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MANAGEMENT OF THORACOLUMBAR FRACTURES: CLINICAL, FUNCTIONAL, AND RADIOLOGICAL OUTCOMES IN A SINGLE INSTITUTION

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ABSTRACT

Objective: The purpose of this study was to evaluate the long-term clinical, functional, and radiological outcomes of operative and non-operative treated patients with thoracolumbar fracture.

Materials and Methods: Between January 2016 and December 2021, data of patients hospitalized in our clinic due to thoracolumbar (T11-L2) fracture were collected and analyzed.

Results: Two hundred eighteen patients met the inclusion criteria. One hundred thirty eight patients (63.3%) were operated and 80 patients (36.7%) were treated with nonsurgical methods. The duration of follow-up ranged from 13 to 82 months. There was a significant difference between the first admission oswestry disability index (ODI) and visual analog scale (VAS) and the final visit ODI and VAS when both operative and nonoperative treatment patients were evaluated separately and when evaluated together. The scores at the last control visit were significantly lower than the initial scores ($p<0.001$). When the fracture level was compared with the ODI and VAS, a significant difference was observed in the ODI score at the first admission ($p=0.03$). The ODI score at first admission was highest in patients with T11 fractures and lowest in patients with L2 fractures. There was a significant correlation between the "Anterior Vertebral Body Compression Percentage %" and four-vessel cerebral angiography ($p<0.001$).

Conclusion: Patients with high vertebral depression and low functionality were operated, and regardless of the treatment protocol, pain decreased and functionality increased in all patients. The height of the vertebral corpus affects the angle of kyphosis, and surgical management is needed for the kyphotic deformity. Patients with high thoracolumbar fractures were more painful.

Keywords: Thoracolumbar junction, vertebral fracture, kyphotic deformity, pain, function

INTRODUCTION

Fractures of the thoracolumbar region account for 90% of all spinal fractures, with the majority occurring at the T11 to L2 level[1,2]. This area, known as the thoracolumbar junction (TLJ), is highly susceptible to injury due to its transition from the rigid and less mobile thoracic spine to the more flexible lumbar spine[3,4]. Causes of thoracolumbar fractures vary depending on the age of the patient, with high-energy trauma being the most common cause in younger patients, while falls from standing position to ground can cause fractures in older patients with osteoporosis[5,6]. Despite being a common fracture, there are currently no evidence-based guidelines for the ideal management of thoracolumbar fractures[7]. Conservative treatments, such as pain medications, bed rest, and bracing, are typically employed initially, with most patients successfully treated within 4 to 6 weeks. However, for patients with persistent pain or other complications, operative treatment may be necessary[8]. The instability of traumas in the TLJ and the frequent occurrence of post-traumatic deformity may result in neurological damage in 20% of cases[9-11]. Even patients without neurological injury may experience limitations in daily activities or difficulty returning to work due to chronic pain[12,13]. Therefore, appropriate management is crucial.

In this study, we aimed to evaluate the long-term functional and clinical outcomes of operative and non-operative treatment of patients with thoracolumbar fractures. We analyzed the Cobb angle of the fractured vertebra four-vessel cerebral angiography (FVCA), the Anterior Vertebral Body Compression Percentage (AVBC%), visual analog scale (VAS), and oswestry disability index (ODI) scores. By providing data on the outcomes of different treatment methods, our study can help inform the development of evidence-based guidelines for managing thoracolumbar fractures.

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MATERIALS AND METHODS

Study Design

Ethical approval was obtained from the University of Health Sciences Turkey, Gülhane Training and Research Hospital Ethical Committee (decision no: 2021-238, date: 20.05.2021), and informed consent was taken from all participants. We collected and reviewed clinical and radiological data of patients who were hospitalized in our institution for operative or non-operative treatment of the thoracolumbar fracture. We radiologically evaluated the patients with conventional X-ray and computed tomography (CT) and we investigated them clinically with VAS and ODI at their first and last visits to the hospital. We obtained CT scan from all patients after surgery to see the position of the stabilization materials as well as to observe the sufficiency of the decompression. We used the modified thoracolumbar injury classification and severity score (mTLICS) to make the surgical decision for the patients.

