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Case Report

# Chance fracture: A case report and review of the literature ☆

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ABSTRACT

A Chance fracture, also known as a "seatbelt fracture," is "an unstable spinal injury that usually occurs at the thoracolumbar junction. Complications of a Chance fracture include spinal cord injury, neurological deficits, and long-term functional impairment if not promptly identified and treated. In this case report, we present the case of a 13-year-old patient who sustained a Chance fracture following a 30-foot vertical fall, an atypical mechanism of injury. Imaging revealed a vertebral body fracture with a horizontal break through the posterior elements and accompanying ligamentous tears. Management included surgical stabilization via pedicle screw fixation and laminectomy. This case highlights the importance of considering axial loading mechanisms in pediatric trauma patients and the role of timely surgical intervention in preventing long-term complications.



## Introduction

A Chance fracture, also known as a "seatbelt fracture," is an unstable spinal injury that typically occurs at the thoracolumbar junction (T12-L2), accounting for approximately 2% of all spinal fractures in pediatric populations. These fractures are associated with a flexion-distraction mechanism, often seen in high-energy trauma like motor vehicle collisions, where a lap belt restrains the lower body while the upper body is forced forward, generating a distraction force along the spine [1]. This results in a horizontal fracture line extending from the posterior to the anterior aspect, through the spinous process, pedicles, and vertebral body [2–7].

Although rare in children, Chance fractures are clinically significant due to their association with other serious injuries, particularly intra-abdominal injuries. In pediatric patients, there is a 63% incidence of intra-abdominal injuries, with hollow viscus injuries being the most common, occurring in 51.3% of cases [2,3]. Neurological complications, including

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spinal cord injuries and long-term functional impairments, are also concerning. Approximately 43% of pediatric patients with Chance fractures present with neurological deficits, with a significant proportion not fully recovering. These complications can result in long-term functional impairments, particularly if spinal cord compression or disruption occurs [2,3,8].

Chance fractures resulting from axial loading injuries, such as a vertical fall, are even more uncommon. This case report presents a 13-year-old male with polytrauma, including a Chance fracture at the L1 vertebra, following a 30-foot vertical fall, highlighting the rarity and clinical importance of this injury mechanism.

## Case report

This is a case of a 13-year-old male with no significant past medical history who presented to the emergency department after a 30-foot vertical fall from a second-story window in a reported suicide attempt. Emergency Medical Services (EMS) reported loss of consciousness at the scene. Upon arrival, the patient had a Glasgow Coma Scale (GCS) of 15 and was hemodynamically stable.

The mechanism of injury—a high-impact vertical fall—suggests an axial loading force, which is typically associated with burst or compression fractures. However, biomechanical studies have shown that Chance fractures can also occur in such falls. Peak compressive forces occurring within milliseconds of impact can weaken vertebral structures, followed by flexion-distraction forces that result in a Chance fracture [9]. This explains the development of a Chance fracture in this patient, despite the atypical mechanism of a vertical fall. On physical examination, a large hematoma with overlying abrasion was noted in the mid-thoracic to lumbar region. Further imaging revealed a right calcaneal fracture-dislocation, which was addressed with a bedside closed reduction. The remainder of the secondary survey was significant for tenderness and step-offs over the thoracic spine, but the patient exhibited no neurological deficits. He was motor and sensory intact, able to move his toes, with no signs of saddle anesthesia or sensory deficits. There were no signs of spinal cord injury on examination.

A CT of the lumbar spine was performed which revealed a Chance fracture at L1 causing focal kyphosis and retropulsion into the spinal canal resulting in canal stenosis (Fig. 1). A MRI was subsequently performed revealing a compression deformity of the L1 vertebral body with approximately 20% loss of height and distraction of the T12-L1 spinous processes with tears of the supraspinatus ligament, flaval ligament and interspinous ligament. (Fig. 2) Also noted were retropulsion of the posterior superior endplate of L1 and an acute posterior epidural hematoma at L1-L2 causing spinal cord compression (Fig. 3). In addition, there was an anterior acute epidural hematoma from the level of L2-S1 resulting in moderate to severe canal stenosis at L2 and L3 (Fig. 3). This fracture was an unusual finding given the patient's mechanism of injury, which was a vertical fall rather than the typical flexion-distraction mechanism typically seen in Chance fractures.

