Monosegmental vs bisegmental pedicle fixation for the treatment of thoracolumbar spine fractures

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\textbf{A R T I C L E   I N F O}

\textbf{Keywords:}
Thoracolumbar fractures
monosegmental stabilisation
bisegmental stabilisation
short fusion

\textbf{A B S T R A C T}

\textbf{Introduction:} The anatomy and biomechanics of the thoracolumbar spine place these segments at high risk of trauma injuries. Treatment options are either conservative or surgical, and there is a lack of consensus about the right indications. International scientific publications agree only on basic surgical principles: vertebral stability, deformity correction, protection of neurological structures and fast functional recovery. The most commonly used approach is the posterior approach, which allows the best management of most vertebral fracture patterns. The aim of this study was to compare clinical and radiological outcomes of monosegmental stabilisation with those of bisegmental stabilisation and fusion in the treatment of traumatic thoracolumbar spine fractures.

\textbf{Materials and methods:} This retrospective clinical and radiological study evaluated 48 consecutive patients treated with monosegmental (Group M; n = 14) or bisegmental (Group B; n = 34) posterior pedicular instrumentation for thoracolumbar fractures. Fractures were classified by the new AO Spine TLIC system. Average follow-up was 30 months. Clinical outcomes in both groups were statistically compared. Radiological outcomes were evaluated in terms of vertebral anterior body height restoration and correction of the kyphotic deformity.

\textbf{Results:} Radiographical results showed no statistically significant difference between the two groups in vertebral body height restoration and correction of the kyphotic deformity. The mean postoperative somatic vertebral anterior body height in Group M was 25.8 ± 4.52 mm and in Group B it was 24.43 ± 4.27 mm. In Group M the mean postoperative kyphotic deformity was 11.10 ± 5.71°, in Group B it was 9.09 ± 4.93°.

\textbf{Conclusions:} The results of this study confirm the validity of short and very short instrumentation for the treatment of well-selected type A and B vertebral fractures. In C type fractures correct surgical indication must be evaluated on an individual basis.

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\textbf{Introduction}

The thoracolumbar segment continually undergoes high biomechanical stresses and is often involved in traumatic fractures that cause severe pain, vertebral deformity and high risk of neurological damage.

There is currently no consensus on the surgical indications and the best surgical approach for the treatment of traumatic thoracolumbar spine fractures. Nevertheless, the main goals of surgical treatment are constant and include restoration of vertebral stability, correction of vertebral deformity, eventual decompression of the neural elements and functional recovery.

Posterior surgical access enables the reduction of the majority of thoracolumbar fractures, but a real understanding of the traumatic mechanism and a precise evaluation of the anatomical damage is needed to identify unstable or potentially unstable lesions that require surgical stabilisation. For this reason, Magner introduced a systematic classification of thoracolumbar fractures that considers the fracture mechanism and the extension of the fracture to the different vertebral elements [1]. Additionally, the Load Sharing Classification proposed by McCormack et al. led to a better understanding of the fractural pattern to avoid the failure of short-segment stabilisation [2]. They proposed a score

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classification system that considered the amount of bone fragmentation, dislocation and kyphotic deformity, and they concluded that a score higher than 6 could be associated with a higher risk of surgical failure. The recently published AO Spine classification and injury severity system for traumatic fractures of the thoracolumbar spine, based on the modified Magerl classification, incorporate both fracture morphology and clinical factors relevant for surgical decision-making, such as the presence of neurological deficits [3].

The new classification system divided thoracolumbar fractures into three different groups that can be identified through the analysis of radiographs and CT: compression fractures (Type A), failure of the posterior or anterior tension band (Type B), and failure of all elements leading to dislocation or displacement in any plane (Type C).

Subtype A1 injuries are fractures of a single endplate without involvement of the posterior vertebral wall; subtype A2 injuries are split- or pincer-type fractures in which the fracture line involves both endplates; subtype A3 injuries are vertebral fractures affecting a single endplate with any involvement of the posterior wall and the spinal canal; and subtype A4 injuries are vertebral body fractures involving both endplates as well as the posterior wall.

