

AN ANALYSIS OF INJURIES DUE TO TRACTOR ACCIDENTS: A TEN YEAR RETROSPECTIVE STUDY

Traktör Kazasına Bağlı Yaralanmaların Analizi: On Yıllık Retrospektif Çalışma

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ABSTRACT

Objective: Although tractors are highly inadequate in terms of safety equipment compared to other vehicles, they are still frequently employed for agricultural activities and even human transportation. This study investigated patients presenting to the emergency department (ED) due to tractor accidents.

Material and Methods: Tractor accidents occurring over a ten year period were examined retrospectively. Victims' demographic data, the cause of the accident, trauma scores (Glasgow Coma Score, Injury Severity Score, Revised Trauma Score and Pediatric Trauma Score), injury localizations, imaging results, and clinical outcomes were recorded.

Results: One hundred sixty-five patients were included. Their mean age was 46.48±23.24 years, 82.4% were men, and 41.8% were tractor drivers. The most frequent cause of accidents was "falling from the tractor". The thorax was the most frequently injured anatomical region. Rates of head and thoracic injury were significantly higher in drivers compared to passengers (p=0.005 and p=0.039, respectively). The post-accident exitus rate was 3.6%. The incidence of abdominal and pelvic injuries was significantly higher in the exitus group than in the survivors (p=0.018 and p=0.015, respectively). Glasgow Coma Score and Revised Trauma Score levels were significantly lower in the exitus group than in the survivors (p<0.001 and p=0.001, respectively), while Injury Severity Score levels were significantly higher (p<0.001). Positive correlation was determined between mortality and abdominal and pelvic injury (r=0.184, p=0.018 and r=0.189, p=0.015, respectively).

Conclusion: Based on our study findings, tractor accidents frequently seen involve middle-aged men, and the thorax is the most commonly injured region. Exitus victims were exposed to greater trauma energy, and mortality was correlated with abdominal and pelvic injury.

Keywords: Emergency department, tractor accident, trauma

ÖZ

Amaç: Traktörler, güvenlik donanımı bakımından diğer araçlara göre çok daha yetersiz olsa da tarımsal faaliyetlerin yanı sıra insan taşımacılığı için de sıkça kullanılır. Bu çalışmada, traktör kazası nedeniyle acil servise başvuran hastalar incelenmiştir.

Gereç ve Yöntemler: On yıllık dönem içerisinde gerçekleşen traktör kazaları retrospektif olarak incelendi. Kazazedelerin demografik verileri, kazanın oluş mekanizması, travma skorları (Glasgow Koma Skoru, Injury Severity Score, Revize Travma Skoru, Pediatrik Travma Skoru), anatomik yaralanma bölgeleri, görüntüleme sonuçları ve klinik sonuçlarını kaydedildi.

Bulgular: Çalışmaya 165 hasta dahil edildi. Bunların yaş ortalaması 46.48±23.24/yıl, %82.4'ü erkek ve %41.8'i şofördü. En sık izlenen kaza mekanizması "traktörden düşme" idi. Toraks, en fazla yaralanan anatomik bölgeydi. Şoförlerde kafa ve toraks yaralanması oranı, yolculardan anlamlı olarak daha fazlaydı (Sırasıyla p=0.005; p=0.039). Kaza sonrası kazazedelerin %3.6'sı eksitus oldu. Eksitus olanlardaki batın ve pelvis yaralanması oranı, yaşayanlardan anlamlı olarak daha fazlaydı (Sırasıyla p=0.018; p=0.015). Eksitus olanların Glasgow Koma Skoru ve Revize Travma Skoru düzeyi yaşayanlardan anlamlı olarak daha düşük (Sırasıyla p<0.001; p=0.001); Injury Severity Score düzeyi ise anlamlı olarak daha yüksekti (p<0.001). Mortalite ile batın ve pelvis yaralanması arasında pozitif korelasyon olduğu saptandı (Sırasıyla r=0.184, p=0.018; r=0.189, p=0.015).

Sonuç: Çalışmamızın sonuçlarına göre, traktör kazaları sıklıkla orta yaş erkeklerde izlenmekte olup, toraks en fazla yaralanan bölgedir. Ölen kazazedeler daha fazla travma enerjisine maruz kalmış ve mortalitenin batın ve pelvis yaralanmasıyla ilişkili olduğu saptanmıştır.

