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Traumatic L5-S1 spondylolisthesis: report of three cases and a review of the literature

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Abstract The literature reports that traumatic spondylolisthesis of L5 is an uncommon lesion. The authors report their experience of three cases of this particular fracture-dislocation of the lumbosacral spine. They stress the importance of certain radiographic signs in the diagnosis: namely, the presence of unilateral multiple fracture of the transverse lumbar apophysis. As far as the treatment is concerned, they state the need for an open reduction and an internal segmental fixation by posterior approach. A preoperative MRI

study appears mandatory in order to evaluate the integrity of the L5-S1 disc. In the event of a traumatic disruption of the disc, they state the importance of posterior interbody fusion by means of a strut graft carved from the ilium or, in case of iliac wing fracture (which is not uncommon in these patients), by means of interbody cages.

Key words Lumbosacral spine · Fracture-dislocations · Traumatic L5-S1 spondylolisthesis · Surgical treatment

Introduction

Traumatic lumbosacral spondylolisthesis is a very uncommon lesion. The literature testifies to this rareness, reporting only 22 cases over the last 50 years [1, 2, 4, 5, 7, 9–11, 13–15, 21, 22]. These include seven cases of pure bilateral dislocation [1, 4, 5, 7, 11, 15, 22]. The specific features of the lesion, as well as the different possible radiographic and clinical findings that characterize it, have encouraged many researchers to attempt to propose possible interpretations of the kinematics of the lesion.

Pathomechanics

The mechanics of the lesion, on the basis of its rareness and its association with monolateral fractures of the lumbar transverse apophyses, which occur in a very high percentage of cases, has been the subject of numerous studies, the conclusions of which often appear to disagree.

Hyperextension has been pointed to as an efficient traumatic vector [23]; other authors appear to disagree, believing that the main mechanism responsible for the lesion is constituted by the association between hyperflexion, compression and rotation [4, 11, 21, 24], or by the action of the direct traumatic vectors [1, 17].

In the cases that came to our observation, an accurate history of each patient allowed us to generally reconstruct the dynamics of the trauma. The patient with a “pure” dislocation had undergone sudden hyperflexion of the lumbosacral spine, with his thighs flexed on the pelvis. This had been provoked by doing a somersault in the air and landing on his bottom. In the patient with fracture-dislocation, the main traumatic mechanism had been violent and direct posterior trauma in the lumbar spine (the patient had been thrown from a motorcycle ending up against a pole). This mechanism, in clear contrast to what has been affirmed by Roaf [20], appears to be similar to that described by Beguirstain et al. [1], and it may be likened to an actual lesion caused by the application of shear traumatic vectors.

Fig. 1 A–E Male patient aged 26 years who owing a motorcycle accident sustained an hemothorax, fractures of the left transverse processes of L2, L3, L4, L5 and right of L5, anterior dislocation of L5 on S1. **A, B** Radiographic appearance. **C** MRI study showing a good morphological condition of the L5-S1 disc, and a slight detachment of the anterior longitudinal ligament from the anterior surface of the disc. An open reduction of the dislocation of L5 on S1, a pedicle-screw-based L5-S1 segmental stabilization and a posterolateral fusion was carried out. **D, E** The 2-year follow-up radiographic control shows the maintenance of reduction and an anterior ossified bridge, in the area corresponding to the anterior longitudinal ligament detached from the anterior surface of the L5 body and sacrum

Case reports

The three cases discussed here are two “pure” bilateral dislocations at L5 on S1, and one fracture-dislocation. The patients were all young men, the victims of motorcycle accidents, with clearly defined high-energy trauma. In two cases there was bilateral fracture of the transverse processes of L5; in one case, monolateral fracture of the transverse apophyses of L2, L3 and L4. As Herron and Williams observed in 1984 [13], these combined lesions are caused by violent traction of the paravertebral muscles, and they

appear to represent a nearly mandatory association [4, 7, 9, 16, 25]. Herron therefore emphasized the importance of this radiographic sign as an element, the presence of which must lead to the suspicion of associated traumatic lesions of the lumbosacral joint.