Subtype B1 injuries are monosegmental osseous failure of the posterior tension band extending into the vertebral body; subtype B2 injuries demonstrate a disruption of the posterior tension band with or without osseous involvement; and subtype B3 injuries disrupt the anterior longitudinal ligament that serves as the anterior tension band of the spine, preventing hyperextension.

A large variety of instrumentation is available for the treatment of thoracolumbar spinal fractures, but posterior pedicle screw instrumentation systems are currently most frequently used because their employment enables the simultaneous application of compression, distraction and translational forces to the spine to reduce deformity [4]. One of the most important decision-making problems in these patients is the fusion area, which should be as short as possible to preserve functional units and adjacent levels. Initial fixation methods employed long stabilisation constructs, which included two to three levels above and two levels below the fractured vertebra; however, the increased risk of long-term degeneration of the adjacent segment, particularly in younger patients, led to the use, in selected cases, of shorter constructs to spare motion segments [5,6]. Short-segment pedicle instrumentation has been widely accepted as an advanced approach to treat thoracolumbar burst fracture since the first report by Roy-Camille [7]. The insertion of screws and rods into the vertebral bodies proximal and distal to the injured vertebra can stretch the anterior and posterior longitudinal ligaments, and subsequently help to restore the injured vertebral body. However, because two motion segments of spine were fixed, the long rod and high-force moment of short instrumentation can lead directly to high stress between the rods and the screws: broken rods and screws have been frequently observed in clinical practice. It has also been suggested that short instrumentation could easily induce loss of correction and degeneration of adjacent segments [8,9]. To preserve more motion segments, some authors have advocated using monosegmental pedicle screw instrumentation to treat thoracolumbar fractures.

The escalating use of minimally-invasive techniques has led surgeons to increasingly reduce the stabilisation area. In fact, the concept of a mini-invasive approach encourages the surgeon to preserve tissues and function as much as possible, without compromising the clinical result. Only incomplete burst fractures with intact pedicles and inferior endplate should be considered for posterior monosegmental reduction and stabilisation. Contra-indications to a monosegmental posterior stabilisation are broken pedicles and complete burst fractures of the body.

The aim of the current study was to compare clinical and radiological outcomes of monosegmental stabilisation with those of bisegmental stabilisation and fusion in treatment of traumatic thoracolumbar spine fractures, evaluating the results in terms of vertebral body height restoration and correction of the kyphotic deformity.

Materials and methods

This study analyses a sample of 48 selected patients who underwent surgical treatment for a traumatic vertebral fracture: 14 patients were treated with monosegmental instrumentation (Group M) and 34 patients with bisegmental instrumentation (Group B); each patient had one level treated giving a total of 48 treated vertebrae. There were 22 male and 26 female patients with a mean age of 46 years (range 26-84 years). The main inclusion criterion was the presence of a type A, B or C traumatic injury of the spine.

All patients underwent posterior spinal instrumentation and fusion with homologous bone graft. All the patients were treated by the same surgeon with the same instrumentation system by using Schanz screws. All cases were treated through the use of a conventional midline posterior access using either monosegmental (14 cases) or bisegmental (34 cases) instrumentation.

Indication for monosegmental instrumentation in type A fractures was determined by the presence of at least one-third of healthy vertebral body to have enough bone tissue to insert the screws.

The treated levels were included between T8 and L5: Fig. 1 shows the distribution of treated levels with reference to the performed surgical procedure (mono- or bisegmental instrumentation).

Monosegmental instrumentation was performed in two patients affected by a type A1 fracture, five patients affected by a type A3 fracture, three patients affected by a type B2 fracture and four patients affected by a type C fracture (Figs. 2–4). Bisegmental instrumentation was used in 22 patients affected by a type A3 fracture, five patients affected by a type B2 fracture, and seven patients affected by a type C fracture (Figs. 5 and 6). No patients were affected by a type A1 fracture. Fig. 7 shows the surgical procedure performed for the different types of fracture.

All patients were evaluated clinically and radiographically at least 6 months and 1 year after the surgical procedure and the main differences between the results of the two techniques were assessed.

Results

The aim of the current study was to compare the clinical and radiographical results of monosegmental and bisegmental stabilisation in the treatment of traumatic thoracolumbar type A and type B spine fractures, in terms of vertebral body height restoration and somatic kyphotic correction.

