Unilateral isolated dislocation at the lumbosacral junction: lateral flexion-distraction as a major vector in the mechanism of injury

Case report and trauma mechanism analysis

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Abstract The description of the unusual mechanism of the trauma to lumbosacral junction is given based on the analysis of the clinical case. The injury of a patient with unilateral dislocation at the L5–S1 intervertebral joint without a bone lesion in this segment is reported. The patient suffered the injury by falling on one side from a height of 8 m. The trauma mechanism is documented by MRI findings and a 3D CT reconstruction of the paravertebral muscles and soft tissues on the injured side, whilst showing intact structures on the contralateral side. This, together with the cause of injury (a fall on the side), provides evidence for forced lateral flexion-distraction being the major vector of the trauma event. Such mechanism of this injury was not taken in account by other authors yet. This type of injury is difficult to classify using the Magerl classification system. The very rare injury has been mentioned in the literature only occasionally.

Keywords Lumbosacral junction · Unilateral dislocation · Trauma mechanism

Introduction

Injuries to the lumbosacral spine, both L5 and sacral fractures, are not very frequent. In contrast to the cervical spine, pure dislocation without fracture is very rare in this region. Unilateral dislocation has been reported only occasionally as a case report, and the mechanism of this injury is still being discussed. The aim of our presentation is to contribute, by the analysis of another case, to a better understanding of the aetiology and morphology of this injury and to distinguish other possible mechanism of the injury which differs from those described in classification systems commonly used.

Materials and methods

Case history

A 30 year-old man was injured by falling from a height of about 8 m at a construction site. The major trauma was a head injury with severe brain concussion, long-term loss of consciousness and central quadriplegia. An objective examination of peripheral neurological status was not possible at the time of injury. On admission there was large oedema, contusion and haematoma in the lower back region, mainly on the right.

The neurological status, as for the state of consciousness, gradually very slowly improved, but because of axonal injury-related brain lesions, spontaneous motor functions still remained unused at 3 post-injury months. At that time, the patient had not regained full consciousness yet, and was not able to describe the circumstances of his injury.

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Radiological findings

On admission a radiograph in AP projection showed asymmetry at the lumbosacral junction and the multiple fractures of right transverse processes and slight rotation of the entire spine against pelvis (Fig. 1); in lateral projection a slight malalignment in the L5–S1 segment was seen. Spiral CT scanning revealed rotational dislocation at the L5–S1 segment with pure unilateral dislocation (Fig. 2) of the right intervertebral joint, with the facets having “jumped” over one another. The rotation deviation of L5 from S1 was 31° . A fracture of the 12th rib below its head and multiple transverse process fractures in the L1–L5 region were found on the right. A 3D CT reconstruction revealed the extent of bone damage to the lumbar spine (Fig. 3a, b).

Magnetic resonance imaging (MRI) showed, in addition to the above mentioned lumbosacral dislocation, a traumatic rupture of the L5–S1 disc without disc protrusion into the spinal canal (Fig. 4), and also large contusion of the right paravertebral muscles with defects and haematomas extending from the L1 to S1 level. The right psoas muscle showed an asymmetric course and multiple haematomas. The right ilio-costal ligament was lacerated over a large area at the L3–L4 level and a large haematoma was present. The boundary between the retroperitoneum (psoas muscle) and the lower back muscles appeared blurred and

Fig. 1 X-ray in AP view shows only slight rotation of the spine against pelvis and serial fractures of the right costal processes

Fig. 2 Rotational deformity on CT scan reached 35°

Fig. 3 3D reconstruction shows pure dislocation in right lumbosacral joint and serial fractures of the XII. rib and costal processes 1–5 on the right

difficult to define, as compared with the contralateral side (Fig. 5a, b).

Clinical per-operative findings

After the patient's overall state had stabilised, he was indicated for surgery on the 10th post-injury day. Large haematomas were present over the lower back including the site of surgical access. The spine was exposed using the posterior longitudinal approach from L3 to S1. Intra-operatively, a

Fig. 4 Damage of L5 disc in MRI on sagittal view, without canal compromise

bare facet of the right S1 superior articular process was found, as well as the right L5 inferior articular process dislocated forward and locked in front of the S1 superior articular process. The articular capsule of the right intervertebral joint was torn and difficult to differentiate, and yellow ligament was also torn. The capsule of the left L5–S1 intervertebral joint was partly elongated. The spinal canal

was free and the dural sac was undamaged. To the right of the spine at the L4 level, the iliolumbar ligament and anterior layer of the thoracolumbar fascia were torn, with tissue damaged over a 5×6 cm area. This made free communication into the retroperitoneal space possible (Fig. 6) and revealed the posterior aspect of the belly of the right psoas major muscle.

