

# Evaluation of Functional and Radiographic Outcomes of Thoracolumbar Fractures

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**Background:** Thoracolumbar fractures are the most common fractures of the spinal column. There is no consensus about treatment method of choice among authors.

**Objectives:** The purpose of this study was to compare radiographic and functional outcomes of conservative management with that of surgical treatment in thoracolumbar spine fractures.

**Patients and Methods:** Forty-nine patients with single level acute thoracolumbar fractures and normal neurological examination were evaluated, of those 21 patients underwent surgery and 28 treated with orthosis. Radiographic outcomes were evaluated by measuring sagittal kyphotic angle, anterior vertebral body collapse and functional outcomes were assessed using SF36 health survey questionnaire and the Denis work and pain scales.

**Results:** Among the surgically treated patients, sagittal kyphotic angle was significantly corrected immediately after operation and in the last follow-up compared to preoperative measurements ( $P < 0.001$ ), functional results of SF36 score and pain scale were satisfactory. Among those received conservative management, sagittal kyphotic angle and anterior vertebral collapse were not significantly different before and after bracing ( $P = 0.4$  and  $P = 0.8$ , respectively); functional outcome of SF36 scores were satisfactory and functional and radiographic results had no correlation.

**Conclusions:** Functional outcome in both groups with surgical and non-surgical treatment was satisfactory. Radiographic indices were improved with surgical treatment and no correlation was found between functional and radiographic outcome.

**Keywords:** Kyphosis; Pain; Spinal Fracture; Spine

## 1. Background

Spinal fractures represent about 6% of all fractures, with 90% occurring in the thoracic and lumbar regions (1). Because of its mobility, the thoracolumbar junction at T11-L2 level is a common site for spinal fracture (2). Although a large number of studies advocated conservative management as well as surgical intervention for reducing and stabilizing these fractures, no consensus has been reached (3). In evaluating efficacy of various treatments, loss of correction is one of the parameters studied. However, the correlation between loss of correction and clinical and functional results has not yet been fully explored (4, 5). In treating spinal fractures, conventional goals are preservation of stability, correction of deformity (in both sagittal and coronal planes), reduction of pain, reversal of neurological deficit and rapid rehabilitation (6). For patients without clinically and radiologically instability and with no neurological deficit, operative treatment is not recommended and present approach is widespread use of braces (1). The pattern of fracture is also important in treatment selection. Patients diagnosed with compression fractures are treated with immobilization for

12 weeks, but if kyphosis is greater than 25 degrees or in the presence of any posterior ligamentous complex (PLC) injury, patients are regularly followed up to curtail the possibility of kyphotic progression or worse, severe collapse (6). In patients with burst fracture, if the spinal canal compromise is less than 50%, PLC is intact and no neurological deficit is present, a nonsurgical treatment is chosen (7). However, flexion-distraction or flexion-dislocation injuries must be treated surgically due to instability they cause (8).

## 2. Objectives

The purpose of this study was to compare radiographic and functional outcomes of conservative and surgical treatments in thoracolumbar spine fractures.

## 3. Patients and Methods

Between January 2008 and December 2011, 49 consecutive patients treated surgically and nonsurgically for spinal fractures were enrolled in a prospective study to

determine treatment outcomes. Type of treatment depended on fracture morphology, clinical and radiologically assessed instability and neurological deficit. After initiation of treatment, radiographic imaging was performed to assess the injury and a demographic survey was performed. Patients were consequently followed up for one year or longer if needed and local kyphosis and vertebral body collapse were assessed in follow-up. Patients with fracture occurring at a single level in thoracic and lumbar spinal regions and without neurological deficit were included. Exclusion criteria were pathologic fracture, occurrence of any neurological deficit at any point and associated major injury able to interfere with our evaluations.

Functional outcomes of patients were evaluated using the validated Persian translation of short form (SF)-36 questionnaire (9, 10) and the Denis Work Scale (11). Patients' pain was also evaluated using the Denis Pain Scale (12). Statistical analysis was performed using Student's t-test, Pearson's chi-squared test and Fisher's exact test and Wilcoxon test for comparing the assessed variables in our study.

