fracture of L3 and L4 without articular process injury nor displacement and no neurological deficit after a severe all-terrain vehicle accident. Surgical treatment allows a good fracture consolidation and offers the option to maintain segmental mobility.

**Conclusion:** Isolated acute traumatic bilateral pedicle fractures are rare. When they occur, it is important to look for other associated injured structures. Alignment, stability and neurological status are fundamental conditions to decide on treatment options. Surgery is essential when these criteria cannot be preserved either during an acute or a chronic phase. Motion preservation procedures should be considered under selected conditions.

**Keywords:** Pedicle; fracture; bilateral; lumbar; trauma.

### Introduction

Isolated traumatic bilateral pedicle fractures of the lumbar spine are rare. Some pedicle stress fractures cases have been widely described; most of them associated with previous spine surgery having undergone diverse stabilization or fusion techniques. They may also be considered associated with osteoporosis and its treatment, secondary to unilateral spondylolysis or due to certain athletic activities [1-8]. Some traumatic cases with L5 pedicle fracture have been previously described but these are commonly associated with facet injury and severe spondylolisthesis [9, 10]. We are presenting a singular case of traumatic bilateral pedicle fracture of L3 and L4 with no neurological deficit that was treated satisfactorily emphasizing on surgical conditions and suitable options.

### Case Presentation

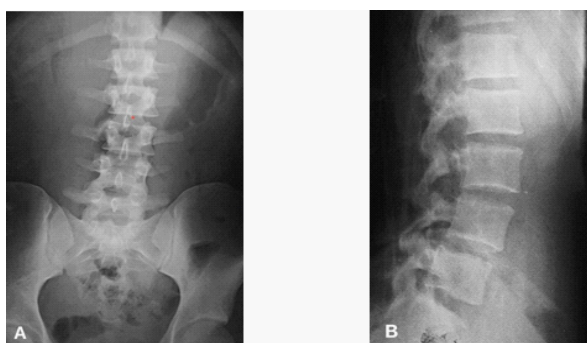
This 24-year-old male was riding his four-wheel motorcycle on the beach at a moderate speed. At the time of a frontal impact against a sand dune he was ejected forward. As described by his relatives, he fell in an extension and flexion position rolling over his torso severely. As no neurological deficit was detected

immediately, he stood up and continued walking until he experienced a severe middle lumbar spine pain and muscle stiffness associated with bilateral leg numbness. Physical examination upon arrival confirmed severe lumbar muscle stiffness, local pain and superficial ecchymosis in the lumbar region but without neurological alterations.

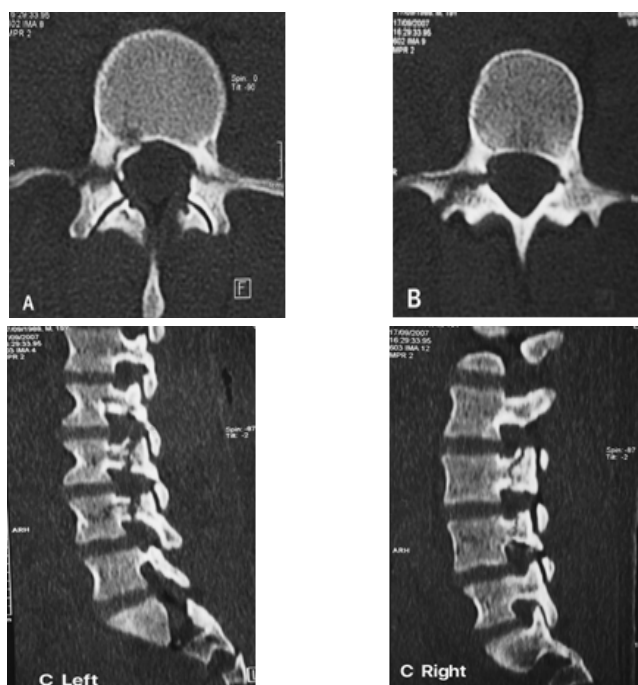
Plain radiographs showed bilateral pedicle and right transverse process fracture of L3, a left L4 pedicle fracture and a trace of fracture at the base of the spinous process of L2. A Lateral image, despite an inadequate technique, confirms a non-displaced L3 pedicle fracture (**Figure 1**). Computed tomographic (CT) scan confirms bilateral pedicle fracture traces of L3 and L4 with lateral extension through the transverse process but without displacement of the vertebral bodies (**Figure 2**). MR images show severe muscle and articular capsule swelling but also preservation of the spinal canal diameter as well as disc characteristics at L3-L4 and L4-L5 (**Figure 3**)

Because the traumatic disruptions of posterior and middle elements of L2, L3 and L4 were considered important enough to preserve segmental stability, the patient was scheduled to be

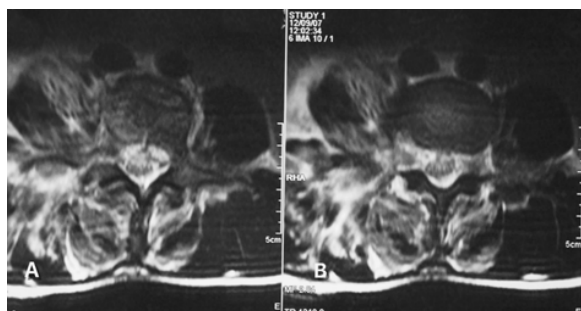
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**Figure 1:** A) Antero-posterior projection in conventional X-ray films show bilateral pedicle and right transverse process fracture of L3, a left L4 pedicle fracture and a trace of fracture at the base of the spinous process of L2 (Red Asterix). B) Lateral image, despite an inadequate technique, confirms a non-displaced L3 pedicle fracture.