Given the unstable nature of the Chance fracture, neurosurgery was consulted. The patient underwent T11-L3 pedicle screw fixation and a T12-L1 laminectomy to reduce the kyphotic deformity and stabilize the spinal column. The patient tolerated the surgery well, with no postoperative neurological deficits. He remained motor and sensory intact with no signs of saddle anesthesia or further complications. At follow-up, the patient demonstrated no new neurological symptoms, and he experienced no major postoperative complications.

## Discussion

Chance fractures are relatively uncommon in the pediatric population, accounting for only 2% of all spinal fractures in children [1]. Despite their low incidence, these fractures are clinically significant due to their strong association with intra-abdominal injuries. Pediatric patients with Chance fractures have a 63% incidence of intra-abdominal injuries, with hollow viscus injuries occurring in 51.3% of cases This is notably higher compared to adults, who experience a 23% incidence of intra-abdominal injuries in similar situations [10]. In addition to intra-abdominal injuries, Chance fractures are often associated with neurological complications, including spinal cord injury or nerve damage. While less common than visceral injuries, these complications can result in long-term functional impairments, particularly if there is compression or disruption of the spinal cord [3]. Early identification and management of both intra-abdominal and neurological injuries are crucial in preventing adverse outcomes [2,3,11].

### *Biomechanical considerations*

In this case report, the unique presentation of a Chance fracture following a 30-foot vertical fall emphasizes an atypical mechanism of injury for this fracture pattern. Typically, Chance fractures are associated with a flexion-distraction force, often seen in restrained passengers during motor vehicle accidents. The injury usually occurs when the seatbelt acts as a fulcrum, allowing for hyperflexion-extension trauma, causing a horizontal fracture often accompanied by rupture of ligamentous spinal elements.

However, biomechanical studies have demonstrated that similar fractures can occur from high-energy axial loading forces, such as those seen in falls from height. In an in vitro biomechanical model, researchers observed that Chance-type fractures developed after initial peak compressive forces, followed by flexion-distraction forces acting on already weakened vertebral structures. These compressive forces can reach up to 40.3 kilonewtons (kN), and within milliseconds of impact, they can lead to burst or compression fractures, with peak flexion forces immediately following, resulting in the development of Chance-type fractures [9].

This case, involving a 30-foot vertical fall, highlights how axial loading forces can also cause a Chance fracture. The high-energy impact from the fall generated compressive forces that weakened the vertebral body, followed by flexion-distraction forces as the body continued to move, creating the typical horizontal fracture line. The rarity of this mechanism


**Fig. 1 – (A) Sagittal CT of the lumbar spine in bone window demonstrates a compression deformity of the L1 vertebral body (blue arrow) and retropulsion of the posterior superior endplate resulting in spinal canal stenosis. In addition, a mild anterior wedge compression fracture of the T12 vertebral body, a small fracture fragment along the anterior superior corner of the L4 vertebral body (green arrow), and an off-midline sagittal CT demonstrating a fracture line through the pedicles (red arrow) were noted. (B) Axial CT at L1 demonstrates comminuted fracture lines(arrows) extending to the pedicles.**

in children makes this case noteworthy and highlights the importance of considering Chance fractures in a broader range of trauma settings.

In comparison to the case reported by Bourghli et al., where a 16-year-old sustained a Chance fracture following a 2-meter fall, the current case involves a significantly greater height and energy, as the patient fell from 30 feet [12]. This likely contributed to the more severe polytrauma seen in this case. Similarly, the case by Sander et al. involved a 3-year-old child who fell from a fourth-floor balcony [13]. However, unlike the present case involving an L1 fracture, the Sander case resulted in a T2-T3 Chance fracture. Although all 3 cases involved high-energy trauma leading to Chance fractures, the mechanisms of injury—particularly the vertical fall in this case—underscore its uniqueness and the need to consider such fractures beyond the more typical motor vehicle accidents.

While neurological deficits are a significant concern with Chance fractures, spinal deformities, particularly kyphotic deformities, are another potential complication. Nonoperative treatment can result in a higher degree of residual kyphosis compared to surgical intervention. In the same study, nonoperative patients had a mean post-treatment kyphotic deformity of 20 degrees, whereas surgically treated patients had a mean of 3.5 degrees. This suggests that surgical stabilization may be more effective in preventing progressive spinal deformity [3].