In order to carry out reduction, it was necessary to remove a greater part of the right S1 posterior articular process (Fig. 7). Distraction of the L5–S1 segment provided access and permitted the restoration of intersomatic space height using the transforaminal lumbar interbody fusion (TLIF) technique and PEAK cages. Subsequently, reduction and pedicle screw fixation of the L5–S1 segment were performed (Fig. 8a, b). The procedure was completed by dorsal decompression with posterolateral fusion.

The operative wound healed without complications. The post-operative outcome was influenced by slow improvement in neurological status, with central right-sided hemiparesis still present at 3 months after injury. The patient showed a decreased level of consciousness, he was able to react to a verbal impetus by opening his eyes. However, his prognosis was uncertain due to the sequelae of brain concussion.

Result

Analysis of the mechanism of the injury

An analysis of the pre-operative radiological and intra-operative surgical findings, in view of the principles of kinematics for a fall where the patient fell from a height to the ground on his hip side, provided clear evidence that, on the right side, both the lumbar spine and the spinal muscles were subjected to excessive tensile forces, whereas the

Fig. 5 Haffematomas and defects in right paravertebral muscles as well as in right psoas muscle. Iliolumbar ligament and thoraco-lumbar fascia are torn on the right side whilst there is no major damage of soft tissues on the left left from the midline

Fig. 6 Defect in Iliolumbar ligament and thoraco-lumbar fascia. Free communication into the retroperitoneal space

Fig. 7 Reduction after resecting of right upper joint process of sacrum

contralateral muscles and spinal structures remained intact. This is supported by the presence of typical unilateral multiple fractures, involving the T12 rib and transverse processes between L1 and L5, produced by tension exerted by the lateral lumbar muscles, namely the intertransversarii and the quadratus lumborum, the lumbar portion of the longissimus dorsi and the iliocostalis, during forced contralateral flexion. Even the more ventrally located psoas major was injured, with multiple haematomas present in the muscle tissue. Further evidence for the mechanism of lateral flexion-distraction is provided by the fact that the contralateral intervertebral joint was found intact both intra-operatively and radiologically. On MRI examination there was a striking difference in the findings of paravertebral soft tissues between the left and the right side. Whilst the left muscles and soft tissues were intact, the right muscles showed multiple haematomas, with ruptures in the

lateral lumbar intertransversarii muscles and the psoas major. A defect was also apparent in the anterior layer of the thoracolumbar fascia, which separates the retroperitoneum including the psoas muscle from the back muscles, and its existence was confirmed intra-operatively. It should be realised that, in the cervical and lumbar spine, the mechanism of lateral flexion-distraction can have a greater effect than in the thoracic spine supported and thus protected by the rib cage; this is evident particularly in high-energy trauma due to uncontrollable falls on one body side. These findings correspond to the lateral flexion-distraction mechanism of the injury. Slight amount on rotation forces heading forwards can lead to the overlapping of the joint facets on one side.

This mechanism considering lateral flexion is not always covered by the criteria of currently used classification systems for spinal injuries that, in the first place, take into account mechanisms operating in the sagittal (flexion, extension) or the transverse (rotation) plane. The mechanism of injury operating in the frontal plane is either lateral flexion (more exactly, lateral flexion-distraction) or lateral shear.

Discussion

A dislocation at the lumbosacral junction was first described by Watson-Jones [19], as cited by many authors. Almost all reports on this type of injury agree on the fact that it occurs very rarely contrary to cervical and thoracic spine as well [16]. Unilateral injuries involving bone damage to a facet joint or pars interarticularis have been described more often [2, 4–8, 11, 12, 14, 20] whilst pure dislocation without bone injury is described rarely [3, 17]. These injuries largely occur due to a high-energy mechanism [15]. In our case, this led to a serious injury to the 12th rib and fractures of five transverse processes on the right side. Many authors have explained the trauma mechanism by flexion-distraction, particularly in bilateral dislocations; a detailed description of its mechanics has been provided by Roaf [13]. A unilateral dislocation can occur, only when rotation forces are involved. The conclusion drawn by Matějka [10] from a case report, suggests that extension with rotation is a probable trauma mechanism, is open to discussion although it is based on the description by Watson-Jones [19]. Matejka et al. [10] (2007) classified the injury as type C 2.3.1 according to the Magerl classification system [9]. It is difficult to imagine such an extent of distraction in extension that would result, even with co-acting rotation, in unilateral facet joint overlapping, particularly when considered that extension itself increases the degree of containment in the intervertebral joint. Rather, there is a possibility that the forced