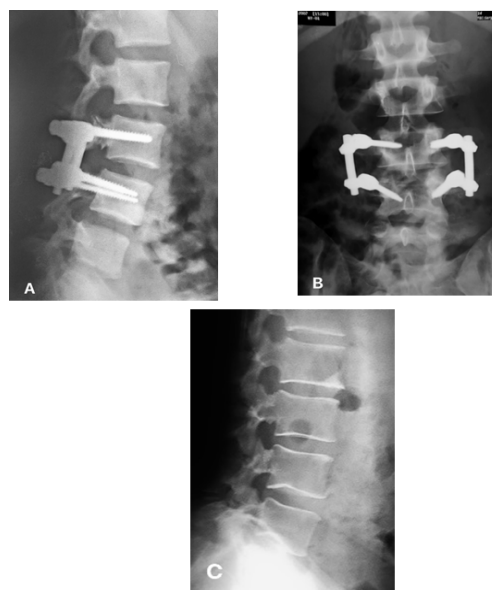


**Figure 2:** A) Axial computed tomography scan shows bilateral L3 pedicle fracture and right proximal transverse process fracture. B) L4 axial CT-scan confirms a right pedicle fracture with partial extension to the transverse process, the articular complex seems to remain in place. C) Left and right parasagittal reconstructions showing bilateral L3 and L4 pedicle fracture traces with wide gaps.



**Figure 3:** MR Images T2-W sequences show severe bilateral multifidus muscle, right iliocostal and psoas muscles swelling. A) Right L3 pedicle and transverse processes are fractured and articular swelling is evident at both levels. B) Preservation of the spinal canal diameter as well as disc characteristics at L3-L4 and L4-L5 and articular swelling are evident at both levels.

surgically stabilized with pedicle screws and rods at L3 and L4 without fusion. Once the patient was in a slight lordotic prone position thus promoting the fractured pedicles to be in contact, which was confirmed under fluoroscopic control, we proceeded with two symmetrical one-inch paravertebral skin incisions. The lumbar fascia was opened and simple longitudinal muscle blunt dissection allowed us to place a couple of lumbar Caspar distractors. We confirmed that the base of the spinous process of L2 was fractured but not displaced, the articular processes and the capsules of L3 and L4 were preserved, although the surrounding ligaments were severely damaged. Under fluoroscopic guidance and by using a high-speed drill, we were able to cannulate L3 pedicles without anterior displacement of the vertebral body. A couple of simultaneous 4.5 mm taps were placed allowing an appropriate contact of the bony fractured edges. By holding one of the taps with a slight traction, a contralateral 6.5 x 45 mm pedicle screw was satisfactory installed without losing a solid bony purchase through the pedicle maintaining the fracture edges in place. After removing the traction tap, the second pedicle screw was able to be safely installed. The procedure was repeated at the adjacent vertebra. Then two 50 mm length rods were descended and blocked without distraction in order to avoid any pedicle tension. Conventional muscle hemostasis and wound suture were performed in both incisions. There were no complications during post-operative evolution and the patient was discharged 48 hours later wearing a soft brace. Postoperative X-ray films revealed adequate placement of the screws with complete closure of the fracture gaps. Fourteen months after the accident and with a previous confirmation of a solid fusion of the pedicles, the stabilization hardware was removed successfully allowing the preservation of the segmental mobility (Figure 4).



**Figure 4:** Postoperative plain radiographs. A) Lateral film shows correct position of the pedicle screws in both levels with acceptable closeness of the fractured edges. B) A-P projection confirms adequate alignment of the L3-L4 segment, the fracture of L2 spinous process at the base remains in place. C) Lateral X-ray film, fourteen months after the accident, the removal of the hardware allowed anatomical functionality of the segment.

## Discussion

When traumatic lumbar fractures occur, they are usually associated to severe and violent physiopathological mechanisms. According to Denis [11], shear injuries can be divided into two types: posteroanterior and anteroposterior. Anteroposterior forces are induced by hyperextension forces, resulting in fractures of the posterior column and pedicles conditioning a free-floating neural arch. Due to the complexity of these injuries, it is risky to propose a sole mechanism for the various thoraco-lumbar fractures. It seems likely that the injury in our case resulted from a violent combination of flexion and anteroposterior mechanism with a split phenomenon of the posterior arch away from their vertebral bodies and fracture of a spinous process of the adjacent level. In this case, and as it was previously emphasized by other authors, it is suitable to consider that lumbar muscles, intrinsic ligament characteristics and disc preservation played an important role in preventing subsequent vertebral displacement [9, 12]. Previous occasional cases with incomplete or intact neurologic function could be explained by spontaneous decompressive mechanisms associated with multiple pedicle fractures allowing the posterior elements to float in continuity [13, 14, 15].

