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CASE REPORT

Isolated multiple lumbar transverse process fractures with spinal instability: an uncommon yet serious association

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Abstract

Purpose Isolated vertebral transverse process fractures of thoracolumbar spine without other vertebral injuries and neurological deficit are generally considered as minor injuries with no concern for associated spinal instability. This report describes a case of multiple lumbar transverse fractures associated with an unexpected yet clinically significant spinal instability.

Methods A young male presented with right flank pain following being pushed and trapped against the ground by a reversing truck. The neurological examination was normal, and computed tomography (CT) imaging revealed multiple fractures at right transverse processes from L1 to L5, a single left-sided transverse process fracture at L2 and subtle facet joint distraction without other spinal lesions or visceral injuries. The injury was initially deemed as stable requiring symptomatic treatment and in-patient observation. However, discharge upright X-rays taken in a brace showed marked subluxation of L2/L3 and L3/L4 levels.

Results Magnetic resonance imaging revealed significant discoligamentous injuries involving anterior and posterior longitudinal ligaments, annulus fibrosus as well as posterior ligamentous complex. The patient underwent posterior spinal instrumentation and fusion of L1 to L5.

Conclusions This is the first case description of association of multisegmental lumbar transverse process fractures with notoriously unstable injuries of the major soft-tissue stabilizers of the spine presenting subtle changes on CT images. When a seemingly benign spinal injury is caused by high-energy trauma, careful scrutiny for associated instability is needed. In this case, the standing in-brace X-ray was able to avoid a misdiagnosis and potentially unfavourable outcome.

Keywords Vertebral transverse process · Lumbar spine · Fracture · Posterior ligamentous complex · Stability

Introduction

Isolated transverse process fractures (ITPF) of the thoracolumbar spine without other vertebral lesions are commonly found in patients undergoing computed tomography (CT) scanning as part of evaluation for spine trauma in the emergency room (ER). These fractures are generally considered as stable injuries that should be managed with supportive treatment including pain management with or without bracing as well as gradual return to unrestricted weight bearing as per tolerance. No further diagnostic workup or surgical intervention is usually recommended because the major soft-tissue stabilizers of the spine including anterior longitudinal ligament, posterior longitudinal ligament, intervertebral disc and posterior longitudinal complex (PLC, consisting of ligamentum flavum, facet joint capsule, interspinous ligament and supraspinous ligament) are not related to the transverse processes anatomically. In a systematic review of studies on patients with single or multiple isolated transverse process fractures, the most common mechanism in the young population was blunt high-energy trauma such as motor vehicle accidents and sport-related collisions [1]. Associated injuries to solid and hollow viscera in the thoracic and abdominal cavities were common indicating significant amount of energy was involved and the need for thorough assessment of these patients. However, none of the 398 patients (including 82 pediatric cases) in

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four published studies were noted to have neurological deficits at the time of injury or at the end of follow-up [1]. In terms of outcomes, one study reported that all 306 patients with ITPF achieved full ambulatory function with only 1.1% reporting persistent back pain [2].

The anterior longitudinal ligament and PLC serve as the anterior and posterior tension bands of the spine and are considered as pivotal elements in spinal stability. Traumatic injuries of these structures are considered as major causes of spinal instability according to the Thoracolumbar Injury Classification and Severity Score (TLICS) and AO Spine Thoracolumbar Spine Injury Classification System [3, 4]. Because of poor interobserver reliability of magnetic resonance imaging (MRI) for identification of PLC injuries, the recently published AO classification has been mainly based on CT scan findings. However, MRI may still be used to detect injuries of the soft-tissue stabilizers in order to differentiate unstable from stable injuries [4]. Currently, the consensus is that MRI should be performed in all patients with neurological deficits or in those with any signs of potentially unstable injuries on CT scan [5]. Isolated fractures of transverse processes do not raise concern for mechanical instability or a neurological deficit, as indicated by AO Spine Classification, and therefore should not require MRI [4].

This report presents a unique and to our best knowledge previously undescribed case of isolated transverse process fractures unexpectedly associated with a mechanically unstable spinal injury demonstrating very subtle changes on the initial CT images.