Case 1

A 26-year old man was the victim of a motorcycle accident (he lost control of vehicle on a wet road); after flying a few meters he fell

Fig. 2A–G Male patient aged 27 years who, owing to a motorcycle accident sustained a very severe injury (chest and pelvis) and fracture-dislocation of L5–S1 with bilateral fracture of the transverse processes of L5 **A, B** Radiographic appearance. **C–E** The presence of a rough detachment of the posteroinferior border of L5 and the consequent herniation of part of the nucleus within the canal was evident at CT study. An intersomatic fusion by posterior approach, with the use of two titanium cages, was then performed. **F, G** One-year follow-up radiographic study revealed the reduction was maintained

on his bottom. He did not lose consciousness; other parts of the body were not hit. First hospitalization was elsewhere, with a diagnosis of "hemothorax, fractures of the left transverse processes of L2, L3, L4, L5 and right of L5, anterior dislocation of L5 on S1"

(Fig. 1A,B). After a left thoracic drainage had been positioned, a lumbosacral CT scan was performed, showing the L5–S1 dislocation, and 2 days later the patient was transferred to our unit. There was no motor deficit in the lower limbs, a left crural pain

Fig. 3 A–D A 26-year-old man who sustained a motorcycle accident. **A, B** A radiographic study showed some skeletal injuries and a fracture of the left transverse process of L4, with no further elements found in the lateral view. Two months later the L5 slipping appeared increased, radiating pain had worsened, and the patient was referred to our unit. **C** Radiography of the lumbosacral region and CT myelography were carried out, leading to the final diagnosis of traumatic lumbosacral dislocation. An open reduction, a posterior interbody fusion with cages and a posterior segmental fixation was then carried out. **D** One year later the radiographic study shows a stable reduction

and dysesthesia was present, with deficit in the patellar reflex. The patient was submitted to lumbar MRI (Fig. 1 C), confirming dislocation of L5 on S1 and the good morphological condition of the L5-S1 disc. Surgery, performed 14 days after trauma, consisted in the reduction of dislocation of L5 on S1, pedicle segmental stabilization at L5-S1 using Cotrel-Dubousset instrumentation, and posterolateral fusion. Because of the lumbar apophyseal fractures and the intense homolateral nerve root symptoms, electromyographic examination was carried out, revealing the presence of a radiculopathy of the L3 and L4 nerve roots. Postoperative treatment comprised immobilization in a plaster pelvicondyloid cast to be worn for 20 days. The patient then was fitted for an orthopedic brace to be worn for 30 more days. Out-patient monitoring showed improvement in lumbocrural symptoms and electromyographic findings.

At follow-up obtained 2 years after surgery, the patient reported occasional lumbar pain caused by stress with radiation to the left thigh. X-ray examination showed maintenance of reduction and anterior ossification in the area corresponding to the anterior

longitudinal ligament (Fig. 1 D,E), detached from the anterior surface of the L5 body and sacrum.

Case 2

A 27-year-old man was the victim of a motorcycle accident (he lost control of vehicle with direct trauma in the lumbosacral region caused by impact against the metal pole of wire fencing). The patient was hospitalized and submitted to X-ray examination, revealing the presence of fractures of the 8th, 9th, 10th, and 11th ribs to the right and the 12th rib to the left, fracture of the right scapula, dislocated multiple fracture of the left iliac wing with fracture-dislocation of L5-S1 and bilateral fracture of the transverse processes of L5 (Fig. 2 A,B).

The clinical finding of progressive acute abdominal symptoms suggested the use of an echotomography, which confirmed our suspicion of a hemoperitoneum. The patient was therefore submitted to explorative laparotomy, which revealed that the

bleeding was related to severe dislocated fracture of the left iliac wing.

Five days after the trauma, the patient was transferred to our unit and submitted to surgery to treat the vertebral lesion. The presence of a rough detachment of the posteroinferior border of L5 protruding into the canal together with some part of the nucleus within the canal (Fig. 2C–E) suggested removal of the bone fragment and the intersomatic disc, followed by intersomatic fusion by posterior approach, with the help of titanium cages.

At 1 year follow-up the patient complained of occasional lumbar pain after prolonged sitting. Radiographs revealed the maintenance of reduction (Fig. 2F,G).

Case 3

A 26-year-old man suffered a motorcycle accident. The patient was hospitalized for abdominal pain and shoulder injury. A radiographic examination showed a right acromion-clavicular dislocation and fracture of the right ileum without displacement; a lumbosacral radiograph showed a fracture of the left transverse process of L4, with no further elements were found on the lateral view (Fig. 3A, B). A pelvic CT scan showed a retroperitoneal hematoma, and pelvic echography demonstrated a hematoma of the right psoas muscle.

The patient complained of low back pain associated with right radiating pain. Fifteen days later the patient underwent surgical reduction of the shoulder dislocation, and was discharged. Right sciatica became more and more acute, and 1 month later a radiographic control showed a slight L5 spondylolisthesis. Two months later the L5 slipping appeared increased, the radiating pain had worsened, and the patient was referred to our unit.