Fig. 8 360° instrumented fusion of L5–S1

lateral distraction on the injured side together with the lateral flexion on the contralateral side produces distraction of the facet joint on the injured side and, by co-action of even minimal forward rotation, results in facet overlapping.

The marked contrast between the extensive soft tissue injury, including tears in the psoas major and the thoracolumbar fascia, on the right side and the presence of intact tissues on the contralateral side suggests that lateral flexion, the most important factor of the trauma mechanism, in combination with rotation was responsible for this injury. The trauma event included an indirect force that produced lateral flexion in combination with rotation in the lumbar region. This is evidenced by the absence of broken ribs, which otherwise would have been present in the case of a direct fall on one body side. In the injury reported here, lateral flexion was the major vector whilst rotation, though significant, was only a complementary vector. The lateral flexion caused rupture of the articular capsule with a subsequent, complete dislocation of the articular processes. Consequently, the effect of even a slight rotation resulted in joint facet overlapping without fracture of the S1 articular process. If forced rotation had been the major vector and lateral flexion only the contributing one, such a fracture, however, could have been expected. A trauma mechanism involving lateral flexion, a vector that operates in the frontal plane, with a minor contribution of rotation is not always covered by the criteria of currently used classification systems for spinal injuries, because these, in the first place, take into account mechanisms operating in the sagittal (flexion, extension) or the transverse (rotation) plane. The mechanism of injury operating in the frontal

plane is either lateral flexion (more exactly, lateral flexion-distraction) or lateral shear. From the diagnostic point of view, this case shows us the necessity to consider potential unilateral injury to the paravertebral soft tissues, the development of extensive retroperitoneal haematoma due to damage to the quadratus lumborum and the psoas major muscles, and also potential unilateral asymmetric injury to the lumbar plexus.

Using the available classification systems for injuries of the lumbosacral junction, the injury described here can be classified as a type 1 injury of the Aihara system [1] or a type 1A injury of the Vialle system [18]. However, these systems only have a descriptive character without paying attention to the trauma mechanism. If the Magerl classification system [9] were used, the injury would best be defined as a type C, sub-type 2 fracture with distraction and co-acting rotation, but with the distraction exerting its effect more laterally in the frontal plane. Obviously, this system is not sufficient to provide an accurate classification for injuries such as reported here. A very similar mechanism of cervical spine injury has been observed in a patient with unilateral C5–C6 dislocation who, as a front passenger, was involved in a side-impact car accident (unpublished observation).

Conclusion

Forced lateral flexion-distraction with rotation is a possible mechanism of spinal injury, particularly in the cervical and lumbar regions of the spine. It results in unilateral

dislocation at the intervertebral joint with asymmetric ipsilateral trauma to soft tissues, to paravertebral muscles or even ligaments on the transverse processes, whilst structures on the contralateral side remain intact. This type of injury is difficult to classify on the basis of the currently used classification systems for spinal injuries.

Summary

The description of the unusual mechanism of the trauma to lumbosacral junction is given based on the analysis of the clinical case. The injury of a patient with unilateral dislocation at the L5–S1 intervertebral joint without a bone lesion in this segment is reported. The patient suffered the injury by falling on one side from a height of 8 m. The trauma mechanism is documented by MRI findings and a 3D CT reconstruction of the paravertebral muscles and soft tissues on the injured side whilst showing intact structures on the contralateral side. This, together with the cause of injury (a fall on the side), provides evidence for forced lateral flexion-distraction being the major vector of the trauma event. Such mechanism of this injury was not taken in account by other authors yet. This type of injury is difficult to classify using the Magerl classification system. The very rare injury has been mentioned in the literature only occasionally.

Conflict of interest statement None of the authors has any potential conflict of interest.

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