Case description

A 38-year-old obese Hispanic male presented to the ER with right flank and lower back pain following a pedestrian accident. While crossing street, the patient was pushed from behind and knocked to the ground by a reversing truck. He was then trapped between the truck and the ground and forced to assume a prone knee–chest position receiving more load on his right side. The truck moved forward and released the patient after several seconds. No tires ran over the patient. Prior to the accident, his medical history was only significant for gastric bypass and abdominoplasty procedures. Initial physical examination revealed an alert and hemodynamically stable patient with bruising over the right flank and iliac spine. There was tenderness to palpation over the lumbar spine. Neurological examination was normal except for strength of 3/5 for flexion of right hip secondary to pain. The rest of the physical examination was unremarkable. There were no other injuries.

Following initial assessment, CT scan of the thoracolumbar spine was performed. There was a slight curve of lower lumbar spine associated with mild coronal pelvic tilt as seen in the scout view (Fig. 1, left). Coronal and axial images were notable for displaced fractures of the transverse processes of all lumbar vertebrae on the right side and only L2 on the left side as demonstrated by multiplanar coronal construction (Fig. 1, middle). There was subtle coronal tilt of L2/L3 disc on only one of the coronal images (Fig. 1, right, white arrow). Other findings consisted of right-sided psoas haematoma, fluid near the right pericolic gutter and a nondisplaced right posterior tenth rib fracture. On sagittal

Fig. 1 Computed tomography: scout view (left) shows a mild lower lumbar curve associated with slight coronal pelvic tilt. The fracture of transverse processes at all lumbar levels on the right side and left L2 can be seen on multiplanar coronal reconstruction (middle). Subtle coronal tilt can be seen at L2/L3 disc level only on one of the coronal images (right, white arrow)

views (Fig. 2), no malalignment, vertebral body wedging, regional kyphosis, axial rotation or horizontal translation of the vertebrae and diastasis of posterior interspinous processes was shown. There were mild degenerative changes at L1/L2 disc space with anterior osteophyte and endplate sclerosis, and the disc at L2–L3 looked unusually tall compared with the other lumbar discs. Parasagittal images (Fig. 2) showed minimal facet diastasis at L3/L4 levels. The alignment of all lumbar facet joints (especially L2/L3 and L3/L4) on axial cuts (Fig. 3) was normal. There was minimal asymmetric widening of the right sacroiliac joint but there was no pelvis fracture. The spinal injuries were considered as stable, and the patient was admitted for further monitoring and pain control. The strength of right hip and knee improved in the subsequent clinical assessments once the pain was controlled.

The patient was decided to be treated with a thoracolumbosacral orthosis (TLSO) brace for support during sitting

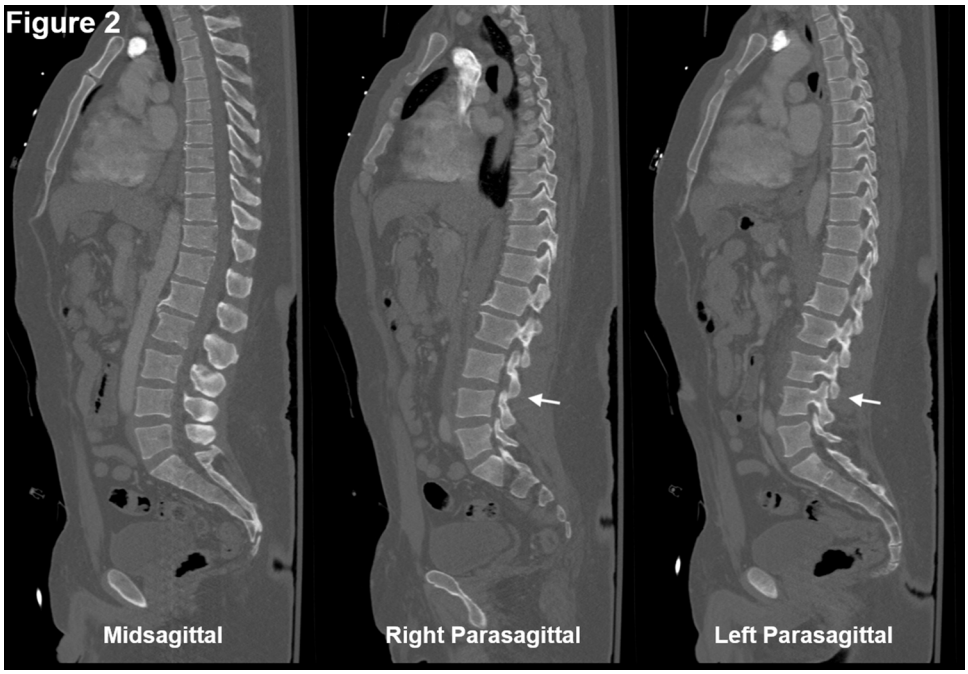

Fig. 2 Computed tomography: midsagittal reconstruction demonstrates an anterior osteophyte at L1/L2 level and increased disc height at L2/L3 without any other malalignment. Right and left parasagittal reconstruction suggests subtle facet joint diastasis at L3/L4 (white arrows)