Reviewing the proposed classification by Kaufer and Hayes in 1966 [9] and re-adopted by Ver et al. in 2019 [12], our patient's injury can be situated as a Type 5 fracture of the lumbar neural arch, in which the line of disruption consists of bilateral fracture through either the pedicles or the pars interarticularis. The integrity of muscle and spinal ligament complex is crucial during thoraco-lumbar injuries, and their condition should always be determined by means of C-T scan and MRI. Even though there was no imminent displacement, the development of a double fracture with these characteristics made us doubt that implementation of simple conservative treatment with just an external immobilization may not be the best option. During surgery, this situation could be confirmed because an excessive displacement of the vertebral body was noticed while progressive pedicle drilling was performed.

Conservative treatment based on pain medication, external orthosis and sometimes epidural or trigger points injections is initially recommended for spontaneous bilateral pedicle and selective acute traumatic cases. The length of this management is not standardized and depends on clinical manifestations and radiological surveillance. According to Kögl [4], in cases of nondisplaced pedicle fractures and in the absence of neurological deficits, conservative treatment has been advocated because pedicle fractures tend to heal spontaneously with external bracing. However, this practice is associated with long-term immobilization and the risk of pseudarthrosis should be considered. Under these circumstances, the potential development of late instability or spondylolisthesis would lead to progressive disc degeneration [4, 10]. Surgery for these lesions must be proposed when an inadequate solution to the fracture is evident either by the development of spondylolisthesis, pseudoarthrosis, progressive secondary disc degeneration or if pain control mechanisms fail.

In cases where bilateral pedicle fractures at L2 and L3 are present, they may present a unique problem in terms of operative planning. The relative rarity of these injuries has led to a paucity of literature regarding surgical recommendations.

Most authors tend to treat this type of trauma by surgery, which can be performed by anterior, posterior or combining both approaches depending on neurological status, stability and patient's systemic condition [15]. It is essential to restore normal lumbar alignment, decompress neural structures and stabilize the lumbar spine. For this purpose, open reduction and rigid fixation are usually recommended [15]. Interbody fusion with its different variants complemented by posterior stabilization can actually be the optimal choice in cases where spondylolisthesis is present [17].

On the contrary, in exceptional cases when alignment is maintained associated with appropriate structural conditions, treatment options that are confined to preserve mobility of the affected segment are the best choice. Han et al [18] proposed a motion-preserving surgical option for nontraumatic, nondisplaced bilateral pedicle fractures at a single lumbar level. They inserted bilateral pedicle screws at L5 to reduce the fractured fragments, and by resecting the lower aspect of L5 spinous process, a rod is placed across the lamina connecting it to the screws. With this the need to fuse the adjacent levels was avoided. Recently Kögl et al [4], described technically an option to reduce and stabilize a bilateral L5 pedicle fracture. Combining the use of a navigation system and intraoperative fluoroscopy to confirm reduction of the fracture and detect fragment dislocation, they performed a percutaneous minimally invasive CT-guided off-label pedicle instrumentation without interbody fusion and inserted a couple of 7.3 mm traction screws to bring the fracture edges closer together with satisfactory fusion results.

Motion preservation procedures may be proposed in cases where an adequate reduction of the pedicle fractures is obtained, when the disc characteristics are maintained and in the presence of acceptable muscle-ligament complex condition. All of these circumstances were present in our case, so the decision to use pedicle screws and rods without intervertebral fusion will allow an appropriate restoration of the pedicles and subsequent stabilization of the double fracture. After optimal conditions of the segment are considered, withdrawal of the system will promote the motion properties in both segments. Contrary to Kögl's procedure [4], although it is a very good surgical option, we considered that it would have been very risky to try this on our patient without taking the rest of the associated radiological findings into account.

It is important to emphasize that aggressive management with early surgical intervention allows prompt mobilization and more rapid rehabilitation. The high-energy nature of these injuries also warrants a thorough evaluation for other bony or soft-tissue injuries. With proper stabilization of the spine, many patients regain a reasonable degree of their neurological function and muscle strength. Chronic issues, such as pain, are susceptible to be managed adequately in a conservative manner [19].

## Conclusions

Isolated acute traumatic bilateral pedicle fractures are rare and when they occur it is important to look for other associated injured structures. Preservation of alignment, stability and neurological status are fundamental conditions to decide on treatment options. Surgery is essential when there is evidence

of failure to meet any of these criteria either during an acute or a chronic phase. In selected cases, motion preservation procedures are excellent options under adequate conditions.

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