A three-phase analysis was developed: firstly, the two techniques were compared considering all the types of fractures (A and B together, overall analysis); secondly, A and B fractures were considered separately, and thirdly, A1, A.3, B.2 and C subgroups were considered separately.

1) Overall Analysis

The aim of this analysis was to give an overview of how the two techniques behave in relation to the new AO Spine classification.

The radiographical results were as follows: the mean value of the pre-operative somatic vertebral anterior body height in patients treated using monosegmental instrumentation (Group M) was $21.82 \pm 5.72$ mm and in patients treated using a bisegmental procedure (Group B) it was $20.45 \pm 5.46$ mm. A Student
T-Test was performed to compare these mean initial heights and there was no statistically significant difference between the two groups (p-value >0.05, considering 0.05 as significance level).

The mean postoperative somatic vertebral anterior body height in Group M was $26.39 \pm 3.81$ mm whereas in Group B it was $25.25 \pm 4.52$ mm. Therefore, the mean body height restoration was $4.57$ mm in Group M and $4.79$ mm in Group B. These results were not statistically significantly different ($p > 0.05$; Student T-Test), which indicates that both procedures have the same effectiveness in vertebral body height restoration.

The mean value of the pre-operative kyphotic deformity was $12.78^{\circ} \pm 5.33^{\circ}$ in patients treated using monosegmental instrumentation, and $12.18^{\circ} \pm 5.95^{\circ}$ in patients treated using a bisegmental procedure. A Student T-Test performed to compare these mean initial kyphotic deformity values did not show statistically significant differences between the two groups ($p > 0.05$).

The mean postoperative kyphotic deformity was $9.72^{\circ} \pm 4.87^{\circ}$ in Group M and $8.68^{\circ} \pm 4.61^{\circ}$ in Group B; the correction of kyphosis was $3.06^{\circ}$ in Group M and $4.11^{\circ}$ in Group B. Although these mean values seem quite different, a Student T-Test still did not prove a significant difference between the two groups ($p > 0.05$).

Vertebral body height and kyphosis were evaluated again during the 12 months following the surgical procedure and were compared to the immediate postoperative data.

As reported in Table 1, patients treated through a monosegmental instrumentation showed a loss of vertebral body height...
that corresponded to a mean value of 3.03 mm and 4.36 mm, after 6 months (6M-Post) and 1 year (1Y-Post), respectively. On the other hand, patients treated using a bisegmental procedure showed a loss of 2.48 mm after 6 months and of 3.91 mm after 1 year. The Student T-Tests performed to compare the vertebral body heights at 6 and 12 months after surgery to the immediate postoperative body height did not prove any statistically significant difference between the results of mono- and bisegmental instrumentation (p > 0.05).

The corresponding results for the correction of the kyphotic deformity are shown in Table 2. Group M showed a loss of correction of 1.85° after 6 months and of 3.75° after 1 year. Similarly, Group B showed losses of 0.78° and 1.23° after 6 and 12 months, respectively.

Using the same algorithm already exploited in the analysis of body height restoration, these results were compared through a Student T-Test, which did not prove a significant difference between the two groups (p > 0.05).

Considering this is a unique group of fractures, the statistical analysis shows that both procedures give similar results in terms of maintenance of vertebral body height restoration and kyphosis correction during long-term follow-up.

**Fig. 4.** One-year follow-up X-rays in standing position show the complete reduction of the T11/T12 subluxation and the restoration of a good coronal and sagittal balance achieved with a monosegmental stabilisation and fusion.