Radiography of the lumbosacral region (Fig. 3C) and CT myelography were carried out, leading to the final diagnosis of traumatic lumbosacral dislocation.

An open reduction, a posterior interbody fusion with cages and a posterior segmental fixation was then carried out. One year later, the radiographic study shows a stable reduction (Fig. 3D); the patient continued to complain of right L5 radiating pain, and the EMG study showed non-deficit of motor function.

Discussion

Taking advantage of the differing interpretations provided by the literature, the mechanics of lesion and the most appropriate treatment seem the most important topics for an in-depth discussion.

Pathomechanics of the lesion

It is our belief that the action of a variety of trauma mechanisms must be hypothesized in order to understand the various possible lesions that together are known as lumbosacral dislocations.

In fact, whenever there is “pure” dislocation at L5-S1 with passing over of both zygoapophyses (with or without minimum skeletal lesions), hyperflexion must have either an exclusive or at least a dominant role [4, 11, 18, 21]. The lesion is characterized from an anatomopathologic point of view by breakage of the supra- and interspinous ligaments and by lesion of the joint capsules; the long ligaments (posterior and anterior longitudinal) may seem in-

tact, like the intervertebral disc. The need for accurate diagnosis regarding the integrity of the latter structures signifies that MRI is required. Evaluation will determine the strategy of treatment, which will be discussed further on.

If the lesion is more complex, including significantly important fractures of the arch bone structures or of the vertebral body, there is no doubt that vectors of compression (whether or not associated with hyperflexion) or axial translation are the cause of the lesion mechanism. It is our opinion that rotation is totally extraneous in cases such as these; while, on the other hand, it is of primary importance in monolateral dislocations.

Vectors of compression, translation and hyperextension (with a mechanism similar to that postulated by Denis and Burkus [6] for thoracolumbar lesions defined by the authors as “lumberjack paraplegia”) may equally be blamed for lesions in which there is an interruption in the arch skeletal continuity, the cause of somatic dislocation. In lesions such as these, in fact (and this is the second case that came to our observation), only fracture of the zygoapophysis, and consequent deficit in function as a joint motion brake, allows for anterior translation of the body of L5 on the sacrum.

Strategy of treatment

The choice of the type of treatment (surgical, nonsurgical) and, more importantly, whether or not it is necessary to attempt reduction of the lesion are the elements on which the opinions of the various authors seem to diverge.

While some authors [7, 17, 22, 25] report satisfactory results with nonsurgical treatment (reduction and immobilization in plaster), this choice is not currently accepted, because of the obvious practical difficulties and the possible neurologic complications that closed reduction entails [5].

Early surgical treatment, postulated by all authors today [9, 13, 25] first of all responds to the general principle of orthopedics, which is that of restoring all normal anatomical relationships between joint structures that were lost as a result of trauma. Surgical reduction, on the other hand, allows for: monitoring of the relationships between osteoarticular and nerve root structures; decompression of the latter, removing osteodiscal fragments and frequently occurring peridural hematoma; truly effective application of reduction forces; performance of solid primary stabilization; achievement of fusion (posterolateral or intersomatic), which responds best to the real needs of the injured segment of movement.

The time interval between trauma and surgery may make reduction difficult [3, 4, 7]; in the cases that came to our observation this never happened. In our opinion the ease of reduction also depends on the method used during surgery, which includes the application of a temporary distraction system placed strut-like between the wing of

the sacrum and the posterior arch of the first or second lumbar vertebra – not unlike what occurs for intraoperative reduction of severe spondylolisthesis [8, 12, 19]. The use of this method of reduction is obviously influenced by the integrity of the longitudinal ligaments. Exploration of the vertebral canal is an essential surgical stage [5]. When there is pure bilateral dislocation we believe that it is sufficient to remove the lacerated ligamentum flavum to obtain a wide view of the canal. We do not believe partial removal of the zygoapophyses to be of use – a practice that is postulated particularly in cases where reduction is difficult [1, 5, 21] – as once normal joint relationships have been restored, the undamaged

zygoapophyses structures constitute an element that stabilizes the reduction. In cases such as these, fusion will be posterolateral only if the integrity of the intersomatic disc is proven by MRI. On the other hand, in case of fracture-dislocation (particularly when osteodiscal fragments are present in the vertebral canal) evidence of a traumatic lesion of the disc must suggest an intersomatic fusion, which will obviously be performed by a posterior approach during surgery. The use of intersomatic cages may in cases such as these, particularly when fractures of the iliac wing exist (which do not recommend taking a strong corticocancellous graft from this site), definitely constitute an effective solution.

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