Selection and Description of Participants

Between January 2016 and December 2021, we admitted 287 consecutive patients with TLJ fracture to our neurosurgery department. We extracted age, gender, date of first diagnosis, fracture site, neurological signs or symptoms, pain progression from the date of diagnosis to the last follow-up, and change in quality of life from the medical records of the patients. We included patients over 18 years of age.

The exclusion criteria were inflammatory diseases such as ankylosing spondylitis and rheumatoid arthritis, history of major surgery of the thoracolumbar spine or treated with vertebroplasty and kyphoplasty of the index vertebra, incomplete radiological or clinical data, or less than 12 months of follow-up.

Treatments

We used the mTLICS system to make the surgical decision for patients, with the unanimous consent of 2 surgeons. In this system, a score of 3 points or less is considered non-operative, a score of 5 points or greater is considered operative, and a score of 4 points can be considered operative or non-operative and must be decided on an individual basis.

Conservative treatment was applied to patients with an mTLICS score less than 4 points. Conservative treatment usually includes palliative pain medicines, bed rest, and bracing. The indications for hospitalization of patients treated conservatively are comorbidities such as diabetes, hypertension, cardiac disorders, ages between 70 and 90, history of osteoporosis (fragil vertebra) and significant pain. Length of stay is determined based on the clinical and radiological condition of the patients ranged between 3 to 10 days. Ambulation with a corset was started as early as possible because prolonged bed rest may cause embolization, pressure ulcer, and pulmonary complications. The clinically and radiologically stabile patients were discharged. The patients weared corset for a period of four to 12 weeks and this period determined based on the radiographic evidence of healing, and the lack of tenderness over the fracture site. We examined follow-up standing radiographs 1-2 weeks after the ambulation. We continued the conservative treatment in patients who did not have an obvious increase in kyphotic angle of more than 10 degrees or pain during conservative treatment, but re-evaluated patients who did have these issues for operative treatment.

All patients whose mTLICS score was greater than 4 underwent posterior stabilization with pedicle screws using an open approach with a freehand technique under general anesthesia. Intermediate short-segment pedicle screws in the fractured vertebra were positioned according to pedicle integrity. In case of a single pedicle fracture, screws were positioned asymmetrically, whereas no screws were positioned in case of bilateral pedicle fracture. We checked screw positioning intraoperatively with fluoroscopic guidance. After surgery, all patients were free to move with or without support or corset.

Patients with an mTLICS score of 4 points were considered in the gray zone. Treatment planning in these patients was performed on a patient basis according to the surgeon's discretion.

Radiological Assessment

Two surgeons evaluated radiological data (CT scans) of all patients in a blinded manner. We evaluated FVCA, "AVBC %" on CT scans at the first visit and final follow-up visit. FVCA was measured on CT scan as the angle between the superior endplate of the vertebra above the fracture and the inferior endplate of the vertebra below the fracture (Figures 1A, C, Figures 2A, B).

"AVBC %" consists of the percentage of anterior vertebral body compression with respect to the average height of the anterior

