Anterior versus modified combined instrumentation for burst fractures of the thoracolumbar spine: a biomechanical study in calves

G Tezeren,1 C Gumus,2 O Bulut,1 M Tukenmez,3 Z Oztemur,1 G Sever1

1 Department of Orthopaedics and Traumatology, Cumhuriyet University School of Medicine, Sivas, Turkey
2 Department of Radiology, Cumhuriyet University School of Medicine, Sivas, Turkey
3 Department of Orthopaedics and Traumatology, Baskent University Hospital, Konya, Turkey

ABSTRACT

Purpose. To compare stability after anterior instrumentation alone versus modified combined anterior and posterior instrumentation for burst fractures of the thoracolumbar spine in calves.

Methods. Thoracolumbar spines of 10 calves were used. An axial compression force was applied on each specimen using a material-testing machine, until there was a burst fracture at T12 or L1. Five specimens were fixed with anterior instrumentation alone, using 2 rods connected by 2 screws above and 2 screws below the fractured vertebra plus one transverse connector. Another 5 were fixed with our modified technique of combined anterior and posterior instrumentation. This entailed one rod connected with one screw above and one screw below the fractured vertebra anteriorly, and another rod connected with one transpedicular screw above and one transpedicular screw below the fractured vertebra posteriorly. After instrumentation, the experiment was conducted again on each specimen and the compressive stiffness and vertebral height loss between the 2 groups compared.

Results. The mean compressive stiffness was significantly greater after modified combined anterior and posterior instrumentation than anterior instrumentation alone (5508 vs 2888 N, p=0.0256), whereas the respective vertebral height losses were 37 and 33 mm (p=0.3808).

Conclusion. Our modified technique of combined anterior and posterior instrumentation provides greater stability than traditional anterior instrumentation alone.

Key words: biomechanics; fracture fixation; spinal fractures

INTRODUCTION

The treatment goals for thoracolumbar burst fractures with neurological deficit are anatomic stabilisation of vertebrae, optimal restoration of neurological function and painless normal life. Anterior decompression and instrumentation using 2 rods connected by 2 screws...
above and 2 screws below the fractured vertebra has been recommended. In cases with additional posterior column injury, posterior instrumentation should be added. We aimed to compare vertebral stability after traditional anterior instrumentation alone versus that following our modified technique of combined anterior and posterior instrumentation.

**MATERIALS AND METHODS**

*Ex vivo* thoracolumbar spines of 10 calves stripped of soft tissues but with intact ligaments were used. An axial compression force (mean, 17250 N; range, 16000–18500 N) was applied on the top and bottom of each specimen using a material-testing machine (Fig. 1) at a speed of 40 mm/minute until there was a burst fracture at the weakest part in the middle vertebrae (T12 or L1).

Five specimens were fixed with anterior instrumentation alone, using 2 rods connected by 2 screws above and 2 screws below the fractured vertebra plus one tranverse connector. Another 5 specimens were fixed with our modified technique of combined anterior and posterior instrumentation. This entailed one rod connected by one screw above and one screw below the fractured vertebra anteriorly, and another rod connected with one transpedicular screw above and one transpedicular screw below the fractured vertebra posteriorly (Figs. 2 and 3). All implants were made of titanium.

After instrumentation, the experiment was conducted again on each specimen and the compressive stiffness (maximum load) and vertebral height loss between the 2 groups compared using the unpaired *t*-test.
RESULTS

According to the Denis classification,\textsuperscript{5} the burst fractures were categorised as types A (n=2), B (n=5), C (n=1), and D (n=2). Before instrumentation, the mean vertebral height loss was 40 (from 70 to 30) mm, and the mean vertebral canal encroachment was 9 (from 16 to 7) mm. After instrumentation, the mean compressive stiffness was significantly greater in the modified combined anterior and posterior instrumentation group than the anterior instrumentation alone group (5508 vs 2888 N, p=0.0256, unpaired t-test; Table), whereas the respective vertebral height losses were 37 and 33 mm (p=0.3808, unpaired t-test; Table).

DISCUSSION

The choice of treatment for burst fractures of the thoracolumbar spine with neurological deficit is controversial. Posterior decompression,\textsuperscript{7–9} anterior decompression and instrumentation,\textsuperscript{3,4,10} and anterior decompression and posterior instrumentation\textsuperscript{11,12} have been recommended. For correction of kyphosis with neurological deficit, the posterior procedure is considered as effective as the anterior or combined anterior and posterior procedure.\textsuperscript{8} The posterior procedure takes the least operating time, causes the least blood loss, and is the least expensive of the 3.\textsuperscript{8} Nonetheless, the anterior procedure should be used in patients with >20% canal compromise or when there is no resolution of neurological deficit after a posterior procedure.\textsuperscript{8} Anterior or combined anterior and posterior instrumentation is superior to posterior instrumentation alone in terms of decompression and stability.\textsuperscript{2,13} As compression in front of the dural tube is the main cause of neurological deficits, one-stage anterior decompression and instrumentation enables unfused segments in the lumbar spine to be left.\textsuperscript{3} Emergency surgery should be performed in cases of incomplete neurological deficit but not when there is complete paraplegia.\textsuperscript{14} When the main lesion is in the anterior and middle columns, anterior decompression and instrumentation should be used.\textsuperscript{15} Acute unstable burst fractures are characterised by posterior column disruption.\textsuperscript{15,16} The degree of neurological impairment is greater in patients with additional posterior column disruption.\textsuperscript{17} Anterior instrumentation alone may not be rigid enough to stabilise patients with severe posterior ligamentous injury.\textsuperscript{18} Therefore, patients with burst fractures of the spine and posterior column disruption should be fixed with combined anterior and posterior instrumentation, despite a higher morbidity.\textsuperscript{17} Our modified technique of combined anterior and posterior instrumentation provides greater stability than traditional anterior instrumentation alone and probably offers lower morbidity than traditional combined anterior and posterior instrumentation. Further studies with rotation and flexion-extension tests are needed.

<table>
<thead>
<tr>
<th>Specimens</th>
<th>Compressive stiffness (N)</th>
<th>Vertebral height loss (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior instrumentation alone</td>
<td>Mean=2888</td>
<td>Mean=33</td>
</tr>
<tr>
<td>1</td>
<td>2900</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>2320</td>
<td>39</td>
</tr>
<tr>
<td>3</td>
<td>3630</td>
<td>42</td>
</tr>
<tr>
<td>4</td>
<td>4860</td>
<td>34</td>
</tr>
<tr>
<td>5</td>
<td>730</td>
<td>24</td>
</tr>
<tr>
<td>Modified combined anterior and posterior</td>
<td>Mean=5508</td>
<td>Mean=37</td>
</tr>
<tr>
<td>instrumentation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>5000</td>
<td>25</td>
</tr>
<tr>
<td>7</td>
<td>3400</td>
<td>37</td>
</tr>
<tr>
<td>8</td>
<td>5500</td>
<td>44</td>
</tr>
<tr>
<td>9</td>
<td>7440</td>
<td>41</td>
</tr>
<tr>
<td>10</td>
<td>6200</td>
<td>39</td>
</tr>
</tbody>
</table>

REFERENCES