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ORIGINAL ARTICLE

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Nonoperative treatment of burst-type thoracolumbar vertebra fractures: clinical and radiological results of 29 patients

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Abstract The treatment of neurologically intact patients with thoracolumbar burst fractures is still controversial. This study was designed to evaluate the role of nonoperative treatment for 29 neurologically intact patients with two- or three-column-injured thoracolumbar burst fractures. Neurologically intact patients with types A, B and C burst fractures were treated conservatively and divided into groups GI and GII, according to their column involvement, with two and three injured columns, respectively. Local kyphosis angle (LKA), anterior and posterior vertebral heights (AVH and PVH) and canal encroachment (CE) were examined for radiological parameters, while Denis' s work and pain criteria were used for clinical assessment. Remodeling determining factors of canal encroachment and the correlation between radiology and functionality were analyzed. The vertebral column deformity that occurred after the injury was stable in GI, while it was progressive for GII patients. There was significant remodeling of CE, proportional to the amount of initial CE but not related to age and radiological parameters. No correlation was found between radiological and functional parameters. None of the patients had neurological deterioration. Most of the functional results were satisfactory. As a result, it was concluded that nonoperative treatment could be an alternative method for neurologically intact two- and three-column-injured Denis-types A, B and C thoracolumbar burst fractures.

Keywords Vertebra · Burst fractures · Canal encroachment · Stability · Conservative treatment

Introduction

There still exists a controversy in the treatment of thoracolumbar burst fractures that are characterized by anterior and posterior failure of the vertebral body, with the failure of both the anterior and middle columns [6, 8, 19]. Although the anatomical reconstruction of the vertebral column by surgical means seems to be necessary to avoid neurological and functional complications, long-term results of conservative treatment methods have shown that most of the thoracolumbar burst fractures can be treated conservatively [20, 26].

It is generally accepted that stable burst fractures should be treated conservatively and unstable ones surgically [13, 14]. However, the concept of stability, which is the most determinative factor for the choice of treatment method, is unclear. Denis et al. concluded that all thoracolumbar burst fractures are unstable, and they should be treated surgically because of neurologic complications [9]. On the other hand, according to

Krompinger et al., those thoracolumbar burst fractures of neurologically intact patients with canal encroachment under 50% and kyphosis angle under 30º are stable and can be treated conservatively [17]. Reid et al. did not accept the amount of canal encroachment as a contraindication in neurologically intact cases, and they reported that selected three-column fractures can be treated nonoperatively [22].

Although many radiological parameters, such as local kyphosis angle (LKA), anterior vertebral height (AVH), posterior vertebral height (PVH) and canal encroachment (CE) were defined to make a decision about the rate of stability, it is difficult to define the critical values of these parameters required for the determination of a stable burst fracture [2, 17, 22]. Consequently, neurologic status of patients seems to be a determinative factor for stability for these fractures [20, 24, 26].

Clinical outcomes of conservative treatment for two-column-injured burst fractures encouraged us to also conservatively treat selected cases in which fractures involved three columns [3, 4]. The aim of this prospective study was to assess and compare the functional and radiological results of two- and three-column-injured thoracolumbar burst fractures that were treated conservatively.

Materials and methods

Thirty-five neurologically intact consecutive patients who had had single-level Denis type A, B and C burst fractures without facet fracture and/or facet dislocation were conservatively treated between 1992 and 1996. Six patients who hadn't had any neurological deficit at the end of first year were lost to follow-up and excluded from the study.

Patients were divided into two groups. The first group (GI) included 16 patients with two-column injury (four type A, 12 type B). Mean age for GI at the time of injury was 41.6 years (range 24–72 years). There were nine males and seven females. The level of injury was T11 in two cases, T12 in one, L1 in nine, L2 in three, and L3 in one case.

The second group (GII) included 13 patients with three-column-injured burst fractures with five monocortical and eight bicortical posterior-arc fractures (five type A, five type B, three type C). There were nine males and four females, and the mean age was 41 years (range 16–76 years). The level of injury was T12 in two cases, L1 in eight, L2 in two and L3 in one case.

All patients were hospitalized after obtaining X-rays and computerized tomograms (CT), and they were kept under strict recumbency, with right and left logrolling. After accompanying posttraumatic symptoms such as pain, bowel and bladder dysfunctions were resolved and patients felt comfortable in bed, they were allowed family-assisted ambulation with hyperextension Jewett brace. Mean recumbency period was 5 days (range 3–8 days). At the end of the second ambulation day, all patients were discharged. Mean hospital stay was 8 days (range 5–10 days). The brace was used part-time during daily activities for 6 months. The aim of bracing was not strict immobilization of the vertebral column, but rather the comfort of patients when they were out of bed.

Patients were followed for every 2-month interval during the first year, and two times per year thereafter. They underwent clinical and X-ray examinations during each visit, and CT examinations at the end of the first year and the final follow-up.