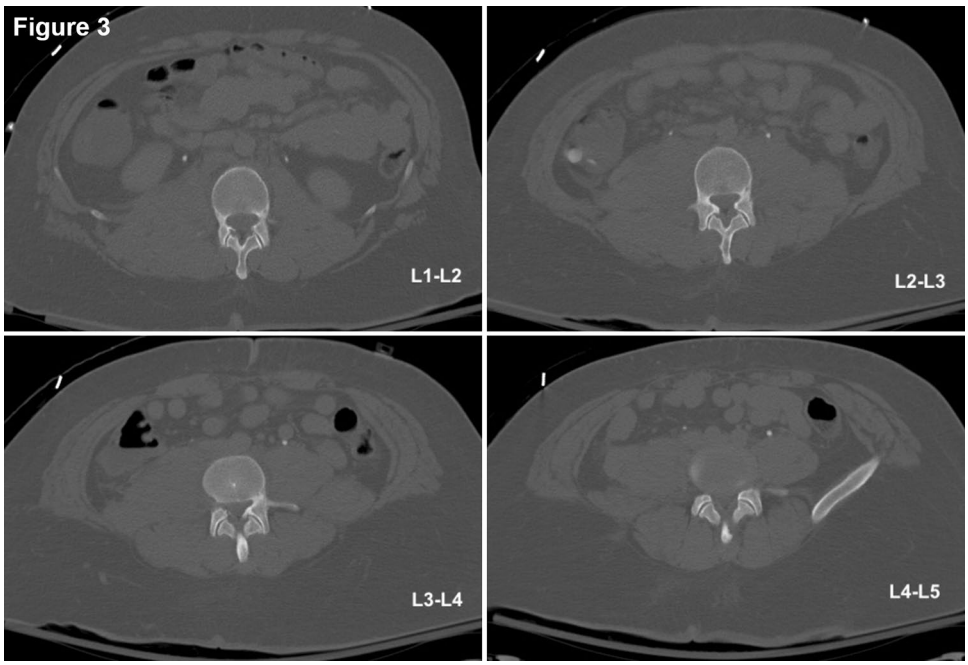

Fig. 3 Computed tomography: the alignment of the pertinent lumbar facet joints look normal on axial images

and ambulation. On post-injury day 2 morning, the patient reported satisfactory pain control at rest. However, he was not seated or walked with physical therapist because he reported significant pain with attempts to transfer him out of bed. Per our institutional protocol, standing X-rays with brace are done before discharge for all patients with high-energy spine trauma who require bracing as part of their treatment. Therefore, standing X-rays with TLSO were performed on post-injury day 2 afternoon. The patient, however, reported significant back pain radiating to both legs but more severe on the right side while standing with the brace for the X-ray. The X-rays surprisingly demonstrated a new deformity at L2/L3 and L3/L4 levels (Fig. 4, left). There was lateral and angular subluxation at both levels with L2 displaced 2 cm laterally to the left of L3, and L3 coronally tilted on L4 causing an asymmetrical L3/L4 disc space open on the right side. Lateral radiograph showed narrowing of disc space and mild retrolisthesis at L2/L3 with superimposition of L2 on L3 bodies and disproportionate widening of L3/L4 disc. The height of the vertebral bodies was maintained at all segments, and there was regional kyphosis of 5° at L2/L3 level (Fig. 4, right). The patient was immediately placed on bed rest. Repeat neurological examination remained normal. MRI of the lumbar spine was ordered, which revealed significant injury to the anterior longitudinal ligament, annulus fibrosus, posterior longitudinal ligament and posterior ligamentous complex including lesions of supraspinous and interspinous ligaments and ligamentum flavum at L2/L3 and L3/L4 intervals. There were signal changes suggestive of blood products at L2/L3 intervertebral disc and increased fluid within bilateral facet joints at L2/L3 and L3/L4. There were no signal changes suggestive of damage to the bony structures of the vertebrae except for fractures of the transverse processes discovered earlier on CT scan (Fig. 5).

