

Analysis of Tree-related Falls in Terms of Thoracolumbar Injury Classification System Scores and Patient Outcomes

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ABSTRACT

Aim: Falling from trees are main problems of occupational healthcare. Patients falling from trees are suffered from spinal and extremity injuries due to high energy traumas. Our aim with this study was to reveal the differences in thoracolumbar injury classification system (TLICS) scores, degrees of spinal damage and treatments of traumas belonging to patients who presented with falls from different tree species in different plantations.

Material and Methods: This is a retrospective observational study. Patients who were brought to the emergency department due to falling from a tree between 2015-2020 were included. Characteristics of injuries due to falls from trees, TLICS scores, treatment types and 3 month follow up results were obtained from the hospital information system and comparative analysis was done.

Results: The mean age of the patients was 53.25±17.9 years and 54.9% were male. 33(64.7%) patients had undergone vertebroplasty or stabilization. According to height categories, TLICS scores(p=0.003) and stabilization levels(p=0.003) were statistically higher in taller tree categories (p=0.003). Although surgical interventions were statistically higher in tree falls higher than four meters (p=0.026), there was no statistically significant difference between trees in terms of treatment type (p=0.315), VAS score (p=0.219) and 30-day VAS score (p= 0.329) In addition, the change in Visual Analogue Scale (VAS) score was statistically higher in operated patients (median VAS=7) than in non-operated patients (median VAS=5.5) (p=0.012).

Conclusion: Our findings reveal that TLICS scores are significantly associated with tree heights and operate with good results in VAS scores.

Keywords: Spinal injury; trauma; tree falls.

Ağaçtan Düşmelerin Torakolomber Yaralanma Sınıflandırma Sistemi Skorları ve Hasta Sonuçları Açısından Analizi

ÖZ

Amaç: Ağaçtan düşmeler, iş sağlığı hizmetlerinin temel sorunlarından biridir. Ağaçtan düşen hastalar, yüksek enerjili travmalar nedeniyle omurga ve ekstremiteler yaralanmalarına maruz kalmaktadır. Bu çalışma ile amacımız, farklı plantasyonlardaki farklı ağaç türlerinden düşme ile gelen hastalara ait torakolomber yaralanma sınıflandırma sistemi (TLICS) skorları, spinal hasar dereceleri ve travma tedavilerindeki farklılıkları ortaya koymaktır.

Gereç ve Yöntemler: Bu retrospektif gözlemsel bir çalışmadır. 2015-2020 yılları arasında ağaçtan düşme nedeniyle acil servise getirilen hastalar dahil edildi. Ağaçtan düşmelere bağlı yaralanmaların özellikleri, TLICS skorları, tedavi türleri ve 3 aylık takip sonuçları hastane bilgi sisteminden alınarak karşılaştırmalı analizler yapılmıştır.

Bulgular: Hastaların ortalama yaşı 53,25±17,9 olup, %54,9'u erkekti. Düşmelerin en çok zeytin ağacından olduğu görüldü(n=23, %45,1) Hastaların 33'üne (%64,7) vertebroplasti veya stabilizasyon uygulandı. Boy kategorilerine göre TLICS puanları(p=0.003) ve stabilizasyon düzeyleri(p=0.003) istatistiksel olarak yüksek ağaç kategorilerinde daha yüksek bulundu (p=0.003). Dört metreden yüksek ağaç düşmelerinde cerrahi müdahaleler istatistiksel olarak daha yüksek olmakla birlikte (p=0,026), tedavi şekli (p=0,315), VAS skoru(p=0,219) ve 30 gün VAS skoru açısından ağaçlar arasında istatistiksel olarak anlamlı fark yoktu(p=0.329)Ayrıca Görsel Analog Ölçeği (VAS) skorundaki değişim opere olan hastalarda (median VAS=7) opere olmayan hastalara göre (median VAS=5,5) istatistiksel olarak daha yüksekti (p=0,012).

Sonuç: Bulgularımız, TLICS puanlarının ağaç boyları ile anlamlı bir şekilde ilişkili olduğunu ve VAS puanlarında iyi sonuçlarla çalıştığını ortaya koymaktadır.

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Anahtar Kelimeler: Ağaçtan düşme; spinal yaralanma; travma.

