Traumatic lumbar spondylolisthesis, a rare pathology with forensic implications

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Abstract: The authors present two cases of traumatic spondylolisthesis operated during the period Jan. 2009 - May 2012, at the Department of Neurosurgery IV of the “Bagdasar Arseni” Emergency Hospital in Bucharest. The traumatic biomechanical conditions were different in the two cases and are presented in the article. Traumatic spondylolisthesis is very rare and usually occurs in competitive sports or road accidents. This has direct forensic implications concerning the analysis of traumatic spondylolisthesis, as well as any traumatic spinal cord injury resulting in neurologic impairment. Symptoms include spinal instability and various neurological syndromes, from simple radiculopathies to cauda equina syndrome. There are usually other thoraco-abdominal injuries associated as well, and treatment generally involves surgical intervention which entails rapid surgical decompression and solid spinal stabilization.

Key Words: traumatic spondylolisthesis, forensic implications, surgical intervention, road accident.

Traumatic spondylolisthesis is a rare form of spondylolisthesis and involves a fracture somewhere other than in the vertebral isthmus, affecting the neural arch, the articular complex or the pedicle. This type is found in high kinetic energy injuries, occurring in professional sports or in road accidents.

The analysis of the circumstances in which the trauma took place and of the biomechanical mechanisms is important from a forensic and a neurosurgical point of view. Surgery is sometimes the only option and rapid neural decompression along with spine fusion with transpedicular screws and rods and intersomatic grafts are required for a solid long-term stabilization.

Case reports

Case 1. A patient 26 years of age suffered a motorcycle accident, crashing into an automobile. The injury mechanism was complex, meaning a hyperflexion-rotation combined with vertebral hyperextension with axial loading. He also had a thoracoabdominal injury with contusion to the left kidney, spleen and left lung, and a retroperitoneal hematoma, but did not require surgical exploration.

The patient presented with a cauda equina syndrome (Frankel D), with a moderate paraparesis, sphincter disturbances of the incontinence type and sexual disorders. The lumbar X-ray revealed a grade 3 spondylolisthesis and MRI examination showed, apart from the spondylolisthesis grade 3, a lesion of the intervertebral disc, the neural arch and of the L5-S1 posterior ligaments, the contusion of the spinal muscle on the left side, the dilacerations of the dura mater and the CSF leakage into the spinal muscles (figure 1, 2).

The patient was operated on 14 days after injury, once the other associated injuries had been stabilized. The decompression of the neural elements was performed, along with the reconstruction of the dural sac with lumbar fascia. Spinal reduction and fixation was accomplished, using bilateral L5-S1 transpedicular screws and rods (Titanium SOLAS System - Biotechni, France) with intersomatic autologus iliac crest graft (figure 3).

The patient was mobilized one week after surgery. Neurological recovery was very good, one year after

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surgery having shown only disabling hypesthesia in the left side of the S2-S3 territory, rudimentary motor deficit on the left side of S1 (ASIA Scale 4/5), but without any sphincter or sexual disturbances.

Case 2. A 36 year old female patient suffered a car accident, while occupying the back seat without having the seatbelt on, after a frontal impact with another vehicle. The patient came with direct abdominal injuries (due to the impact with her own buckle), with intestinal lesions and retroperitoneal hematoma. She was operated on two times for intestinal resections and reconstructions.

Three months after the injury she was admitted to the neurosurgery department for intense lumbar pain and left L3 radiculopathy. The lumbar X-ray and the MRI exam established a diagnostic of L3-L4 traumatic spondylolisthesis, with L3 disc lesion, lesion of the L3 posterior arch and left L3-L4 articular pillar lesion.

The mechanism of injury was hyperflexion-distraction, the severe hyperflexion of the spine that has associated a distraction of the posterior spinal ligaments (figure 4 and 5). She was operated on for decompression and spinal stabilization, using intersomatic PEEK cage synthesis and augmentation with an autologous bone graft and with bilateral L3-L4 posterior fusion with transpedicle screws and Titan Xia System (Stryker instrumentation).

A total remission of the radiculopathy was observed and the patient was mobilized 3 days postoperatively, without significant lumbar pain. Three months after the surgery, the spine was aligned and a good L3-L4 vertebral bodies fusion was obtained (figure 6).

Figure 1: Preoperative MRI showing grade 3 spondylolisthesis, intervertebral disc and thecal sac dilacerations, CSF leakage in the left spinal muscle (A, T1 weighted image; B, T2 weighted image; C, D, axial – T2 weighted image).

Figure 2: Preoperative Radiography showing 60% anterior L5-S1 dislocation (A, lateral view; B, anteroposterior view)

Figure 3: Postoperative Radiography showing excellent spinal alignment.

