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Relationships between posterior ligamentous complex injury and radiographic parameters in patients with thoracolumbar burst fractures

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ABSTRACT

Introduction: The purpose of this study was to determine whether radiographic findings associated with thoracolumbar burst fractures could also indicate the presence of posterior ligamentous complex (PLC) injuries, which were identified through short-tau inversion-recovery (STIR)-weighted MRI.
Patients and method: Sixty-four patients were surgically treated for thoracolumbar burst fractures between April 2007 and February 2014 at our institution. Twenty-four patients were excluded from this study because of the lack of STIR-weighted MRIs, and therefore 40 patients were included in this study. The patients were divided into two groups based upon the integrity of the PLC, which was evaluated using STIR-weighted MRI: a P group with a PLC injury and a C group without such injury. The following radiographic parameters were evaluated: loss of vertebral body height (LOVBH), local kyphosis (LK), vertebral body translation, canal compromise (sagittal transverse ratio, STR), interlaminar distance (ISD), supraspinous distance (SSD) and interspinous distance (ISD). Frankel scale score and total severity score (load sharing and thoracolumbar injury classification systems, respectively) were also evaluated.
Results: Preoperative STIR-weighted MRI showed that 25 patients had a PLC injury (P group: 15 men and 10 women), and 15 patients did not have a PLC injury (C group: 8 men and 7 women). More patients in the P group had an LK $> 20^{\circ}$: 14 patients in the P group and 1 patient in the C group ($p < 0.01$). The % SSD differed between the P and C groups ($118.8\% \pm 53.4\%$ and $88.0\% \pm 24.3\%$, respectively; $p < 0.05$). Multivariate logistic analysis showed that an LK $> 20^{\circ}$ was a risk factor for PLC injury in patients with thoracolumbar burst fractures (odds ratio, 55.5 [95% confidence interval, 1.30–2360.1]; $p < 0.05$).
Conclusions: These results demonstrate that while LOVBH, vertebral body translation, and canal compromise do not correlate significantly with the presence of a PLC injury in patients with thoracolumbar fractures, an LK $> 20^{\circ}$ and increased % SSD are associated with a PLC injury.

Introduction

Although thoracolumbar burst fractures are a relatively common injury of the spine, they pose a challenge to the treating physician due to the controversy remaining over the diagnostic modalities and therapeutic options for this condition [1,2]. Many studies have focused on the management of thoracolumbar burst fractures, yet there is little consensus on the guidelines for treatment. Hu et al. [3] reported that the majority of thoracolumbar burst fracture cases with no neurological deficit may be managed conservatively. However, for patients with neurological deficits, especially incomplete neurological injury, it is generally accepted that surgical treatment has significant advantages of improving pain, mobilization, and pulmonary function. Ideally, surgery should effectively correct the deformity, induce neurological recovery, allow early mobilization and return to work, and be associated with minimal risk of complication.

The controversy in part stems from the different methods employed to evaluate fracture stability, which leads to a variability in treatment choices for thoracolumbar burst fractures [4–6]. The

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integrity of the posterior ligamentous complex (PLC) has recently been shown to greatly influence the degree of stability in patients with thoracolumbar fractures. In a biomechanical study, James et al. [7] revealed that thoracolumbar burst fractures with associated posterior element disruption are unstable and at risk for local kyphotic progression. Therefore, accurate diagnosis of PLC integrity is important for the assessment of traumatic spinal instability. Vaccaro et al. [8] reported the first classification system that included the patient's neurological status and PLC injury as items that can be evaluated. They introduced a thoracolumbar injury classification and severity score (thoracolumbar injury classification system: TLICS), which was later modified. This classification system has proven to be helpful in identifying posterior instability and is often used as a guide for treating thoracolumbar burst fractures [9,10].

In the evaluation of thoracolumbar burst fractures, radiological examinations are of critical importance for detecting the presence of fractures, assessing the severity of the injury, and guiding clinical decisions. Plain radiographs provide important information regarding the injury, but the current modality of choice is computed tomography (CT), since it provides a more accurate portrayal of the degree of vertebral body comminution and canal compromise by the retropulsed bony fragment. The role of magnetic resonance imaging (MRI) in the assessment of spinal injuries is also continuing to evolve. Generally, in the absence of neurological deficits, MRI of thoracolumbar fractures is not considered necessary in the acute phase. However, MRI provides a direct visualization of the soft tissues of the spine, which previously could only be evaluated through secondary or indirect signs. In particular, MRI provides greater diagnostic accuracy for detecting PLC injuries [11].