Denis Work Scale is a five-level scale ranging from W1 to W5, as detailed below (11):

W1: Return to previous employment (heavy labor) or physically demanding activities

W2: Able to return to previous employment (sedentary) or return to heavy labor with restrictions

W3: Unable to return to previous employment, but works full time at a new job

W4: Unable to return to full time work

W5: No work, completely disabled

#### 4. Results

In this study, 76 patients primarily included. Nine patients were excluded due to occurrence of neurological deficit or associated major injury and three patients were excluded due to diagnosis of pathologic fractures. Another 15 patients failed to complete the follow-up process and eventually 49 (55.1% male) patients were evaluated.

Twenty-one patients (42.9%) were treated surgically and 28 (57.1%) received conservative treatment.

In the group of patients undergoing surgical treatment, the mean age was 45.6 years, ranging from 19 to 76 years and 47.6% of patients in this group were male. Eighteen patients underwent posterior spinal fusion on the injured spinal region, of which 13 had short segment instrumentation and five had long segment instrumentation. Three patients underwent anterior surgical approach on the spinal fracture region. Fracture level in this group is shown in Figure 1.

According to the Denis Pain Scale, six patients (28.6%) reported to have no pain, 10 (47.6%) experienced pain occasionally and five (23.8%) reported moderate pain. None of the patients in this group reported severe pain (Table 1).

For evaluation of employment according to the Denis work Scale, 14 patients (66.6%) were employed at the time of injury, 10 (47.6%) working fulltime and four (19%) part-time. Seven patients (33.3%) were unemployed, of those five (23.8%) being unemployed although capable of working. The mean score extracted from SF-36 questionnaire was 67.2 (ranged 45-95) in patients undergoing surgery, which is similar to the values in a normal population. Data extracted from the SF-36 questionnaire is shown in Table 2.

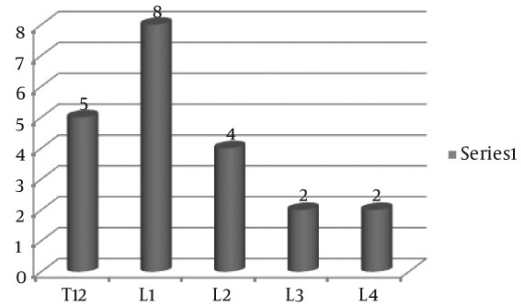


Figure 1. Distribution Frequency of Vertebra Level Fracture in Operated Patients With Thoracolumbar Fractures

Table 1. Pain in Operated Patients With Thoracolumbar Fractures

Patients' Characteristics	Painless	Occasionally	Moderate	Moderate to Severe	Severe and Permanent	Sum
<b>Gender</b>						
Total	6 (28.6%)	10 (47.6%)	5 (23.8%)	0	0	21 (100%)
Female	3	6	2	0	0	11
Male	3	4	3	0	0	10
<b>Age, y</b>						
Age < 30	2	3	0	0	0	5
30 < Age < 40	3	3	1	0	0	7
Age > 40	1	4	4	0	0	9

Patients' functional outcomes (based on the results of SF-36 and Duty and Pain Scales), along with demographic factors (age, gender, marital status, insurance status), and also data on the level of vertebral fracture, duration of hospitalization, surgical approach and choice of instrumentation (long or short) were evaluated using non-parametric statistical testing. No correlation was found between these factors.

Vertebral collapse and local kyphosis were evaluated pre and post-operatively and in the last follow-up (Tables 3 and 4). The Wilcoxon test was applied to assess the results.

Results demonstrated that kyphosis correction after surgery was significant ( $P < 0.001$ ); however, data from the last follow-up showed a significant decrease in kyphosis correction ( $P, 0.001$ ), with a partial loss of surgical correction.

As for postoperative vertebral collapse, follow-up radiography showed significant differences compared with preoperative radiography ( $P < 0.001$ ). However, data showed no significant differences between just postop-

erative and late follow-up ones ( $P = 0.37$ ). Based on these results, vertebral height correction after the operation was significant and no loss of correction occurred during the follow-up.