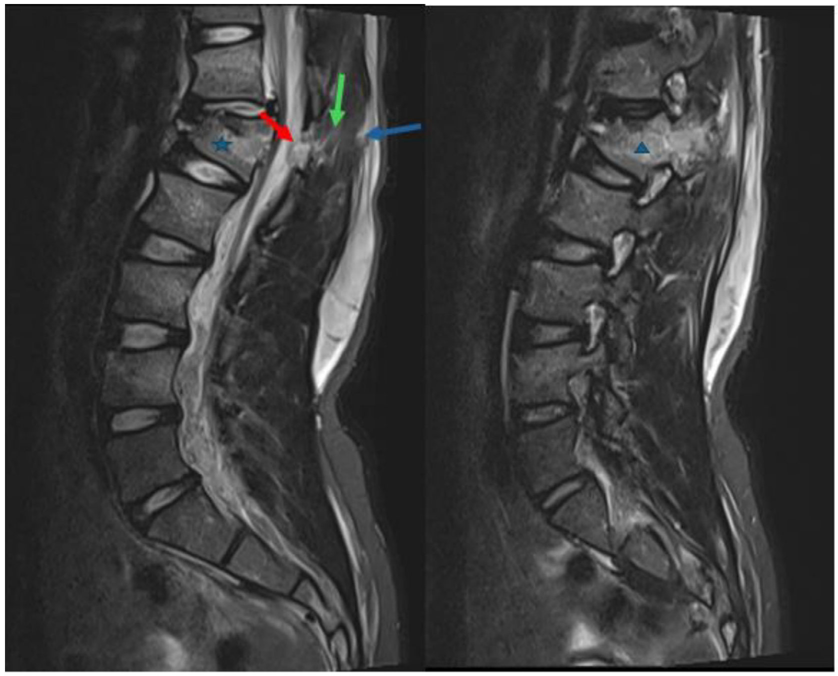

**Fig. 2 – Sagittal MRI of the lumbar spine STIR sequence demonstrates a fracture of the L1 vertebral body with approximately 20% loss of height (star) and associated edema extending to involve the pedicles (triangle). Distraction of the T12-L1 spinous processes with tears of the supraspinous ligament (blue arrow), flaval ligament (red arrow), and interspinous ligament (green arrow) were noted. Subcutaneous hemorrhage along the back is also noted.**

Chronic pain is also a notable long-term complication. In a retrospective review, patients with delayed diagnosis of Chance fractures often presented with chronic back pain. Additionally, functional outcome scores indicated that patients with Chance fractures scored poorly on pain and disability components, highlighting the chronic nature of pain associated with these injuries [8,14].

### *Imaging*

Imaging plays a central role in diagnosing and managing Chance fractures. Initially, plain radiographs are used as the first-line imaging modality, revealing key features such as a horizontal fracture through the posterior elements or distraction of facet joints and spinous processes. Specific signs on plain radiographs include the “empty vertebral body sign,” which results from the vertical separation of the posterior elements displacing the spinous processes or spinous process fracture fragments. Other signs are transverse fractures across the transverse processes, laminae, and articular processes, widening of the interpedicular distance—suggesting a burst component, widening of the facet joints, increased intercostal spacing, and widening of the interspinous distance. However, plain radiographs may miss soft tissue or ligamentous damage. CT is the gold standard for confirming Chance fractures, offering a detailed view of the vertebral column, fracture lines, and any retropulsion of bony fragments into the spinal canal, indicating instability. CT also helps evaluate vertebral collapse and associated injuries. MRI is essential for detecting soft tissue injuries, such as ligamentous disruptions, epidural hematomas, and spinal cord compression. In Chance fractures, MRI confirms ligamentous injury and rules out spinal cord involvement, especially when neurological deficits are absent. Complications such as neurological deficits or chronic pain, can arise if the fracture is not properly assessed and managed. A multimodality imaging approach, involving radiographs, CT, and MRI, is vital for a thorough evaluation of Chance fractures, aiding in the assessment of fracture stability and guiding management decisions.

### *Management*

Non-surgical management may be suitable for patients without neurological deficits and stable posterior structures. In this case, surgical intervention was necessary due to significant displacement, canal stenosis, and posterior ligament damage, all of which increased the risk of neurological compromise. Long-segment posterior screw fixation and laminectomy were performed to stabilize the spine and decompress neural elements. Literature supports this approach for preventing further displacement, deformity, and neurological deterioration.