The PLC is comprised of the supraspinous ligament, interspinous ligament, ligamentum flavum, and the facet capsule. The PLC is considered to be a critical predictor of spinal fracture stability [12], and is regarded as a determinant of the stability of burst fractures. Some groups have reported that PLC injuries are a risk factor for late kyphosis after burst fractures, because the PLC plays a significant role in resisting flexion-deforming forces [13–15]. Although short-tau inversion-recovery (STIR)-weighted MRI has been shown to be capable of identifying PLC injuries [11,16], reports regarding the use of STIR-weighted MRI to examine PLC injuries in association with thoracolumbar burst fractures are limited. Furthermore, it would be of tremendous value if the possibility of a PLC injury could be evaluated from plain radiographs.

Therefore, the purpose of this study was to determine whether radiographic findings associated with thoracolumbar burst fractures could be predictors of PLC injuries, which were identified through STIR-weighted MRI.

Methods

This investigation was designed as a single-centre retrospective comparative study. The fractures were located in the thoracolumbar junction between T11 and L2. Sixty-four consecutive patients (38 men and 26 women) were treated surgically between April 2007 and February 2014 at a single institution. The exclusion criteria were: (1) pathological fractures, (2) underlying inflammatory arthropathies of the spine, (3) pre-existing neurological deficits, and (4) dislocation fractures. In the assessment and treatment of spinal trauma, a coherent and logical rationale must be followed in order to achieve the desired results, but individualised decisions are often required. Although non-operative treatment may play a role in cases without neurological deficit and instability, prolonged recumbency increases the risk for complications such as decubitus ulcers, deep vein thrombosis and pneumonia. Recognizing the fact that such complications can be reduced by early operative treatment, we recommended surgery for cases with neurological deficit and/or instability.

The diagnosis of thoracolumbar burst fracture was established by X-ray and CT in the sagittal and axial planes. STIR-weighted MRI in the sagittal plane was used to identify the morphological pattern of the fractures and to evaluate the state of the intervertebral discs and the PLC (Fig. 1). The thoracolumbar burst fracture or PLC injury were analyzed by experienced orthopaedic surgeons and radiologists. The results of these imaging methods were used to assess the level of injury and the integrity of the PLC at the spinal level involved. Preoperative MRI was used to classify the PLC as either intact or disrupted based on the following criteria: (1) a discontinuity of the black stripe (low signal intensity) on T1- and/or T2-weighted images, and/or (2) a high signal intensity on STIR-weighted MRI. The high signal intensity on STIR-weighted MRI was the most important finding, and the PLC injury was further classified as a supraspinous ligament and/or interspinous ligament injury based upon the MRI findings. The patients were divided into two groups for the comparative study: a P group with

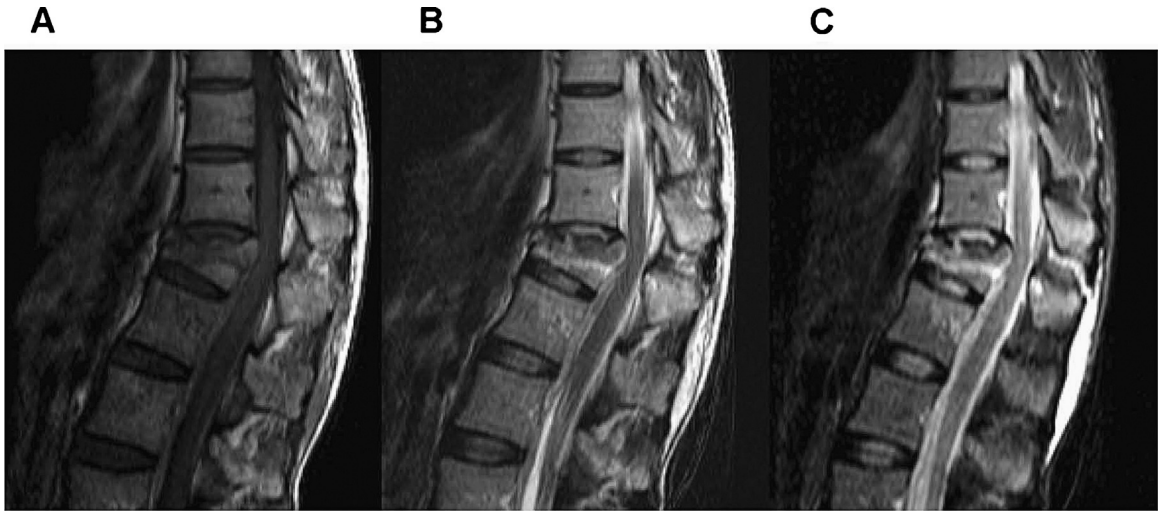

Fig. 1. Evaluation of PLC integrity in a patient with a L1 burst fracture. The presence of a PLC injury was evaluated by the signal change in STIR-weighted MRI. (a) T1-weighted, (b) T2-weighted, and (c) STIR-weighted sagittal images.