**Fig. 5.** Supine antero-posterior and latero-lateral radiographic views of a 22-year-old man who had a high-energy road traffic trauma with an L1 burst fracture and a T12-L1 vertebral subluxation. It is a type C fracture of the classification and ISS proposed by AO Spine. The picture on the right shows the immediate postoperative X-rays after a bisegmental stabilisation and fusion. It is possible to see the complete reduction of the subluxation with a perfect reconstruction of the vertebral body by using ligamentotaxis.
Considering the mean value of the height of the healthy vertebra overwhelming the fractured level (HVOFL) as a target value to be reached in body height restoration (Group M: 28.06 mm, Group B: 27.75 mm) \textbf{Fig. 8}, shows a plot of the attained percentage of the HVOFL height versus time for levels treated through mono- and bisegmental instrumentation. The results on the graph indicate that both procedures offer similar performance in terms of vertebral body height restoration: short instrumentation offers a little advantage immediately after the surgical treatment and in short-term follow-up (6 months); nevertheless

\textbf{Fig. 6}. Comparison between the CT scans performed before and two years after surgery. The two years follow-up shows a perfect posterior wall reconstruction and remodelling with a complete restoring of the neural canal.
this advantage is lost after 1 year. The precise values corresponding to this plot are reported in Table 3. No difference was seen between the two groups in terms of clinical results regarding pain and return to work. Both groups had excellent clinical results with 95% of patients able to return to their previous activities.

2) Type A and Type B fractures

The aim of this analysis was to study the effectiveness of the two procedures with the type A and type B fractures considered separately following the new AO Spine classification.

2.1. Type A fractures

A total of 29 patients in the study suffered from a type A fracture, seven of them were treated using monosegmental (Group M-A) instrumentation and the remaining 22 using a bisegmental technique (Group B-A).

Table 1
Vertebral body height differences ($\Delta h$) measured in mm at successive times.

<table>
<thead>
<tr>
<th></th>
<th>$\Delta h$ (Post – Pre)</th>
<th>$\Delta h$ (6 M – Post)</th>
<th>$\Delta h$ (1Y – Post)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group M</td>
<td>4.57 ± 4.56</td>
<td>-3.03 ± 2.78</td>
<td>-4.36 ± 2.61</td>
</tr>
<tr>
<td>Group B</td>
<td>4.79 ± 3.25</td>
<td>-2.48 ± 2.67</td>
<td>-3.91 ± 4.98</td>
</tr>
</tbody>
</table>

Table 2
Somatic kyphosis correction ($\Delta kc$) and loss of this correction ($\Delta kl$) measured in degrees at successive times.

<table>
<thead>
<tr>
<th></th>
<th>$\Delta kc$ (Post – Pre)</th>
<th>$\Delta kl$ (6 M – Post)</th>
<th>$\Delta kl$ (1Y – Post)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group M</td>
<td>3.06 ± 1.83</td>
<td>1.85 ± 3.16</td>
<td>3.75 ± 3.23</td>
</tr>
<tr>
<td>Group B</td>
<td>4.11 ± 4.28</td>
<td>0.78 ± 2.72</td>
<td>1.23 ± 1.29</td>
</tr>
</tbody>
</table>
Observing radiographic results, the mean value of the pre-operative somatic vertebral anterior body height in Group M-A was 20.70 ± 5.01 mm and in Group B-A it was 19.96 ± 5.64 mm. There were no statistically significant differences in mean initial height between these two groups (p > 0.05; Student T-Test).

The mean postoperative somatic vertebral anterior body height in Group M-A patients was 25.8 ± 4.52 mm whereas in Group B-A it was 24.43 ± 4.27 mm. The mean body height restoration in Group M-A was 5.1 mm and in Group B-A it was 4.47 mm. Again, there was no statistically significantly different between the two groups (p > 0.05; Student T-Test).

The mean value of the pre-operative kyphotic deformity was 14.11° ± 6.36° in Group M-A and 13.08° ± 5.93° in Group B-A (p > 0.05). The mean postoperative kyphotic deformity was 11.10° ± 5.71° and 9.09° ± 4.93° in Group M-A and Group B-A, respectively. Therefore, the mean correction of kyphosis was 3.01° in Group M-A and 3.99° in Group B-A, which again was not statistically significant in the Student T-Test (p > 0.05).

The follow-up results concerning vertebral body height and kyphosis are reported in Table 4 and Table 5, respectively. For a comparison, the differences between pre-operative and postoperative mean values were also reported.

Several T-Tests were performed to compare the differences between groups at respective times of the follow-up period and none reported a statistically significant p-value.