Patients who received conservative management included 28 ones (60.7% male) with the mean age of 50.2 years, ranged 26 to 76 years. All patients were treated with braces and the mean duration of brace wearing was three months. The level of fracture level in these patients is shown in Figure 2.

In this group, five patients (17.9%) had no pain, 15 patients (53.6%) expressed occasional pain, five (17.9%) had moderate pain and three (10.7%) reported moderate to severe pain. None of the patients complained of severe pain (Table 5). According to the Dennis Work Scale, 16 patients (57.1%) were employed, 12 (42.8%) worked fulltime and the other four worked part time. At the final follow-up, 12 patients (42.8%) were unemployed, nine of these (32.1%) were capable of working and three patients (10.7%) were disabled and could not work.

**Table 2.** SF 36 Score in Operated Patients With Thoracolumbar Fractures

Variables	Male	Female	Age (< 30, y)	Age (31- 40, y)	Age (> 41, y)
Mean SF-36 score	66.4	68	64.8	68	68.7

**Table 3.** Kyphosis Angle in Operated Patients With Thoracolumbar Fractures<sup>a</sup>

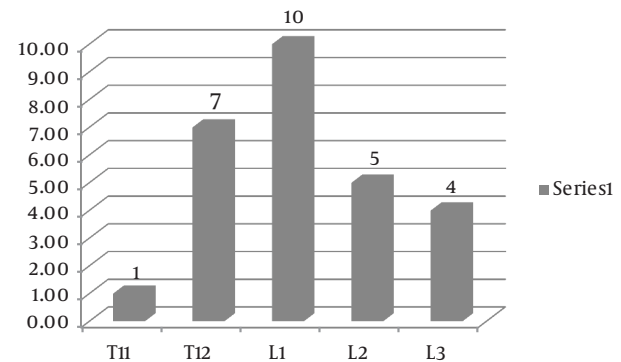
Kyphosis (Angle)	Min	Max	Mean ± SD
Pre-op	-5	52	18.6 ± 14.2
Post-op	-20	23	0.8 ± 10.4
Last follow up	-15	25	4.1 ± 10.3

<sup>a</sup> Abbreviations: Min, minimum; Max, maximum; SD, standard deviation; Pre-op, pre-operative; Post-op, postoperative.

**Table 4.** Anterior Vertebral Body Collapse in Operated Patients With Thoracolumbar Fractures<sup>a</sup>

Kyphosis (Angle)	Min	Max	Mean ± SD
Pre-op	11	45	23.5 ± 8.8
Post-op	6	25	13.8 ± 5.7
Last follow up	7	25	15.7 ± 5.9

<sup>a</sup> See abbreviations in the Table 3.



**Figure 2.** Distribution Frequency of Vertebra Level Fracture in Non-Operated Group of Patients With Thoracolumbar Fractures

**Table 5.** Pain in Non-Operated Patients With Thoracolumbar Fractures

Patients' Characteristics	Painless	Occasionally	Moderate	Moderate to Severe	Severe and Permanent	Sum
<b>Gender</b>						
Total	5 (7.9%)	15 (53.6%)	5 (17.9%)	3 (10.7%)	0	28 (100%)
Female	2	6	2	1	0	11
Male	3	9	3	2	0	17
<b>Age, y</b>						
Age < 30	0	2	0	0	0	2
30 < Age < 40	2	3	2	0	0	7
Age > 40	3	10	3	3	0	19

**Table 6.** Kyphosis Angle in Non-Operated Patients With Thoracolumbar Fractures<sup>a</sup>

Kyphosis (Angle)	Min	Max	Mean ± SD
Before bracing	-12	22	9.6 ± 8.1
After bracing	-12	28	11.1 ± 8.6
Last follow-up	-11	31	15 ± 9.7

<sup>a</sup> See abbreviations in the Table 3.

**Table 7.** Ant. Vertebral Body Collapse in Non-Operated Patients With Thoracolumbar Fractures

Ant. Body Collapse (Angle)	Min	Max	Mean ± SD
Before bracing	-12	22	9.6 ± 8.1
After bracing	-12	28	11.1 ± 8.6
Last follow-up	-11	31	15 ± 9.7

The mean score of SF-36 was 61.6 in this group, which is similar to the score in the normal population.