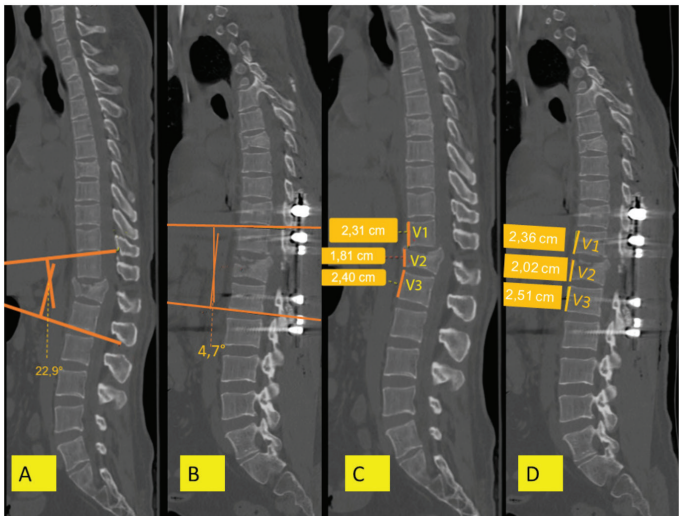

Figure 1. Twenty-one years old female a case of fall from standing position. mTLICS=2. First visit FVCA and "AVBC%" measurement **(A, B)**. After 30 day FVCA was increased 1.7°. Last visit (6 months after trauma) measurements are same with the 30th day **(C, D)**

mTLICS: Modified thoracolumbar injury classification and severity score, FVCA: Four-vessel cerebral angiography, AVBC: Anterior Vertebral Body Compression Percentage

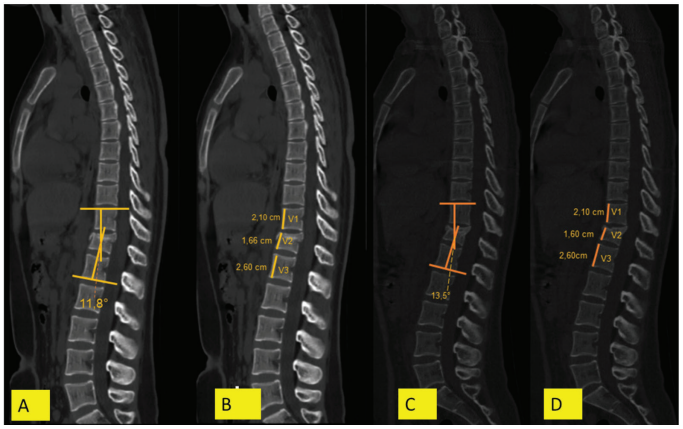

Figure 2. Thirty-four years old male fall from a height case. mTLICS=5. Pre-operative FVCA is increased (22.9°), vertebral alignment is lost **(A)**. Postoperative FVCA is decreased (4.7°) and alignment was preserved **(B)**. Preoperative and postoperative "AVBC%" measurements of relevant and adjoining vertebral bodies. After instrumentation the relevant vertebral body has gained height **(C, D)**
mTLICS: Modified thoracolumbar injury classification and severity score, FVCA: Four-vessel cerebral angiography, AVBC: Anterior Vertebral Body Compression Percentage

vertebral bodies immediately cephalad and caudad to the injury level (Figures 1B, D, Figures 2C, D).

Measurements

The functional outcomes and pain scores of the patients were assessed at their first admission and final follow-up visit using the VAS and ODI. Chronic pain was evaluated through self-reported questionnaires using the VAS, where patients were asked to rate their pain levels on a scale of 0 to 4. Group 0 represented no pain, group 1 represented mild pain, group 2 represented moderate pain, group 3 represented distressing pain, and group 4 represented severe pain. Function was evaluated using the ODI, and the results were grouped based on the patient's disability in function. ODI scores of 0-20% indicated minimal disability, 21-40% indicated moderate disability, 41-60% indicated severe disability, 61-80% indicated crippling back pain, and 81-100% indicated bedbound or exaggeration of symptoms.

Statistical Analysis

IBM SPSS Statistics software version 28.0.1.0 (IBM, SPSS, Chicago, Illinois, USA) was used for the statistical analysis of this study data. The collected data are expressed as mean ± standard deviation. The Shapiro-Wilk test was used to evaluate whether parameters were normally distributed. Independent Sample t-test was used to compare normally distributed parameters between groups, while the Kruskal-Wallis test was used for comparing data without normal distribution between groups. Mann-Whitney U test was used to analyze clinical and radiological variables, while the Wilcoxon rank-sum test and paired sample t-test were used to detect the period causing the difference between groups. Spearman's rank correlation test was used to define the direction and degree of inter-variable relationships.