Within 24 h, the patient underwent posterior segmental instrumented fusion of L1–L5. Unfortunately, the postoperative course was complicated by persistent wound drainage and deep surgical wound infection requiring irrigation and debridement surgery and antibiotic treatment. Six months after surgery, the patient was able to ambulate comfortably and reported occasional discomfort with daily activities.

Discussion

The main spinal injury initially detected in this case was bilateral vertebral transverse process fractures of lumbar spine. Vertebral transverse process fractures are common injuries and most frequently happen in the lumbar region and at multiple vertebrae. These fractures are considered minor compared to the fractures of vertebral body, pedicle and lamina. However, high-energy trauma is often required to cause these fractures and prior studies have cautioned about their high potential for association with other significant injuries of the lumbar spine and major intra-abdominal visceral organ damages of up to 48% [6–9].

According to AO Spine Injury Classification, these injuries are classified as A0 injuries and have the least clinical

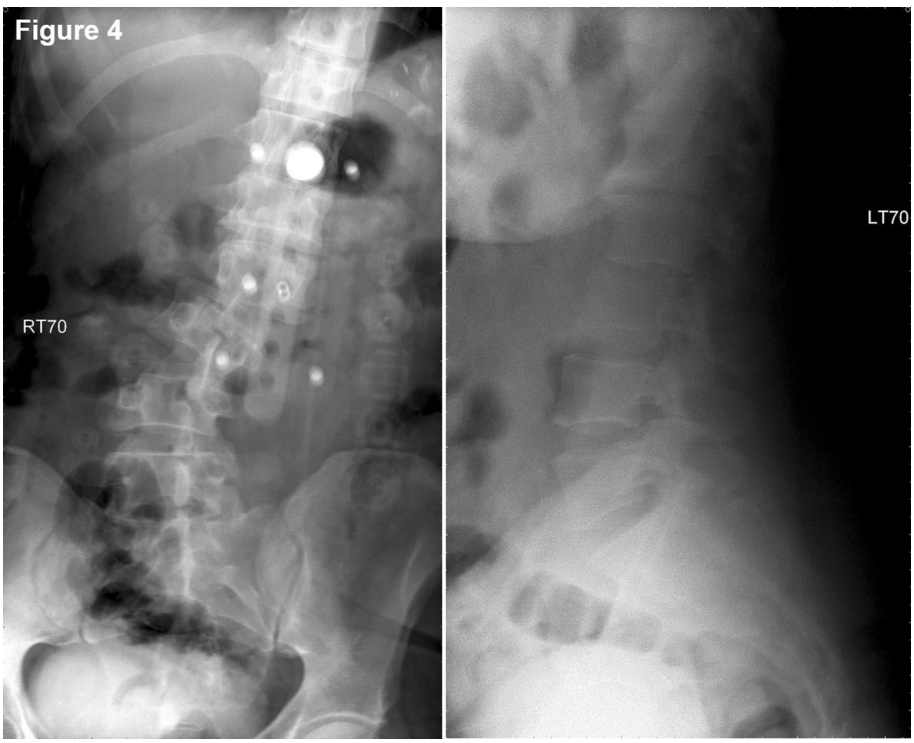

Fig. 4 Anteroposterior radiograph (left) taken in standing position with thoracolumbosacral brace prior to the initially planned discharge showing marked deformity with subluxation of L2/L3 and L3/L4 levels. Lateral radiograph (right) demonstrating narrowing of disc space and mild superimposition of L2 on L3 bodies, regional kyphosis of 5° at L2/L3 level and disproportionate widening of L3/L4 disc