INTRODUCTION

Falls from height are recognized as trauma in which multiple system injuries are common. Pre-hospital and in-hospital management is crucial in preventing morbidity and mortality. Head injuries and axial spinal traumas are the leading injuries caused by falling from a height. These may be accompanied by abdominal visceral injuries, fractures of the pelvis or acetabulum, and bilateral lower extremity fractures. In particular, falling from a height of 3 meters or more or 3 times the person's height is called high-energy trauma (1). The reason for this is that being 6 meters and above causes cardiac injuries, aortic ruptures, vertical pelvic tears being 12 feet and above (3.6 meters and above), brain damage and thoracolumbar junction fractures if it is 3 feet (1 meter) or 5 steps or more (2). These trauma-related injuries are usually caused by potential deceleration injuries or high kinetic energy transfer mechanisms (2,3).

Falls from trees account for a significant proportion (14.8%-27%) of falls from height (3-6). While most of the falls from trees may be work accidents due to fruit harvest, sports injuries due to tree-stand falls due to trees in hunting have been shown in the literature (5,7,8). Although some of the tree species in which fall-related damage is analyzed are walnut, coconut, mango, betel nut and apricot, it has been determined that it is difficult to identify the tree they fall from in terms of the height they fall (6). The importance of walnut tree falls, especially in vertebral injuries, has been shown in the literature (9-11).

Comparing the fall cases due to trees at different heights that cause these traumas (3), which can also present as work accidents, is important in terms of increasing foresight, determining the relevant needs and increasing precautions.

Our aim in this study was to reveal the differences in thoracolumbar injury classification system (TLICS) scores, degrees of spinal damage and treatments of traumas belonging to patients who came from different tree species in different plantations. Thus, this study aims to contribute to patient management with foresight about the causes and consequences of trauma-related damage.

MATERIAL AND METHODS

Study design and settings

This was a retrospective observational study. Patients who were brought to the emergency department due to falling from the tree between 2015 and 2020 were included. Our study was approved by the local ethics committee (date 17/03/2021, no: 235) and was conducted according to the Helsinki ethical declaration.

Study population

Patients who were admitted to the emergency department, fell from a tree as a result of falling from a height and had a thoracolumbar spine trauma in the study period were included in the study.

Patients whose data could not be reached, those with cervical trauma, a history of previous trauma or surgery and patients whose outcomes could not be reached were not included in the study.

Dataset

Patient age, sex, tree type, thoracic vertebral fracture type and level, lumbar vertebral fracture type and level, morphological type of fracture, neurological damage, presence of posterior ligament damage, additional injuries, time/season of the event, Glasgow coma score, TLICS scores, outcome, presence and type of operation, 3-month mortality and post-control results obtained from the hospital database and archive, and the data obtained were recorded.

Thoracolumbar injury classification and severity scores were developed by the Spinal trauma group in 2005 for the development of the thoracolumbar injury severity score (12). This classification, which addresses both the clinical and morphological features of the injury, aims to predict spinal instability and the need for surgery in patients with thoracolumbar fracture. According to the morphology, presence of neurological damage, calculation made for the damage of the posterior ligamentous complex, 0-3 points refer to the patients who do not need surgery, and 5 points or more refer to the patients who require stabilization with surgery, including fracture reduction.

Statistical Analyses

Statistical analysis of the findings obtained in the study was performed with the IBM SPSS Statistics 27 (SPSS Inc., Chicago, IL, USA) package program. Numerical variables were shown as the mean \pm standard deviation or median (minimum-maximum), and qualitative variables will be shown as numbers and percentages.

Shapiro Wilk test is used for defining the distribution of the numerical variables. The differences between groups are analyzed with independent t test and Mann-Whitney U test. Correlation tests and Fisher tests are performed and all the tests are evaluated based on the $p < 0.05$ significance level.

RESULTS

There were 944 patients falling from height, including 64 who fell from the tree. Fifty-one patients whose data were accessible were included in the analysis. The demographic characteristics of the patients are listed in table 1.

The mean age of the patients was 53.25 ± 17.9 , and 23 (45.1%) of the patients were women. Falling from trees was most common in October ($n=13$, 25.5%). It was observed that the tree type with the highest number of falls was olive ($n=23$, 45.1%).

Most of the complaints were back pain ($n=37$, 72.5%) and lumbalgia ($n=35$, 68.6%). Most of the fractures were seen in the thoracic ($n=24$, 47.1%) and lumbar ($n=21$, 41.2%) vertebrae. Motor loss was seen in 9 patients, all in the lower extremities, from 1/5 to 4/5. Lung injury was seen in 9 of the patients (7 of them had burst fractures of thoracic and lumbar vertebrae), and extremity fractures were seen in 6 of the patients.

No patient had cervical fracture. While no posterior injuries occurred in the thoracic vertebral fractures, posterior elements were involved in 7 (13,8%) of the lumbar fractures, 41.7% ($n=21$) of which were corpus fractures. The distributions of the levels of the thoracic and lumbar vertebrae are shown in figure 1 and figure 2.