RESULTS

A total of 218 patients met the inclusion criteria, with 138 patients (63.3%) undergoing surgery and 80 patients (36.7%) treated with non-surgical methods. The mean follow-up duration was 37.2±18.1 months (range: 13-82 months). Table 1 presents demographic data and basic characteristics of all reported patients. Comparison between patients treated with operative and non-operative methods revealed no significant difference in terms of age, gender, fracture level, mechanism of injury, FVCA, and VAS. However, a significant difference was found in the "AVBC%" and ODI, with the surgically treated group having a significantly lower "AVBC%" and significantly higher ODI scores (Table 2). Among patients with mTLICS 4 points, no significant difference was found between those treated with operative and non-operative methods in terms of any of the evaluated criteria (Table 3). Both operative and non-operative treatment groups showed a significant difference between the first admission ODI and VAS and the final visit ODI and VAS, with the scores at the last control visit being significantly lower than the initial scores ($p<0.001$). Comparison of preoperative and postoperative FVCA in patients treated with surgery showed a statistically significant difference, with the postoperative group having a significantly lower FVCA ($p<0.001$). When the fracture level was compared with the ODI and VAS, there was no significant difference between the fracture level and the VAS at the first admission and the ODI and VAS at the last visit. However, a significant difference was observed in the ODI score at the first admission ($p=0.03$), with the ODI score being highest in patients with T11 fractures and lowest in patients with L2 fractures (T11 > T12 > L1 > L2 in descending order). Comparison of the fracture level and FVCA revealed a statistically significant difference ($p<0.001$), with the FVCA being highest at the T11 level and decreasing downwards (T11 > T12 > L1 > L2). No significant difference was found when the FVCA and first and last admission ODI and VAS were compared (ODI first $p=0.188$, ODI last: $p=0.470$, VAS first: $p=0.425$, VAS last: $p=0.875$). Spearman's rank correlation test revealed no significant relationship between age and ODI or between age and pain VAS score. Analysis of VAS and ODI in correlation with sex revealed no significant differences. However, a significant correlation was found between "AVBC%" and FVCA ($p<0.001$).

DISCUSSION

The thoracolumbar spine is the most common region of spinal fractures, accounting for nearly 90% of all spinal fractures in adults[14,15]. The majority of thoracolumbar spine injuries occur at the junction (50-60%), followed by the thoracic (25-40%) and lumbar (10-14%) regions[1]. The rigid thoracic spine transitions to the mobile lumbar spine (T11-L2 level), resulting in increased biomechanical stress[16]. Injury to the TLJ can occur from motor vehicle accidents, falls from height, recreational accidents, and occupational injuries.

Numerous classification systems have been proposed for thoracolumbar spine injuries, but none have gained universal acceptance[17]. The first modern classification based on radiological findings and 2-column theory (anterior and posterior) was established by Holdsworth[18] in 1963. Denis defined the "3 column theory" by dividing the anterior column into two in 1983, and the definition of the middle column allowed better analysis of thoracolumbar fractures[3].

There is still controversy in the literature on the treatment of thoracolumbar vertebral fractures. An ideal classification

Table 1. Basic characteristics of all reported patients

Overall (n=218)			
Age		mTLICS	
Mean (SD) 52.513±19.920		Mean (SD) 4.165±1.613	
Range 18-90		Range 1-9	
Sex		1. 4 (1.8%)	
Female 98 (45%)		2. 46 (21.2%)	
Male 120 (55%)		3. 14 (6.4%)	
Fracture level		4. 62 (28.4%)	
T11 8 (3.7%)		5. 48 (22%)	
T12 66 (30.3%)		6. 34 (15.6%)	
L1 100 (45.9%)		7. 4 (1.8%)	
L2 44 (20.2%)		8. 4 (1.8%)	
		9. 2 (0.9%)	
Mechanism of injury		Cobb angle of the fractured vertebra (FVCA)*	
Fall from standing position	70 (32.1%)	<10	96 (44%)
Fall from a height[a]	86 (39.4%)	10-20	88 (40.4%)
Motor vehicle accident[b]	44 (20.2%)	>20	34 (15.6%)
No relevant trauma[c]	18 (8.3%)		
The anterior vertebral body compression percentage ("AVBC %")**			
Mean (SD) 65.103±16.435			
Range 10.000-99.000			