As before, considering the mean value of the height of the HVOLF as a target value to be reached in body height restoration (Group M-A: 28.32 mm, Group B-A: 27.74 mm), Fig. 9 shows a plot of the attained percentage of the HVOLF height versus time for levels treated through monosegmental and bisegmental instrumentation. As shown in the graph, both procedures offer similar performances in terms of vertebral body height restoration: short instrumentation offers a little advantage immediately after the surgical treatment and in short-term follow up (6 months); nevertheless this advantage is lost after 1 year. The values corresponding to this plot are reported in Table 6.

2.2. Type B fractures

A total of eight patients in the study suffered from a type B fracture, three of them were treated using monosegmental instrumentation (Group M-B) and the remaining five using a bisegmental procedure (Group B-B).

With regard to radiographic results, the mean value of the pre-operative somatic vertebral anterior body height in Group M-B was 23.5 ± 7.06 mm and in Group B-B was 22.08 ± 4.80 mm (p > 0.05).

The mean postoperative somatic vertebral anterior body height in Group M-B patients was 27.27 ± 2.80 mm whereas in Group B-B patients it was 27.93 ± 4.54 mm. The mean body height restoration in Group M-B patients was 3.77 mm while it was 5.85 mm in Group B-B patients. There was no statistically significant difference between these groups for these results (p > 0.05).

The mean value of the pre-operative kyphotic deformity was 10.77° ± 2.99° in Group M-B while it was 11.87° ± 6.32° in Group B-B (p > 0.05).

The mean postoperative kyphotic deformity was 7.65° ± 2.68° in Group M-B and 7.36° ± 3.34° in Group B-B. Therefore, the mean correction of kyphosis was 3.125° in Group M-B and 4.51° in Group B-B. A Student T-Test did not prove a significant difference between the two groups (p > 0.05).

The follow-up results concerning vertebral body height and kyphosis are reported in Table 7 and Table 8, respectively. For a comparison, the differences between pre-operative and postoperative mean values are also reported.

Several T-Tests were performed to compare the differences at respective times of the follow-up period and none reported a statistically significant p-value.

Considering the mean value of the height of the HVOLF (Group M-B: 27.67 mm, Group B-B: 27.33 mm), Table 9 reports the attained percentage of the mean value of the HVOLF height for both groups at different times. As reported in the table, although the results of the two techniques are very similar, the bisegmental procedure offers an advantage in the immediate postoperative period; this advantage is partially lost after 6 months and is entirely lost after 1 year.

Table 3

<table>
<thead>
<tr>
<th>Group</th>
<th>% Pre</th>
<th>% Post</th>
<th>% 6 Months</th>
<th>% 12 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group M</td>
<td>77.76</td>
<td>94.05</td>
<td>86.06</td>
<td>78.98</td>
</tr>
<tr>
<td>Group B</td>
<td>73.72</td>
<td>91.01</td>
<td>80.34</td>
<td>79.10</td>
</tr>
</tbody>
</table>

Table 5

<table>
<thead>
<tr>
<th>Group</th>
<th>Δh (Post – Pre)</th>
<th>Δh (6M – Post)</th>
<th>Δh (1Y – Post)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group M</td>
<td>3.01 ± 1.35</td>
<td>2.9 ± 4.1</td>
<td>4.04 ± 4.23</td>
</tr>
<tr>
<td>Group B</td>
<td>3.99 ± 4.29</td>
<td>0.5 ± 2.69</td>
<td>1.01 ± 3.28</td>
</tr>
</tbody>
</table>

Table 4

<table>
<thead>
<tr>
<th>Group</th>
<th>Δh (Post – Pre)</th>
<th>Δh (6M – Post)</th>
<th>Δh (1Y – Post)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group M-A</td>
<td>5.1 ± 2.29</td>
<td>-4.42 ± 3.32</td>
<td>-4.70 ± 3.33</td>
</tr>
<tr>
<td>Group B-A</td>
<td>4.47 ± 3.14</td>
<td>-2.24 ± 2.46</td>
<td>-3.96 ± 5.32</td>
</tr>
</tbody>
</table>

Discussion

Posterior spinal fusion with pedicular instrumentation is currently the gold standard for the treatment of thoracolumbar fractures. The diffusion of minimally-invasive surgery led to the development of short-segment pedicle stabilisations. Monosegmental pedicle instrumentation is the shortest spine stabilisation that better defines the concept of minimally-invasive surgery.

