Laminar fractures as a severity marker in burst fractures of the thoracolumbar spine

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ABSTRACT

Purpose. To assess the correlation between the presence of lamina fractures, narrowing of the spinal canal, and the severity of injury.

Methods. Records of 146 men and 44 women aged 13 to 84 (mean, 39) years diagnosed with burst fractures of the thoracolumbar spine were retrospectively reviewed. The laminar fractures and narrowing of the spinal canal were measured using computed tomography. The severity of injury was determined using the Injury Severity Score (ISS) and the New Injury Severity Score (NISS). The ISS and NISS of patients with and without laminar fractures were compared. The sensitivity and specificity of ISS, NISS, and narrowing of the spinal canal in association with laminar fractures were also compared.

Results. 92 (48%) of the patients had laminar fractures. The mean narrowing of the spinal canal was more severe in patients with laminar fractures than those without (47% vs 28%, p<0.001). Patients with laminar fractures had a significantly higher mean ISS (17 vs 12, p<0.001) and NISS (19 vs 13, p<0.001). Narrowing of the spinal canal is more sensitive and specific than the ISS and NISS when correlating laminar fractures.

Conclusion. In patients with burst fractures of the thoracolumbar spine, the presence of laminar fractures indicates a more severe injury.

Key words: injury severity score; lumbar vertebrae; neurologic examination; spinal fractures; thoracic vertebrae

INTRODUCTION

Burst fractures of the thoracolumbar spine are due to collapse of the vertebral body under great axial pressure. Their radiographic characteristics are: the presence of spacing between the pedicles on the anteroposterior (AP) view, a reduction in vertebral height on the lateral view, and fragmentation of the vertebral body into the spinal canal.\(^1,2\) Computed tomography (CT) enables measurement of the diameter of the compromised spinal canal and the posterior arch (Fig. 1) and thus a more accurate diagnosis.\(^3\)

The energy of trauma determines the severity of the injury and therefore can be measured indirectly...
by the Injury Severity Score (ISS) and the New Injury Severity Score (NISS).4–6 In burst fractures of the thoracolumbar spine, the narrowing of the spinal canal caused by bone fragments of the vertebral body (frequently associated with neurological deficits) is considered the best indirect measurement of the energy of trauma.7,8 Nonetheless, the exact impact of an associated laminar fracture as an isolated severity marker remains unknown. An associated laminar fracture is a main contributor to the severity of injury and should be included in the treatment plan.1,9–13 We assessed the correlation between the presence of laminar fractures, the narrowing of the spinal canal, and the severity of injury.

MATERIALS AND METHODS

Records (clinical and neurological data, AP and lateral radiographs, and axial CT) of 146 men and 44 women aged 13 to 84 (mean, 39; standard deviation [SD], 15) years diagnosed with burst fractures of the thoracolumbar spine from January 1985 to July 2006 were retrospectively reviewed. Patients with neurologic deficits prior to trauma, penetrating injuries, and pathological fractures were excluded. The most common cause of injury was a fall from height (n=140). Most fractures were at the transition between the thoracic and lumbar spine; 83 patients had fractures at L1. 102 and 88 patients underwent conservative and surgical treatment, respectively.

The laminar fractures and narrowing of the spinal canal (the midsagittal diameter) were measured using a transparent millimetric ruler.8,11,14 The normal diameter was estimated by averaging the diameter of adjacent vertebrae (above and below).

The neurologic deficit of patients was graded according to the Frankel classification.15 The severity of injury was determined by the ISS4 and the NISS.6 Both are based on the Abbreviated Injury Scale (AIS) used to classify anatomic lesions resulting from trauma.16

The ISS and NISS of patients with and without laminar fractures were compared using the Mann-Whitney U test. The sensitivity and specificity of ISS, NISS, and narrowing of the spinal canal in association with laminar fractures were compared using the receiver operating characteristic curve. A p value of <0.05 was considered statistically significant.