Values are presented as mean ± standart deviation or number
[a]Work accident or jumping from a height as a suicide attempt
[b]Inside or outside a vehicle
[c]After coughing, sneezing, heavy lifting
*Cobb angle of the fractured vertebra
**The anterior vertebral body compression percentage
SD: Standard deviation, mTLICS: Modified thoracolumbar injury classification and severity score, FVCA: Four-vessel cerebral angiography

Table 2. Evaluation of parameters among the non-operated and operated groups

Parameters	**Non-operated**	**Operated**	**P value**
	Mean ± SD	Mean ± SD	
Age	51.775±20.523	52.942±19.702	0.873+
Cobb angle	11.610±6.774	13.107±8.100	0.327*
AVBC	72.800±13.218	60.642±16.546	<0.001*^
VAS			
First visit	2.725±0.750	2.885±0.974	0.335+
Last visit	1.225±0.831	1.188±0.895	0.821+
ODI			
First visit	51.425±17.048	60.492±20.877	0.022*^
Last visit	21.275±11.681	34.666±20.814	<0.001+^

*Independent sample t-test, +Mann-Whitney U test, ^p<0.05
SD: Standart deviation, AVBC: Anterior vertebral body compression percentage, VAS: Visual analog scale, ODI: Oswestry Disability Index

Table 3. Evaluation of parameters among the non-operated and operated groups in patients with mTLICS=4 point

Parameters	Non-operated	Operated	P value
	Mean ± SD	Mean ± SD	
Age	59.000±18.631	45.826±20.772	0.124*
FVCA	10.750±5.732	12.205±9.210	0.512+
AVBC	66.250±13.925	61.608±11.625	0.362*
VAS			
First visit	47.875±15.541	2.652±0.831	0.655+
Last visit	23.125±10.105	1.000±0.904	0.273+
ODI			
First visit	47.875±15.541	53.869±22.742	0.497*
Last visit	23.125±10.105	34.217±19.064	0.130*

*Independent sample t-test, +Mann-Whitney U test
SD: Standart deviation, AVBC: Anterior vertebral body compression percentage, VAS: Visual analog scale, ODI: Oswestry Disability Index, mTLICS: Modified thoracolumbar injury classification and severity score, FVCA: Four-vessel cerebral angiography

should be able to fully identify all types of fractures, determine the prognosis and guide treatment, as well as being simple, easily applicable, diagnostically repeatable. We used mTLICS scoring in the treatment decision of our patients because it is useful in predicting surgical treatment and its repeatability is good[19]. Conservative treatment was applied to 64 patients with a score of 3 and below, and surgical treatment was applied to 92 patients with a score of 5 and above. Of 62 patients with a score of 4, 16 (25.81%) were treated conservatively and 46 (74.19%) underwent surgical treatment.

There are several studies in the literature reporting satisfactory results following both operative and non-surgical treatment. Wood et al.[2] compared the long-term outcomes of surgically and conservatively treated patients with thoracolumbar fractures and they found that the non-surgical group had a significantly better outcome. Soultanis et al.[20], in a retrospective study evaluated 75 patients with non-operated thoracolumbar fractures, reported satisfactory results. In contrast to these, Siebenga et al.[21] showed in a multicenter, prospective, randomized study that surgically treated patients had better clinical outcomes and a higher percentage of patients returning to work. In this study, in which 218 patients treated with and without surgery were compared; there was no significant difference in terms of age, gender, fracture level, mechanism of injury, FVCA and VAS; however, AVBC was significantly lower and ODI scores were significantly higher in the surgical treatment group. When the patients treated with operative and non-operative methods among 62 patients with mTLICS 4 score were compared, no significant difference was found in terms of age, gender, fracture level, mechanism of injury, FVCA, AVBC, VAS and ODI scores.