Postoperatively, the patient tolerated the surgery well with no new neurological deficits. Early mobilization and physical therapy were initiated to prevent complications such as deep vein thrombosis and muscle atrophy. Short-term risks such as infection and hardware failure were closely monitored. Long-term concerns include residual kyphosis and adjacent segment degeneration, with follow-up imaging and rehabilitation aimed at preventing these complications. Additionally, com-

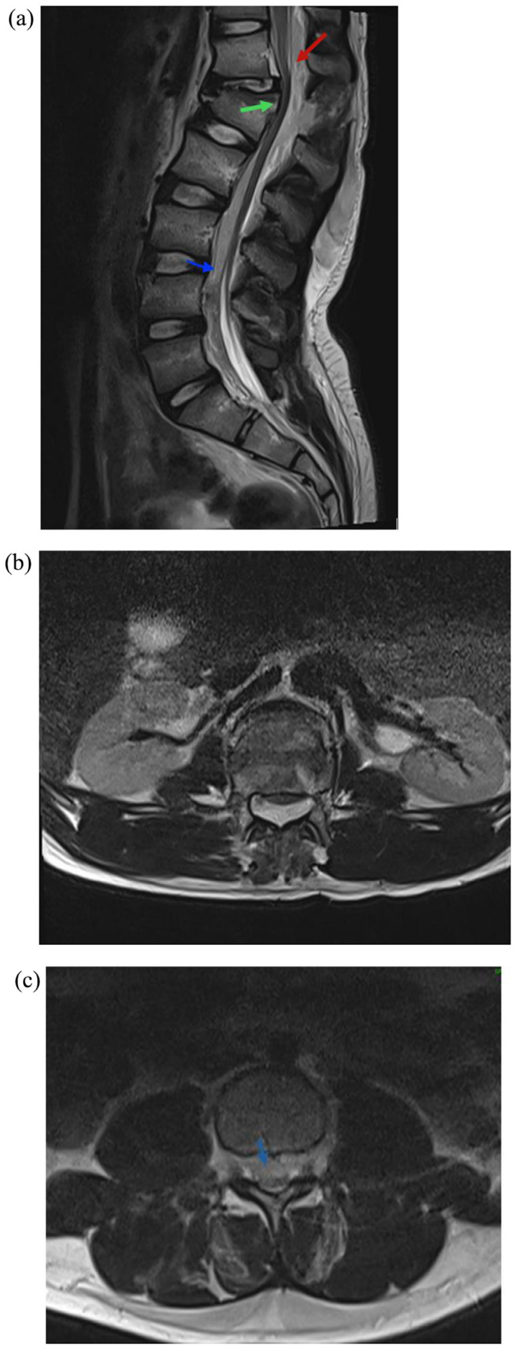


**Fig. 3 – (A) Sagittal T2 MRI of the lumbar spine demonstrating a posterior epidural hematoma at L1-L2 (red arrow), which combined with retropulsion of the posterior superior endplate of L1 (green arrow) results in cord compression. (B) Axial T2 MRI demonstrating cord compression (yellow arrow) at the L1 vertebral body level. (C) Axial T2 MRI demonstrates an anterior epidural hematoma extending from L2-S1 resulting in moderate to severe canal stenosis at L2 and L3 (blue arrow).**

prehensive rehabilitation, including physical therapy and pain management, is critical for optimizing functional outcomes and long-term recovery.

## Conclusion

This case highlights the importance of recognizing atypical mechanisms of injury, such as a vertical fall, that can lead to a Chance fracture, which is more commonly associated with flexion-distraction injuries in motor vehicle accidents. Early identification through imaging and timely surgical intervention are crucial for optimizing patient outcomes, particularly when there is significant displacement, canal stenosis or ligamentous injury, as seen in this patient.

The successful surgical management of this patient, with no postoperative neurological deficits and a stable recovery, underscores the importance of a multidisciplinary approach in treating such complex fractures. Long-term monitoring for potential complications, such as spinal deformity, adjacent segment degeneration, and chronic pain, remains essential for ensuring continued functional recovery and quality of life. This case serves as a reminder to consider the possibility of Chance fractures following high-energy axial loading injuries, even in scenarios that deviate from the typical mechanisms. Prompt surgical intervention and comprehensive postoperative care, including rehabilitation, are key to achieving favorable outcomes in pediatric patients with Chance fractures.

## Patient consent

Written informed consent was obtained from the patient's mother.

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