Local kyphosis angle, anterior and posterior vertebral heights and canal encroachment were measured in all of the radiograms and CTs. LKA was accepted as an angle between the superior end-plate above intact vertebra and the inferior end-plate below intact vertebra. The percentage of height of injured vertebrae was calculated by dividing the anterior and posterior heights of the fractured vertebrae by the average heights of vertebrae adjacent, above and below, multiplied by 100. Canal encroachment was measured on CT scans and defined as a maximum percentage occupancy of the involved canal's sagittal diameter, compared with the average canal diameters of the vertebrae above and the below the fracture [3, 4]. Degree of LKA, CE, and loss of AVH and PVH were not criteria for exclusion. None of the patients had any associated injuries or medical illness that required prolonged bed rest.

Denis's work (W) and pain (P) scales were used for clinical assessment [9]. W1–3 and P1–3 were accepted as satisfactory results [22].

Paired t test, independent t test, chi-square test and correlation analysis were used for statistical analysis of the data. A p value less than 0.05 was considered significant. In order to avoid type II error, statistical power (sp) of statistical tests with p values closer to 0.05 were analyzed. P values not strongly supported by high sp rates were signed as $p\downarrow$.

Results

Mean follow-up period was 6.6 years (range 4.4–9.4 years) for GI and 5.2 years (range 3–8.4 years) for GII. There were no significant differences with regard to fracture level ($p = 0.679$), gender ($p = 0.702$), age ($p = 0.503$), and follow-up periods ($p = 0.170$) between two groups.

The mean values of LKA, AVH and PVH for GI and GII on admittance, after 1 year and at final follow-up were summarized in Table 1 and Table2. Differences between admittance and final-follow-up values were not significant for GI (LKA $p\downarrow = 0.051$, AVH $p\downarrow = 0.162$,

Table 1 Mean values of local kyphosis angle (LKA), anterior vertebral height (AVH) and posterior vertebral height (PVH) for group I

	Admittance	First year	Last follow-up	Final loss
LKA (º)	14.75	16.87	17.13	2.38
AVH (%)	72.13	66.13	62.13	10
PVH (%)	95.19	89.50	87.13	8.06

Table 2 Mean values of local kyphosis angle (LKA), anterior vertebral height (AVH) and posterior vertebral height (PVH) for group II

	Admittance	First year	Last follow-up	Final loss
LKA (º)	14.23	16.62	21.46	7.23
AVH (%)	59.69	49.54	43.31	16.38
PVH (%)	88.54	83.62	75.39	13.15

PVH $p\downarrow = 0.101$), while they were significant for GII (LKA $p = 0.001$, AVH $p = 0.001$, PVH $p = 0.01$).

Rate of CE was $45.9 \pm 20\%$ for GI and $48.6 \pm 14\%$ for GII on admittance, and it resolved to $20.8 \pm 9\%$ for GI and $25.8 \pm 9\%$ for GII at final follow-up. The remodeling rate of the vertebral canal was calculated as a difference of CE between the first and last follow-up tomograms [20]. Mean remodeling ratio was $24.8 \pm 15\%$ in GI and $22.8 \pm 8\%$ in GII. There was a highly significant difference when initial and final follow-up values of CE were compared for each group ($pI = 0.00$, $pII = 0.00$). The difference between the remodeling rates of the two groups was not significant ($p = 0.878$).

The pain and work status of all GI and GII patients were summarized in Table 3. Of all patients, there were 27 satisfactory (93%) and two unsatisfactory (7%) results. All the clinical results were satisfactory (100%) in GI, while there were 11 satisfactory (85%) and two unsatisfactory results in GII (15%). There was a statistically significant difference between the two groups when the dispersion of percentages of both groups with respect to pain and work status were compared, if they were classified from P1 to P5 and from W1 to W5 ($p = 0.003$). The difference between GI and GII for pain and work status of patients was not significant if the functional results were classified as satisfactory or unsatisfactory ($p = 0.197$).

The correlation between the last radiological and functional status was examined. No relationship was found between LKA, AVH, PVH and CE and functional status for GI and GII (LKA $rI = 0.189$, LKA $pI = 0.483$, LKA $rII = 0.041$, LKA $pII = 0.894$, AVH $rI = 0.267$, AVH $pI = 0.317$, AVH $rII = 0.157$, AVH $pII = 0.608$, PVH $rI = 0.172$, PVH $pI = 0.521$, PVH $rII = 0.184$, PVH $pII = 0.545$, CE $rI = 0.346$, CE $pI = 0.189$, CE $rII = 0.318$, CE $pII = 0.288$).

None of our patients had had any neurological deterioration during the treatment. Complications of conservative treatment, such as bedsores, deep venous thrombosis, pulmonary emboli, and spinal stenosis were not faced. Urinary system infections were detected in three patients from GI (18%) and in two patients from GII (15%). LKA over 30° was observed in one case whose functional level were P2 and W2 from GII at the last follow up.