Anahtar Kelimeler: Acil servis, traktör kazası, travma



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INTRODUCTION

Tractor accidents represent only a small part of all traffic accidents (1). However, they are frequently seen in countries with significant agricultural sectors, and are one of the “agriculture-related occupational hazards” in the USA and Canada (2,3). Their different design to that of other vehicles, the disproportion in size between the front and rear wheels, the lack of accident-prevention systems, inadequate safety equipment, and the uneven nature of and obstacles on the terrain on which they are employed all facilitate the occurrence of tractor accidents (4). The fact that tractors may be used to carry humans as well as for agricultural purposes can also result in numerous injuries or deaths in the event of accidents (5).

This study investigated patients presenting to the emergency department (ED) due to tractor accidents. Through the data obtained, we intend this study to contribute to the existing literature and to produce some understanding of the important points to be considered during the management of traffic accident victims in the ED.

MATERIALS AND METHODS

Study design

This retrospective study involved patients presenting to the Kırıkkale University faculty of medicine ED in Turkey, due to tractor accidents over a 10-year period from 2012 to 2021. Approval was granted by the local ethical committee (no. 2021.10-11). Patient data were retrieved from the hospital information processing automation system and archive information. All patients' demographic data, the cause of the accident, where the victim was sitting on the tractor when the incident occurred, the injury localizations, and trauma scores (GCS, Glasgow Coma Score; ISS, Injury Severity Score; RTS, Revised Trauma Score and PTS, Pediatric Trauma Score), imaging results, and clinical outcomes were recorded. Individuals with deficient file data or whose data could not be retrieved were excluded. GCS is a scoring indicator of neurological status in which the patient's motor response along with verbal and

eye-opening responses are evaluated. The highest score value is 15, while the lowest value is 3. A decrease in the score is interpreted as worsening neurological status. RTS is a physiologically based triage score. It is obtained by evaluating systolic blood pressure, respiratory rate and GCS. RTS ranges from 0-12. A decrease in score indicates fatal trauma-related injuries. ISS is an anatomical score established to assess the severity of trauma. Post-traumatic mortality is associated with morbidity and length of hospital stay. ISS ranges from 1 to 75. An increase in score indicates an increase in injury severity. PTS is a scoring that evaluates the patient's physiological status (Airway, Systolic blood pressure, Central nervous system, Open wound, Skeletal system) and body weight together. The total score ranges from -6 to +12. Values below eight points indicate potentially significant trauma for pediatric patients (6).

Statistical analysis

The study data were analyzed on SPSS version 21.0 software (IBM Corporation, Armonk, NY, USA). Descriptive statistics were expressed as number (n), frequency (%), median, and mean plus standard deviation (\pm SD) values. Normality of data distribution was evaluated using the Kolmogorov-Smirnov test. Student's t-test was used to compare normally distributed variables and the Mann-Whitney U-test for abnormally distributed variables. Pearson's chi-square test was applied in the comparison of categorical variables. The relationship between mortality and injury sites was analyzed using Spearman's correlation test. *p* values <0.05 were considered statistically significant.

RESULTS

Demographic data: One hundred seventy-three patients presented to the ED due to tractor accidents during the study period. Eight patients with deficient data were excluded, and the research was thus completed with 165 patients. The accident victims' demographic data are shown in Table 1.