RESULTS

According to the Frankel classification, 9 (5%) of the patients were grade A, 4 (2%) grade B, 10 (5%) grade C, 21 (11%) grade D, and 146 (77%) grade E. 92 (48%) of the patients had laminar fractures. The mean narrowing of the spinal canal of all patients was 37% (range, 5–100%); it was more severe in patients with laminar fractures than those without (47% vs 28%, p<0.001, Table). The mean ISS and NISS values of all patients were 14 and 16, respectively. Patients with

<table>
<thead>
<tr>
<th>Variable</th>
<th>Laminar fracture</th>
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<tbody>
<tr>
<td>No. of patients</td>
<td>190</td>
</tr>
<tr>
<td>Present</td>
<td>92</td>
</tr>
<tr>
<td>Absent</td>
<td>98</td>
</tr>
<tr>
<td>Mean±SD (range) narrowing of the spinal canal (%)</td>
<td>47±18 (14–100)</td>
</tr>
<tr>
<td>Mean±SD (range) Injury Severity Score</td>
<td>17±8 (4–43)</td>
</tr>
<tr>
<td>Mean±SD (range) New Injury Severity Score</td>
<td>19±10 (4–50)</td>
</tr>
<tr>
<td>Mean±SD (range)</td>
<td>28±14 (5–66)</td>
</tr>
<tr>
<td>Mean±SD (range)</td>
<td>12±7 (4–43)</td>
</tr>
<tr>
<td>Mean±SD (range)</td>
<td>14±8 (4–43)</td>
</tr>
</tbody>
</table>

* p<0.001, Mann-Whitney U test
laminar fractures had significantly higher ISS (17 vs 12, p<0.001) and NISS (19 vs 13, p<0.001). In 50% of the patients with and without laminar fractures respectively, the narrowing of the spinal canal was 33 to 57% and 17 to 37%; the mean values for ISS were 21 and 13, and for NISS were 25 and 15. Narrowing of the spinal canal showed a greater area in the receiver operating characteristic curve than ISS or NISS did (Fig. 2), indicating such narrowing had higher correlation with laminar fractures.

**DISCUSSION**

Determining the severity (stable or unstable) of spinal fractures is important in planning treatment and avoiding neurologic deficits. CT enables accurate measurement of the narrowing of the spinal canal, and hence determination of correlation between the severity of the lesion and neurologic deficits. The presence of laminar fractures in patients with burst spinal fractures is indicative of greater severity and potential instability. However, a greater mechanical force dissipated over the vertebra does not necessarily imply greater instability. The presence of laminar fractures in burst fractures of the thoracolumbar spine indicates a higher chance of damage to the posterior dural sac and trapping of neural elements between laminar fragments.

Classification of burst spinal fractures based on anatomic and functional alteration facilitates treatment. Morphologic evaluation of the burst fractures, the posterior ligament complex, and the neurologic status are all important. Narrowing of the spinal canal caused by fragments of the fractured vertebrae in burst thoracolumbar fractures is associated with impaired neurological function. In our study, narrowing of the spinal canal was associated with laminar fractures.

The ISS and NISS help determine the management and prognosis of the injury and are routinely used to evaluate the severity of trauma in emergency cases. Only a few studies used these scores in isolated burst fractures of the thoracolumbar spine. In our study, the presence of laminar fractures in patients with burst fractures of the thoracolumbar spine was associated with higher ISS and NISS values, consistent with other studies on similar fractures caused by blunt trauma secondary to diverse aetiologies. Both the ISS and NISS are not appropriate markers for the presence of lamina fractures, because the ranges of both scores were wide in patients without laminar fractures. Narrowing of the spinal canal is more sensitive and specific than the ISS and NISS for correlating laminar fractures. In patients with burst fractures of the thoracolumbar spine, the presence of laminar fractures indicates a more severe injury.

**REFERENCES**