Short-segment pedicle instrumentation has evolved significantly since its initial use. Early failure of short constructs opened the discussion on which fractures need a longer stabilisation or an anterior support, but today surgical techniques have been improved and the instrumentation can expand the indication of this procedure.

Currently, short-segment pedicle instrumentation is most commonly used for surgical treatment of thoracolumbar fractures. Screws were usually implanted in the levels above and below the
Fig. 9. Comparison between the percentages of HVOFL obtained through mono- and bisegmental treatments of Type A fractures at different times. Time = −1 corresponds to Preoperative value and Time = 0 corresponds to Postoperative value.

### Table 6
Attained percentage of the mean value of the overwhelming healthy vertebra (Group M-A: 28.32 mm, Group B-A: 27.74 mm) for both groups at different times.

<table>
<thead>
<tr>
<th>Group</th>
<th>% Pre</th>
<th>% Post</th>
<th>% 6 Months</th>
<th>% 12 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-A</td>
<td>73.1</td>
<td>91.11</td>
<td>80.07</td>
<td>68.42</td>
</tr>
<tr>
<td>B-A</td>
<td>71.94</td>
<td>88.06</td>
<td>78.09</td>
<td>76.87</td>
</tr>
</tbody>
</table>

### Table 7
Vertebral body height differences (Δh) measured in mm at successive times.

<table>
<thead>
<tr>
<th>Group</th>
<th>Δh (Post – Pre)</th>
<th>Δh (6 M – Post)</th>
<th>Δh (1Y – Post)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-B</td>
<td>3.77 ± 7.23</td>
<td>−1.65 ± 1.36</td>
<td>−4.25 ± 2.75</td>
</tr>
<tr>
<td>B-B</td>
<td>5.85 ± 3.60</td>
<td>−3.07 ± 3.26</td>
<td>−4.1 ± 3.65</td>
</tr>
</tbody>
</table>

### Table 8
Somatic kyphosis correction (Δk) and loss of this correction (Δkl) measured in degrees at successive times.

<table>
<thead>
<tr>
<th>Group</th>
<th>Δh (Post – Pre)</th>
<th>Δh (6 M – Post)</th>
<th>Δh (1Y – Post)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>3.12 ± 2.64</td>
<td>0.8 ± 1.9</td>
<td>3.27 ± 0.35</td>
</tr>
<tr>
<td>B</td>
<td>4.51 ± 4.33</td>
<td>1.47 ± 2.88</td>
<td>2.23 ± 0.66</td>
</tr>
</tbody>
</table>

### Table 9
Attained percentage of the mean value of the overwhelming healthy vertebra (Group M-B: 27.67 mm, Group B-B: 27.33 mm) for both groups at different times.

<table>
<thead>
<tr>
<th>Group</th>
<th>% Pre</th>
<th>% Post</th>
<th>% 6 Months</th>
<th>% 12 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-B</td>
<td>84.91</td>
<td>98.55</td>
<td>92.59</td>
<td>80.93</td>
</tr>
<tr>
<td>B-B</td>
<td>80.79</td>
<td>102.19</td>
<td>97.16</td>
<td>93.22</td>
</tr>
</tbody>
</table>

### Table 10
Type of fractures and adopted surgical method.

<table>
<thead>
<tr>
<th>Type</th>
<th>Mono</th>
<th>Bi</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.1</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>A.3</td>
<td>5</td>
<td>22</td>
<td>27</td>
</tr>
<tr>
<td>B.2</td>
<td>3</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
<td>7</td>
<td>11</td>
</tr>
</tbody>
</table>

Injured vertebra, which sacrificed two motion segments. In 1993, McLain et al. reported one-level fixation for thoracolumbar wedge compression fractures, and since then many surgeons have attempted to obtain better curative results using monosegmental pedicle instrumentation [10]. Saving motion segments by limiting the number of fusion segments has always been considered a fundamental target of spine surgery [11].

Gotzen et al. was the first to publish results after monosegmental reduction and stabilisation [12]. In their initial report, 14 patients with unstable compression fractures Grade II were treated by posterior one-level fixation [13]. The results were compared to a series of 11 patients with equivalent fractures treated non-operatively. The authors concluded that posterior single-level stabilisation and fusion is a recommendable surgical procedure.