Although FVCA and AVBC are two of the objective criteria in the radiological evaluation of TLJ fractures, FVCA is a more controversial issue as there are conflicting studies on the amount of kyphosis that leads to poor results. In their study of 37 patients with thoracic and lumbar fractures, Gertzbein et al.[1] concluded that a kyphotic deformity greater than 30° was associated with an increased incidence of more severe back pain. However, Shen et al.[22] showed a poor correlation between clinical outcomes and kyphosis greater than 30°. Krompinger et al.[23] stated that if the kyphosis angle is less than 30° and the spinal canal narrowing is less than 50%, they can be defined as stable. In our study, FVCA and first and last admission ODI and VAS scores were compared and no significant difference was found. When the preoperative and postoperative kyphosis angle of 138 patients treated with surgery was compared, a statistically significant difference was found and it was found to be significantly lower in the postoperative group.

After radiologically evaluating the patients with TLJ fracture, it was necessary to evaluate how these radiologic results were reflected in clinical presentation. In our study, we examined the VAS and ODI values of our patients. In our study, when 138 patients who were operated on and 80 patients treated with non-surgical methods were compared, no significant difference was found in terms of VAS; however, ODI scores were significantly higher in the surgically treated group. When the patients with mTLICS score of 4 who were treated operatively and non-operatively were compared, no significant difference was found in terms of VAS and ODI scores. When the first admission ODI and VAS scores of all patients were compared with the last admission ODI and VAS scores, a significant difference was found where the scores at the last control were low. When the fracture level was compared with the ODI and VAS scores, there was no significant difference between the fracture level and the VAS score at the first admission and the ODI and VAS scores at the last visit, while a significant difference was observed in the ODI score at the first admission. The ODI score at first admission is highest in patients with T11 fractures and lowest in patients with L2 fractures (T11 > T12 > L1 > L2 in descending order). When the FVCA and first and last admission ODI and VAS scores were compared, no significant difference was found. Correlation analysis of VAS and ODI with gender or age did not show any significant difference.

Study Limitations

The limitations of this study include its retrospective study design and the lack of randomization. Measurement of the entire spine was not available for proper assessment of sagittal balance and pelvic incidence. This study was also limited as there was no standardized conservative treatment that was strictly administered and patient compliance varied throughout the conservative treatment period, particularly with regard to the bracing, so treatment options may be another possible factor affecting clinical outcomes. Despite these limitations, follow-up is satisfactory and evaluation of patients has been extensively documented. The risk of bias is eliminated, as preoperative values are comparable and clinical evaluations are performed by 2 surgeon.

CONCLUSION

Patients who underwent surgery had lower "AVBC %" and higher ODI scores. Based on this, it can be thought that patients with more vertebral depression and less functionality were operated on. The ODI and VAS at the final follow-up visit were lower than the ODI and VAS at first admission. This means that over time, all patients are relieved of pain and increase in functionality, regardless of the treatment protocol. The postoperative FVCA values of the patients were lower than before the surgery. This may suggest that we contributed to the correction of the kyphotic deformity with our surgery. Patients with high thoracolumbar fractures have higher ODI score at the first admission, so they are more painful due to fractures.The correlation between "AVBC%" and FVCA shows that the height of the vertebral corpus affects the angle of kyphosis. The advantages of surgery include better correction of kyphotic deformity, greater initial stability, an opportunity to perform direct or indirect decompression of neural elements, decreased requirements for external immobilization, and an earlier return to work.

Ethics

Ethics Committee Approval: This study was approved by the University of Health Sciences Turkey, Gülhane Training and Research Hospital Ethical Committee (decision no: 2021-238, date: 20.05.2021).
Informed Consent: Informed consent was taken from all participants.
Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: M.O.D., M.C.E., D.E.K., G.K., Concept: M.O.D., M.C.E., Design: M.O.D., M.C.E., Data Collection or Processing: D.E.K., G.K., Analysis or Interpretation: M.O.D., M.C.E., D.E.K., G.K., Literature Search: M.O.D., D.E.K., G.K., Writing: M.O.D., D.E.K.
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