Thoracic spinal cord injury without major bone injury associated with ossification of the ligamentum flavum

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Conflict of interest

The authors report no conflicts of interest concerning the materials or methods used in this study or the findings specified in this paper.

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Introduction

Spinal stenosis is becoming frequent with the ageing of the general population. Spinal cord injury without major bone injury, caused by minor trauma, is also becoming more frequent, with the cervical spine being the most common site [1-3].

In contrast to the cervical spine and lumbar spine, the thoracic spine is biomechanically stable because it is supported by costovertebral articulations and the rib cage [4, 5]. Therefore, thoracic spinal cord injury without major bone injury is uncommon [6-8]. Here we report three cases of thoracic spinal cord injury without major bone injury following injury by a low-energy mechanism. To our knowledge, they are the first reported cases of spinal cord injury without major bone injury of the lower thoracic spine associated with ossification of the ligamentum flavum (OLF).

Consent for publication was obtained from all patients.

Case report

Case 1.

A 73-year-old-male sustained an injury by a fall in the bathroom. He showed bilateral lower-extremity weakness and numbness after the injury. He had neurological impairment of American Spinal Injury Association impairment scale (AIS)-C at initial examination, which did not improve after 2 days. Thoracic spine plain radiography and computed tomography (CT) showed no bony injury. T2-weighted magnetic resonance imaging (MRI) revealed intramedullary high-signal intensity (increased signal intensity: ISI) at the T10–T11 level. There was no evidence of bony and discoligamentous injury (Fig. 1a). CT myelography confirmed OLF at the same level (Fig. 1b). The patient underwent decompression surgery at the T10–T11 level. After en bloc laminectomy, conical laminoplasty was performed. Since its unique shape resembles a traditional Japanese conical hat (Sugegasa hat), we refer the method as the “conical laminoplasty” [9]. The day after the surgery, bilateral lower-extremity weakness and numbness improved. He had recovered gradually with symptoms in his lower extremities. One month later, the patient showed good recovery. His neurological symptoms improved to AIS-D postoperatively. He was followed up during 5 years after surgery. He was able to walk assisted with cane at his last follow-up (Figs. 2a-c).

Case 2.

A 77-year-old-male was sustained an injury after falling down the stairs at home. He showed bilateral lower-extremity numbness and gait disturbance after the injury. He was admitted to the hospital because of inability to stand. His neurological impairment was AIS-C at admission. Thoracic spine MRI and CT were performed because thoracic spinal cord injury was suspected. T2-weighted MRI revealed an ISI at the T9–T10 level (Fig. 3a). CT thoracic spine showed no bony injuries, and OLF was observed at the same level (Figs. 3b-c). We diagnosed thoracic spinal cord injury without major bone injury and performed conical laminoplasty after en bloc laminectomy at the T9–T10 level. One day postoperatively, bilateral lower-extremity numbness was reduced. He had recovered gradually with symptoms in his lower extremities. His neurological symptoms improved to AIS-D postoperatively. He was followed up after surgery during 3 years, was able to walk assisted with cane at his last follow-up (Figs. 4a-c).

Case 3.

A 65-year-old-female sustained an injury after a fall from a motorcycle. She had bilateral lower-extremity weakness and numbness (AIS-C) after the injury. Plain radiograph and CT of the thoracolumbar spine showed no bony injury. T2-weighted MRI showed ISI at the T11–T12 level, suggesting spinal cord injury (Fig. 5a). CT myelography showed OLF at the same level (Figs. 5b-c). We diagnosed thoracic spinal cord injury without major bone injury associated with OLF and performed conical laminoplasty after en bloc laminectomy at the T11–T12 level. One day postoperatively, bilateral lower-extremity numbness was reduced. She had recovered gradually with symptoms in her lower extremities. Two weeks later, the patient walked independently. Her symptoms improved from AIS-C to AIS-D postoperatively, and follow-up period was 7 years after surgery. She was able to walk unassisted at her last follow-up (Figs. 6a-c).