Table 3 Pain and work status dispersion of all patients

Pain						Work				
	P1	P2	P3	P4	P5	W1	W2	W3	W4	W5
Group I	12	4	-	-	-	12	4	-	-	-
Group II	2	8	1	2	-	2	8	1	2	-
All Patients	14	12	1	2	-	14	12	1	2	-

Discussion

The choice of type of treatment for burst thoracolumbar fracture seems to be a confusing decision in recent decades. According to some authors, e.g., Denis et al. and Esses et al., these fractures should be treated surgically for better functional outcome, and nonoperative treatment poses the risk of neurologic complications [9, 10]. However, after following cases for 20.2 years, Weinstein et al. claimed that all neurologically intact burst fractures could be treated conservatively without any functional impairment[26].

All fractured thoracolumbar vertebra should have some degree of instability, which may cause the resultant vertebral column deformity. It is accepted that vertebral fractures due to rotational injuries can cause facet joint disruptions and/or pedicle fractures, that they are highly unstable and should be treated surgically, such as E- and D-type burst fractures [22]. On the other hand, it is difficult to accept the number of injured columns as a determinative factor for the type of treatment. One- and two-column-injured neurologically intact burst fractures are usually accepted as low-grade unstable fractures, which are usually defined as stable fractures that can be treated nonoperatively [4, 14, 26]. However, some authors have advised nonoperative treatment for three-column-injured burst fractures, which are usually accepted as unstable [24, 27]. Still, in the literature there hasn't been any series comparing the results of two- and three-column-injured burst fractures that were treated

nonoperatively. Consequently, we believed that comparison of radiological criteria (AVH, PVH, LKA and CE) and clinical results for these patients could clarify the indications for the nonoperative treatment of three-column-injured burst fractures.

Although the difference between admittance and final follow-up LKA was not strongly supported statistically, the disruption rates of AVH, PVH and LKA during the treatment were not significant for GI patients, and most of the final structural deformities were similar to those that occurred just after the injury. In other words, most of the resultant vertebral column deformity occurs at the time of injury for two-column-injured patients. The amount of AVH and PVH loss was greater in GII patients than in GI patients. There were also significant differences between initial and final follow-up values of AVH and PVH that caused a significant, continuous increase in LKA through the treatment. All these changes in radiological parameters showed us that the degree of instability was higher in GII patients. The critical value of LKA that causes clinical problems for burst fractures is not clear. According to Reid et al., degree of LKA should not be more than 35° for a satisfactory result of nonoperative treatment [22], while some authors did not find any correlation between LKA and clinical results [4, 20, 24, 26, 27]. We also did not find any correlation between the final LKA and functional results, for either GI or GII patients. There was only one patient with LKA deformity greater than 30° in GII patients. This patient was also satisfied with outcome of the treatment. It seems that the extent of posterior arc fracture didn't affect the functional outcome of our patients clinically, because one of the unsatisfactory cases had a monocortical fracture, while the other one had a bicortical arc fracture.

Although the significant remodeling of CE had been shown by many authors [5, 7, 11, 15], the role of CE as a determinative factor for the treatment method of burst fractures is not clear [2, 12, 16, 18, 23]. CE didn't cause any deterioration in the neurological status of our patients in either group during the treatment. The remodeling rates of GI and GII were similar ($p = 0.249$). So, we thought that it was difficult to accept CE as a determinative and prognostic factor during the treatment of burst fractures of neurologically intact patients with two- or three-column involvement.

When we evaluated our clinical results according to Denis's work and pain scales, as many authors have [3, 9, 22, 24, 25], we found that there were no significant differences between GI and GII if our results were classified as satisfactory and unsatisfactory. The rate of excellent results was significantly higher in GI. However, most of the patients with moderate pain in GII had returned to their original jobs, and occasional use of anti-inflammatory agents was required. None of our patients showed any neurological deterioration during the treatment. In the literature, Denis et al. reported six patients who deteriorated neurologically among the 29 conservatively treated cases, while Mumford reported only one case of radiculopathy among his series [9, 20].

The role of external support during the nonoperative treatment of burst fractures is also not clear [24]. It was found that external support restricts macro movements of the vertebral column, but not the intervertebral movements, and that it is not very effective on the final kyphosis deformity [1, 21, 25]. Therefore, we used a Jewett hyperextension brace, but not for strict immobilization. The comfort of our patients during their daily activities was the primary goal.

Although our clinical results were 100% satisfactory in GI and 85% satisfactory in GII, the limited number of patients of each group led to lower statistical power rates for some comparisons. Studies with higher number of patients should be performed in order to draw stronger statistical conclusions. With the numbers available in the present study, the rate of instability may be higher in three-column-injured burst fractures, and changes in radiological parameters may not effect the functional outcome.

As a result, we concluded that neurologically intact two-and three-column injured Denis type A, B and C thoracolumbar burst fractures with intact facet joints can be treated nonoperatively.

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