Fig. 5 Sagittal T2-weighted short tau inversion recovery magnetic resonance imaging showing signal change indicative of injuries of the anterior longitudinal ligament and annulus fibrosus (left, yellow arrow), posterior longitudinal ligament (right, blue arrow) and ligamentum flavum (left, red arrow). Facet distraction can also be seen at L2/L3 interval (right, green arrow). There is also high signal intensity denoting inflammation at posterior subcutaneous tissue

significance because there is no concern for the biomechanical integrity of the spinal column or neurological deficit [4, 10]. Isolated transverse process fractures of lumbar spine (i.e. without any other type of spinal column injuries) are expected to recover fast with no adverse influence on short- and long-term functional outcomes [1, 2, 6, 9]. Some authors have even discouraged urgent consultation with spine specialists for patients with isolated transverse process fractures of the thoracolumbar spine in the absence of other vertebral injuries in order to save time and money and allow patients to be mobilized earlier [2, 9, 11]. Vertebral transverse processes serve as attachment for paraspinal muscles and ligaments. They are not thought to be linked to the major soft-tissue stabilizers of the spine, and their fractures are rarely, if ever, associated with neurological deficits considering their distance from the spinal canal and the fact that displaced fragments do not usually jeopardize the lumbar plexus. The common practice for isolated thoracolumbar transverse process fractures is that no further diagnostic assessment is required and supportive nonsurgical treatments including pain management and bracing for comfort are recommended [11].

MRI is undoubtedly the most accurate diagnostic method that is currently available for the assessment of ligamentous injuries in spine trauma with a reported accuracy of 88–97% based on prior studies [5, 12, 13]. However, because it is a time-consuming and costly procedure, its indications in urgent trauma setting are limited to the presence of neurological deficit or certain injury patterns that can potentially be associated with mechanical instability such as flexion distraction and hyperextension injuries [5]. Nevertheless, CT scan, as the first-line imaging modality in spine trauma, has been reported to have modest reliability for detection of injuries to the posterior longitudinal complex in thoracolumbar spine. One study reported increased interspinous distance as the best parameter to differentiate compression-type spine injuries from anterior and/or posterior tension band injuries on CT scan. The intra- and interobserver reliability for any sign of PLC injury was 0.62–0.86 and 0.26–0.71, respectively [14]. Moreover, based on a systematic review, the sensitivity and specificity of CT scan for detection of PLC injuries of thoracic and lumbar spine were 28.6–53.6% and 60.4–100%, respectively [15].

In our case, the CT scan showed subtle changes that could have raised suspicion of spinal instability due to discoligamentous injury. MRI was not initially indicated because there was no neurological deficit and the injuries that were appreciated on the CT scan were not deemed suggestive enough for an associated spinal instability. Thorough review of the CT images showed slight coronal tilt of L2 on L3 on coronal reconstruction with sagittal reconstructions demonstrating subtle facet joint diastasis at L3/L4 and increase in disc height (which can perhaps be considered as "disc diastasis") at L2/L3 level (Figs. 1 and 2).

The posterior distraction forces begin at the facet capsules and subsequently extend throughout the interspinous ligament, supraspinous ligament and ligamentum flavum. Therefore, facet joint diastasis may not be enough to define a posterior tension band incompetence [16, 17]. Nonetheless, facet joint diastasis in the context of spinal instability can reduce in non-weight-bearing supine position required for CT scan and can therefore be challenging to detect on CT images. Asymmetric facet subluxation on axial CT images has been suggested as a potential hint [13] although this was not visible in the axial CT images of our case (Fig. 3).

There were certain aspects of the case that were concerning for a significant spinal instability and prompted a more thorough assessment: a high-energy injury and the fracture of multiple lumbar transverse processes on both sides (including all right sided) in a young obese yet otherwise healthy patient. However, to our best knowledge, such injury pattern has not been specified in the literature in terms of its association with spinal instability prior to the present case report. Moreover, the degree of instability observed

in the upright radiograph would still be surprising to most spine surgeons even if the MRI findings had been available beforehand. The critical learning point in this case is how to avoid missing such significant instability. For this purpose, we recommend that patients with high-energy thoracolumbar trauma and seemingly benign injuries be screened with standing X-rays before discharge. Similarly, it has been demonstrated in patients with cervical spine trauma that an even completely normal CT scan cannot exclude instability and any trauma protocol should include standing X-rays in order for stability to be assessed thoroughly [18].

It may not be feasible to comment on the indication of MRI based on this single case report, although our case showed subtle findings of spinal instability on the initial CT scan in patients sustaining high-energy trauma can be suggestive of serious discoligamentous injuries, which can be confirmed by an MRI promptly. Further studies on the prevalence of subtle CT changes (such as facet diastasis) in patients sustaining high-energy trauma and their correlation with MRI findings suggestive of discoligamentous injuries and spinal instability would be required for a more confident recommendation.

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Compliance with ethical standards

Conflict of interest The authors do not have any particular disclosure with regard to this investigation.

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