TLICS scores ($p=0.003$) and stabilization levels ($p=0.003$) regarding height categories were statistically found to be higher in taller tree categories ($p=0.003$). Although

surgical interventions were statistically higher in treefalls higher than 4 meters ($p=0.026$), there was no statistically significant difference among trees regarding treatment type ($p=0.315$), VAS score ($p=0.219$) and 30 days VAS score ($p=0.329$) (Table 2).

Table 1. Demographic characteristics of the patients

Variable	n (%)	Mean (CI 95%)
Age(mean, year)		53.25 (48.22- 58.29)
Gender		
Female	23 (45.1)	
Male	28 (54.9)	
Type of tree		
Olive	23 (45.1)	
Apple	9 (17.6)	
Apricot	8 (15.7)	
Cherry	2 (3.9)	
Walnut	7 (13.7)	
Fig	2 (3.9)	
Height of tree		
≤4	29 (56.9)	
>5	22 (43.1)	
VAS Score on Admission		7 (IQR=7)
GCS		15 (IQR=1)
Fracture in thoracic vertebrae	24 (47.5)	
Fracture in lumbar vertebrae	21 (41.2)	
Neurological findings		
Intact	42 (82.4)	
Complete cord	1 (1.9)	
Incomplete cord	8 (15.7)	
Morphology		
Compression	23 (45.1)	
Burst	13 (25.5)	
None	15 (29.4)	
Posterior ligament involving		
Intact	37 (72.5)	
Injury suspected/indeterminate	5 (9.8)	
Injured	9 (17.6)	
TLICS score		1(IQR=3.5)
Outcome		
Conservative	18 (5.3)	
Surgical	33 (64.7)	
Stabilization	15 (54.5)	
Vertebroplasty	18 (54.5)	
3-month days VAS score		0 (IQR=6)

Abbreviations: GCS: Glasgow Coma Score, VAS: Visual Analog Scale, TLICS: thoracolumbar injury classification system, IQR: Interquartile range

Table 2. TLICS score, treatment choices regarding height of tree

	Height	n	Median	p
TLICS	>4m	29	1	0.003
	≤4m	22	2	
Surgery	>4m	18		0.315
	≤4m	15		
VAS	>4m	22	7	0.219
	≤4m	29	7	
Stabilization levels	>4m	22	1.5	0.003
	≤4m	29	0	
Vertebroplasty levels	>4m	22	0	0.614
	≤4m	29	0	
30 days VAS score	>4m	22	0	0.329
	≤4m	29	0	