Defino et al. reported satisfactory clinical evaluation and functional assessment with follow-up lasting from two to 12 years and showed that posterior monosegmental fixation is an adequate and satisfactory procedure in specific types of thoracolumbar spine fractures [14]. Radiographical evaluation demonstrated increased kyphotic deformity in the fixed vertebral segment during the late postoperative period, accompanied by a reduced height of the intervertebral disc. Wei et al. reported three cases with loss of correction greater than 10°, including one case of screw loosening at 27.8 months follow-up [15].

The surgical practice is well coded and must be conducted using a very precise and standardised technique, starting from the positioning of the patient on the operating table to enable an initial
fracture reduction. Posterior monosegmental instrumentation provides a precise and careful surgical technique: pedicular screws have to be positioned into the non-fractured part of the injured vertebral body. Screws must be placed into the fractured level and into the adjacent upper level as much as possible divergent on the sagittal plane. We suggest using monoaxial pedicle screws or Schanz screws that enable excellent stability and adequate fracture reduction.

The biomechanical concepts support the execution of monosegmental fixation for the restoration of the damaged posterior tension band as long as there is integrity of the vertebral body for weight support. Biomechanical advantages of short-segment instrumentations are obtained because of the short lever arm and the divergent orientation of the screws in sagittal plane that increase the stiffness of the posterior spinal instrumentation constructs.

The aim of the current study was to compare clinical and radiological outcomes of short-segment instrumentations (monosegmental and bisegmental stabilisation) to better understand in which cases it is prudent to extend the fusion area to more than one motion segment.

Radiographical results showed no statistically significant differences between the two different stabilisation groups in vertebral body height restoration and correction of the kyphotic deformity. This work has shown that the mean postoperative somatic vertebral anterior body height in Group M was 25.8 ± 4.52 mm, whereas in Group B it was 24.43 ± 4.27 mm. The mean body height restoration in Group M was 4.57 mm and it was 4.79 mm in Group B. In Group M the mean postoperative kyphotic deformity was 11.10° ± 5.71°, in Group B it was 9.09° ± 4.93°. The mean correction of kyphosis was 3.06° in Group M and 4.11° in Group B. The reduction of the vertebral kyphotic deformity when using monosegmental instrumentation was not significantly different from that with bisegmental instrumentation. This is probably because during monosegmental instrumentation, the stretching stress can be applied directly to the anterior and posterior longitudinal ligaments, which are connected to the vertebrae on the injury side of vertebral bodies; whereas during bisegmental instrumentation, the stretching stress can only be applied indirectly to the longitudinal ligaments through a normal intervertebral space, which subsequently leads to attenuation of the stretching forces.

The results of this study indicate that monosegmental instrumentation achieves similar clinical and radiographical results to bisegmental fixation at 1-year follow-up for the treatment of type A1, A3, B2 and some well-selected type C fractures. In type A3 fractures it is necessary to carefully evaluate the integrity of pedicles and the presence of adequate vertebral bone tissue to avoid loosening of the instrumentation. Monosegmental instrumentation is not indicated in complete burst fractures.

In the authors’ opinion, type C fractures can be treated with monosegmental instrumentation only in those cases with displacement in the sagittal plane; type C fractures with lateral displacement or with a rotary component must be treated with longer instrumentation to obtain adequate dislocation reduction and good stability.

Conclusions

The results of this study confirm the clinical and radiographical efficacy of the short and very short segment instrumentation for selected thoracolumbar burst fractures. Monosegmental pedicle screw fixation can provide the same or better treatment, preserving one motion segment, compared with bisegmental fixation for the treatment of well-selected patterns of A3 and B2 type fractures. The appropriate surgical indication for the use of the monosegmental technique for type C fractures must be evaluated on an individual basis. Posterior surgical instrumentation using monosegmental stabilisation is a safe, reliable and effective method in the management of well-selected thoracolumbar spine fractures.

Conflict of interest statement

None of the authors have any conflicts of interest to declare. No funding was received in support of this study.

References

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