Figure 4: Case 2. Preoperative MRI shows L3-L4 traumatic spondylolisthesis, disc laceration and spinal canal compression.

Figure 5: Case 2. Preoperative lateral radiography.

Figure 6: Case 2. Good vertebral fusion (3 months after surgery).
Discussion

Lumbar spondylolisthesis was first described by Herbiniaux (1782), in which he had observed an abnormal narrowing of the pelvic strait caused by a slippage of the last lumbar vertebrae over the top of the sacrum. The term "spondylolisthesis" comes from the Greek words spondylos (vertebra) and olisthesis (slippage) and was introduced by Kilian (1854), who believed that the problem derived from the joints being affected. Later, Lamb (1885) explains the slippage through a fracture at the level of the vertebral isthmus.

In 1976, Wiltse, Newman si MacNab proposed a classification of lumbar spondylolisthesis into 5 types, based on etiopathogenic criteria:

1. Dysplastic - congenital, due to malformations in the evolution of the neural arch;
2. Isthmic – in young adults, due to a spondylolysis of the vertebral isthmus;
3. Degenerative – in the elderly, due to arthritis in the small posterior articulations;
4. Traumatic – after an acute lumbar vertebral trauma;
5. Pathological – found in any disease which affects the bones: metabolic, infectious, tumoral.

The most known and used method for classifying spondylolisthesis is “Meyerding grading system for severity of slip” and was proposed in 1932. On the X-ray of the lumbar spine in profile, the distance between the posterior border of the superior vertebra and the posterior border of the inferior adjacent vertebra is measured and than is expressed as a percentage of the total length of the superior plateau of the inferior adjacent vertebra, obtaining five degree (figure 7):

- Grade 1: 0-25% slip;
- Grade 2: 25-50% slip;
- Grade 3: 50-75% slip;
- Grade 4: 75-100% slip;
- Grade 5 (Spondyloptosis).

Hyperflexion of the lumbar spine produces a stretching of the posterior ligamentous apparatus (the distraction), and the extreme forces cause lesions in the posterior ligamentous apparatus: supraspinous and interspinous ligament, yellow ligaments, articular capsules, posterior longitudinal ligament and the posterior portion of the fibrous disc ring. If it does not appear immediately at the moment of the injury, traumatic spondylolisthesis can subsequently appear, in time, several months after the trauma. Clinically however, the patient accuses lombalgies and sometimes radicular syndromes of small intensity and the lumbar X-ray and MRI exam can establish a diagnosis.

Hyperextension with axial loading mechanism of the lumbar spine causes lesions opposite to those of hyperflexion, affecting the anterior longitudinal ligament and the anterior portion of the disc ring. Posterior bone elements may suffer fractures (spinous apophysis, vertebral blades, joints and vertebral pedicles). The symptoms can be limited, the patient accusing lumbar pain, in simple cases.

The rotation mechanism does not appear by itself, but often in combination with hyperflexia.

Hyperextension of the spine may result in translation movement, and lesions can be very severe: disc dilacerations with immediate posttraumatic lumbar sprains, neural arch and vertebral canal lesions, direct dural sac and neural elements dilacerations. In these cases symptoms can be severe, with varying degrees of paralysis, up to the cauda equina syndrome.

We believe that in the case 1, the traumatic forces have produced a more complex injury mechanism than in case 2. They have given a rotational hyperflexion, followed by vertebral hyperextension with axial loading forces, the traumatic aftermath being much more severe. In case 2, we believe that the mechanism produced was that of hyperflexion-distraction, and the posttraumatic spondylolisthesis was diagnosed late.

Posttraumatic spondylolisthesis receives surgical treatment for decompression and spinal fusion. Intersomatic spinal fusion is by far the most appropriate because it provides a larger area of contact between the two vertebral plateaus and ensures a firm stability in time. Intersomatic fusion must be associated with one level bilateral posterior instrumentation at the affected segment, in order to ensure a solid and immediate vertebral stability. This allows rapid mobilization of the patient and reduced hospital costs. Neurological recovery depends on the severity of the injuries and the speed of the surgical decompression.

Conclusions

Traumatic spondylolisthesis is an extremely rare entity in spinal cord pathology. The mechanism that leads to it consists in hyperflexion-distraction with a degree of rotation, in simple case of spondylolisthesis, or hyperextension with axial loading, when the main lesion appears alongside a vertebral arch fracture.

Forensic assessments related to this pathology are similar to those of a classical spine injury, with spinal cord involvement, in those patients who receive surgical treatment, not only in relation to the number of days of hospitalization, but also to the recovery time and the postoperative evolution.
References