Discussion

Spinal cord injury without major bone injury is associated with hyperextension injuries of the cervical spine. It is common after minor trauma in the absence of bony injuries in patients with preexisting pathology such as cervical spondylosis, ossification of the posterior longitudinal ligament, and spinal canal stenosis [3]. The importance of narrowing of the canal in the context of spinal cord injury without major bone injury, which is seen in elderly patients. Ligamentum flavum protrusion is also observed in the spinal canal in such patients [10, 11]. As such, spinal canal stenosis and OLF are important risk factors for spinal cord injury without major bone injury in adults. Smith et al described that the presence of previously asymptomatic spinal canal narrowing may contribute to the pathenogenesis of this injury [8]. In thoracic spinal cord injury without major bone injury, neurological damage is frequently attributed to spinal hyperflexion injury [7, 8].

Unlike the cervical and lumbar spine, the thoracic spine is protected by ribs and their articulations. The rib cage restricts thoracic spine motion and contributes to its stiffness. The junction between the rigid thoracic spine and the mobile lumbar spine is exposed to concentrated stress levels, leading to a higher likelihood of injuries [4, 5]. OLF is also frequently observed in the lower thoracic spine or the thoracolumbar junction [12, 13]. In the present study, all patients showed OLF located in the lower thoracic spine.

MRI clearly delineates ISI, and it is useful in accurately diagnosing spinal cord injury without major bone injury [2, 3]. Samsani et al reported a case of thoracic spinal cord injury without radiographic abnormality in a skeletally mature patient, and associated spinal ligamentous injuries were excluded by MRI [6]. CT is recommended because it demonstrates thoracic OLF distribution patterns.

Management of cervical spinal cord injury without major bone injury has been a matter of debate [2, 3]. The therapeutic strategy for thoracic spinal cord injury without major bone injury is also controversial [4, 7]. The major goals of spinal cord injury treatment include reduction of neurologic deficit and limiting progression of the neurologic deficit. Spinal cord injury without major bone injury patients with OLF in the thoracic spine might have deterioration of symptoms and poorer outcomes. Therefore, decompression surgery should be considered to avoid secondary damage [12, 13]. In the present study, decompression surgery was performed in all patients with OLF because of the compressive etiology in the thoracic spine, and neurological symptoms improved postoperatively.

Conclusions

We reported three cases of thoracic spinal cord injury without major bone injury associated with OLF. In geriatric populations, especially in patients with OLF, spinal cord injury without major bone injury of the lower thoracic spine should be suspected following injury by a low-energy mechanism.

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Figure legends

Figure 1. Case 1

Preoperative MR T2-weighted imaging sagittal view (A) and CT myelography sagittal view (B) at admission

MRI showed the lesion with occurrence of ISI at the T10–T11 level. CT myelography confirmed the OLF at the same level.

Figure 2. Case 1

Postoperative MR T2-weighted imaging sagittal view (A), plain radiograph at final follow-up: anterior-posterior view (B) and lateral view (C)

MRI showed decompression of the OLF at the lesion. Radiographs confirmed the laminoplasty at the T10–T11 level.

Figure 3. Case 2

Preoperative MR T2-weighted imaging sagittal view (A), CT myelography sagittal (B), and axial views (C) at admission

MRI indicated compression of the spinal cord with occurrence of ISI at the T9–T10 level. CT myelography showed OLF at the same level.

Figure 4. Case 2

Postoperative MR T2-weighted imaging sagittal view (A), plain radiograph at final follow-up: anterior-posterior view (B) and lateral view (C)

MRI showed decompression of the OLF at the lesion. Radiographs confirmed the laminoplasty at the T9–T10 level.

Figure 5. Case 3

Preoperative MR T2-weighted imaging sagittal view (A), CT myelography sagittal (B), and axial views (C) at admission

MRI showed ISI suggesting spinal cord injuries at the T11–T12 level. CT myelography showed OLF at the same level.

Figure 6. Case 3

Postoperative MR T2-weighted imaging sagittal view (A), plain radiograph at final follow-up: anterior-posterior view (B) and lateral view (C)

MRI showed decompression of the OLF at the lesion. Radiographs confirmed the laminoplasty at the T11–T12 level.