Independent Samples Mann-Whitney U test

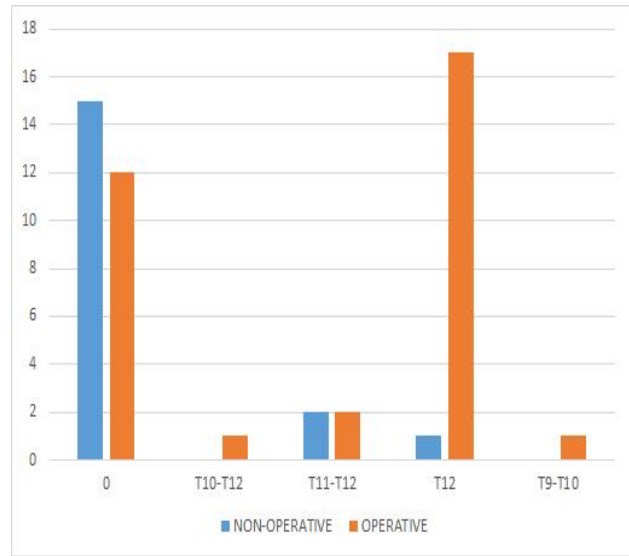


Figure 1. The levels of thoracic vertebrae distributions

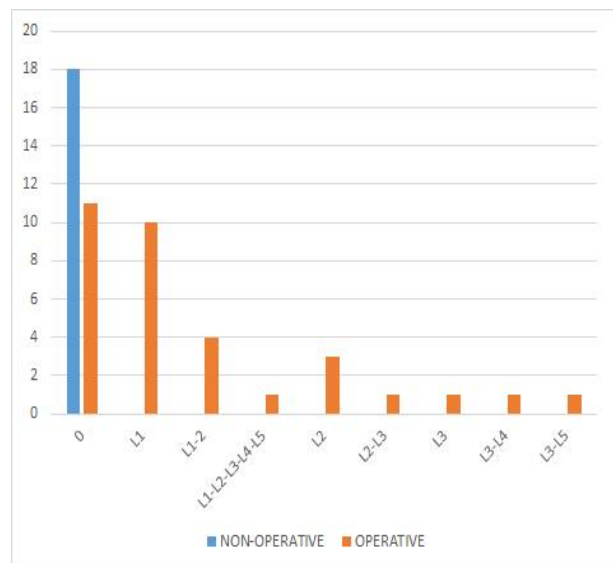


Figure 2. The levels of lumbar vertebrae distributions

Thirty-three (64,7%) of the patients underwent vertebroplasty or stabilization (Figure 3). One patient underwent surgery with 6-level stabilization. In most cases, 4-level stabilization was used. The maximum level of vertebroplasty was two levels and was used in one patient. All conservative patients were observed with a thoracolumbar corset. The three-month survival rate was 100%. There was a weak correlation between the visual analog scale (VAS) score on admission and the TLICS score in patients ($p=0.008$, $r=0,365$). Patients without pain at 3 months had lower TLICS scores ($p=0.021$); however, there was no correlation between TLICS scores and 3-month VAS scores ($p=0.069$) (Table 3).



Figure 3. a) Lumbar CT of a 55-year-old male patient showing burst fracture in L2 and L3 vertebrae with spinal cord injury at L2 level after falling from a walnut tree, b) Postoperative control lumbar x-ray shows posterior transpeduncular stabilization at T12-L1-L3-L4 levels.

Table 3. Correlations between TLICS and VAS Scores of the patients

Correlation Matrix*		TLICS	VASSCORE	@30days VASscore
TLICS	Pearson's r			
	p			
VASSCORE	Pearson's r	0.365		
	p	0.008		
30daysVASscore	Pearson's r	0.257	0.059	
	p	0.069	0.679	

Pearson's r correlation*

DISCUSSION

Our study is a descriptive study of the characteristics, TLICS scores and outcomes of patients who admitted due to falling from a tree and the TLICS scores of the patients. More than two-thirds of patients (70,5%) had compression and burst fractures and were treated surgically (64,7%), which required stabilization (21,4%). Olive trees were found to have the highest number in October among the tree species in which surgical patients fell. There is no study in the literature in this number of patients comparing more than one tree similar to this study.

Although it is known that patients due to high-energy trauma fall from a height of at least 3 meters and 3 times the person's own height, it is not known whether all tree falls are from the highest part of the tree (13,14). For this reason, although it is expected that there may be more injuries in falling from the tallest tree, which is normally the tallest tree, in our study, the presence of other concomitant damages and spinal fractures in the fall of the tree were/do not depend on height.

In the literature, 5 cervical fractures and 2 thoracolumbar fractures were found in a study of 50 patients due to a fall from a walnut tree (11). In our study, no cervical fractures were observed, and the number of thoracic and lumbar fractures was 36 (70,5%) with no cauda equina and no complete spinal injuries. No mortality was observed at 3 months.

In the study conducted with 30 patients who fell from the apricot tree, 30% had accompanying spinal injury (15). In our study, most of the patients who fell from apricot trees had spinal trauma.

Walnut, fig and grape were detected most causing mortality due to falling from trees by forensic medicine (4). And it has been reported that tree falls are most common in autumn and summer (4). In our study, there were no patients with mortality.

TLICS score has been emerged and validated tool for the aid spinal surgeons in decision making of the patients with thoracolumbar injuries (12,16,17). Especially in harvesting times or the year, thoracolumbar injuries may significantly related to falls from height including tree falls (18-20). Falling from height shows higher TLICS scores and stabilization levels. That may affect the choice of management of the thoracolumbar fractures which is statistically higher in thoracolumbar surgeries (21). The right management choice and outcomes depend on the level of high energy. In our study, although higher TLICS scores have statistically higher VAS scores in admission, no difference was found in 30 days VAS score between surgery and non-surgery group. Further studies should focus on the choice of management regarding outcome and pain scores of thoracolumbar fractures of tree-falls with large sample size.

It should be kept in mind that there may be trees of the same species, which may have different heights, among the limitations of our study. Since the mechanisms of the event during falling from the tree cannot be clarified in the story, further studies are needed on the mechanism of occurrence and protective measures that can be taken on this subject. There may be a need for prospective studies where more of these data can be collected, especially in rural areas. It is known that there is more than one vegetation in our country and that there is a workforce for fruit harvest in the food sector.

CONCLUSION

As a result, tree falls are one of the causes of trauma that can be prevented by taking precautions. It is necessary to predict these traumas and reveal the results at the collection times of the harvests obtained at different times and to increase the precautions. For this reason, it is essential to take preventive measures for this etiology, especially during these periods.

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