Similar to the group undergoing operation, in patients treated non-operatively, there was no correlation between functional outcomes (SF-36 data, Pain and Duty Scales) and demographic factors including age, gender, marital status and insurance status, level of vertebral fracture and duration of hospitalization, as assessed by non-parametric statistical testing.

Pre- and post-bracing anterior vertebral collapse and kyphosis were evaluated by radiography upon follow-up (Tables 6 and 7).

Before and after treatment with braces, the kyphosis index was unchanged ( $P = 0.40$ ); however; at the last follow-up, the kyphosis index increased significantly ( $P < 0.001$ ). Regarding brace treatment, anterior vertebral collapse showed no significant improvement ( $P = 0.44$ ), and at the last follow-up, the degree of collapse increased significantly ( $P < 0.001$ ).

## 5. Discussion

In our study, in the surgically-treated group, radiologic findings after surgery were improved compared to pre-operation; however; there were slight changes at the last follow-up and slight deterioration was noticed. Similarly, in a study performed by Defino et al. on 20 patients with spinal burst fractures, radiographic results showed deterioration at the last follow-up (13).

As for the group receiving conservative management, our study showed that radiographic findings remained the same before the treatment and after brace wearing and had significantly worsened at the last follow-up. In a cohort study performed by Moller et al. (14), those patients with burst fractures of the thoracic and lumbar spine in adults with or without minor neurological deficits treated conservatively and following up for 27 years

had a predominantly favorable long-term outcome, and there was no increased risk for subsequent disc height reduction in the adjacent disc.

Evaluation of functional outcomes in both groups and comparing it with the radiographic findings showed no correlation in our study, which is similar to the findings of Defino et al. (13), Andreychik et al. (15) and Mumford et al. (16).

At the last follow-up in the surgically-treated group, 87.5% of patients had either no pain or only occasional experience of pain, while in the group receiving conservative treatment 71.4% reported similar pain levels. Regarding the capability to return to work, 62.5% of patients in the surgically treated group regained employment, with 25% remaining unemployed but able to work as before their vertebral fractures. In the conservatively managed group, 52.5% of patients returned to work and 38% remained unemployed, but able to work.

In the Defino study which used the Denis Scale for work evaluation, in the group that had surgery, 83% of patients were employed and the other 17% were not able to work (13). In a large cohort study by Burnham et al. (17), unemployment was common in the first year after spinal fracture in the both groups (operated and nonoperated). Those who return to work are more likely to modify the amount and type of work they do compared to preinjury.

Most patients with thoracolumbar fractures are neurological intact and most of these patients are treated non-operatively. Two absolute indications for surgery in thoracolumbar fracture are progressive neurological deficit and global imbalance in the sagittal (kyphosis) or coronal (scoliosis) plane; however, regional deformity is not an indication for surgery. There is no correlation between radiologic indices at the injured level and functional outcome, although we must consider injury to the PLC that is structurally important. If non-operative treatment was chosen, to detect changes in overall alignment, upright radiographs are obtained after wearing brace. Although anatomical reduction in thoracolumbar fracture is desirable, this issue has not been the primary treatment objective. Another study found that of 50 patients who returned to full function after thoracolumbar fracture and had been working as miners for at least two years, approximately one half of patients (24 patients) had some residual deformity (18). Heterogeneous results from different studies may be due to differences in patients' jobs. Factors that determine return to work are length of hospitalization, type of treatment and quality of insurance. In this study, employment status and pain level showed no significant association with any of the factors evaluated.

On the basis of clinical and radiographic findings, our functional outcomes were acceptable in both groups. In the operated group, radiologic results showed greater improvement after treatment compared to the group managed non-operatively. We found no correlation between radiographic results and functional outcomes.

## Authors' Contributions

Conception, study design, data collection, statistical analysis, drafting the manuscript and critical revision of the manuscript for important intellectual content: Hasan Ghandhari, Ali Andalib, Hooshang Tavajohi, Ebrahim Ameri and Hossein Vahid Tari. Study supervision: Hasan Ghandhari.

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