Table 1. Accident victims' demographic data

Age (mean±SD)	46.48±23.24
Sex	n (%)
▪ Female	29 (17.6)
▪ Male	136 (82.4)
Accident victim	n (%)
▪ Driver	69 (41.8)
▪ Passenger	96 (58.2)
Position of the victim on the tractor	n (%)
▪ Driver's seat	69 (41.8)
▪ Above the wheel	52 (31.5)
▪ Trailer	44 (23.7)
Month of accident	n (%)
▪ January	-/-
▪ February	6 (3.6)
▪ March	9 (5.5)
▪ April	15 (9.1)
▪ May	13 (7.9)
▪ June	21 (12.7)
▪ July	35 (21.2)
▪ August	13 (7.9)
▪ September	23 (13.9)
▪ October	22 (13.3)
▪ November	7 (4.2)
▪ December	1 (0.6)
Time of accident	n (%)
▪ 00:00-04:00	8 (4.8)
▪ 04:00-08:00	3 (1.81)
▪ 08:00-12:00	30 (18.2)
▪ 12:00-16:00	40 (24.2)
▪ 16:00-20:00	55 (33.3)
▪ 20:00-00:00	29 (17.5)
Accident mechanism	n (%)
▪ Fall from tractor	76 (46.1)
▪ Rollover of tractor	39 (23.6)
▪ Hitting another vehicle and/or object	6 (3.6)
▪ Being crushed under the tractor	30 (18.2)
▪ Injury with other equipment belonging to the tractor	14 (8.5)
Clinical outcome	n (%)
▪ Discharged from the emergency department	78 (47.2)
▪ Hospitalized for treatment	85 (51.5)
▪ Admitted to relevant department	61 (71.7)
▪ Admitted to intensive care unit	24 (28.3)
▪ Exitus	6 (3.6)
▪ Driver	5 (3.0)
▪ Passenger	1 (0.6)

Examination of injury locations: Injuries were most common to the thoracic region. The rates of injuries to the head and thorax were significantly higher in drivers

than in passengers ($p=0.005$ and 0.039 , respectively) (Table 2).

Table 2. A comparison of drivers' and passengers' injury localizations

Localization	Total (n=165)	Passenger (n=96)	Driver (n=69)	p
	n (%)	n (%)	n (%)	
Head	72 (43.6)	33 (34.4)	39 (56.5)	0.005
Cervical	20 (12.1)	9 (9.4)	11 (15.9)	0.319
Thorax	80 (48.5)	40 (41.7)	40 (57.9)	0.039
Abdomen	42 (25.5)	25 (26.1)	17 (24.6)	0.838
Pelvis	25 (15.2)	14 (14.6)	11 (15.9)	0.810
Extremity	75 (45.5)	44 (45.8)	31 (44.9)	0.908

The rates of injuries to the abdominal and pelvic regions were significantly higher in the exitus victims than in the surviving patients ($p=0.018$ and 0.015 , respectively) (Table 3). Positive correlations were determined

between post-accident mortality and abdominal and pelvic injuries ($r=0.184$, $p=0.018$ and $r=0.189$, $p=0.015$, respectively). No correlation was observed between mortality and other region injuries.

Table 3. A comparison of exitus and surviving patients' injury localizations

Localization	Total (n=165)	Surviving (n=159)	Exitus (n=6)	p
	n (%)	n (%)	n (%)	
Head	72 (43.6)	68 (42.8)	4 (66.7)	0.247
Cervical	20 (12.1)	18 (11.3)	2 (33.3)	0.266
Thorax	80 (48.5)	75 (47.2)	5 (83.3)	0.092
Abdomen	42 (25.5)	38 (23.9)	4 (66.7)	0.018
Pelvis	25 (15.2)	22 (13.8)	3 (50.0)	0.015
Extremity	75 (45.5)	72 (45.3)	3 (50.0)	0.082

Examination of imaging findings: Fracture was determined in 37.6% of victims at direct radiography. The five most common pathologies at computed tomography (CT) were, in descending order, rib fracture

(57.5%), thoracolumbar fracture (30.7%), pneumothorax (22.2%), maxillofacial fracture (20.8%), and pelvic fracture (17.2%) (Table 4).

Table 4. Accident victims' imaging test results

Direct radiography findings, (n=133)	n (%)
▪ Fracture detected	50 (37.6)
Brain CT findings, (n=101)	n (%)
▪ Hemorrhage (epidural, subdural hematoma or subarachnoid hemorrhage)	9 (8.9)
▪ Pneumoencephaly	3 (2.9)
▪ Fracture (head and maxillofacial bone)	27 (26.7)
▪ Eye injury	1 (0.9)
▪ More than one pathology	27 (26.7)
Vertebral CT findings	n (%)
▪ Cervical CT, (n=81)	
▪ Fracture detected	11 (13.6)
▪ Corpus	6 (7.4)
▪ Spinous process	3 (3.7)
▪ Transverse process	3 (3.7)
▪ More than one site	1 (1.2)
▪ Thoracolumbar CT, (n=117)	
▪ Fracture detected	36 (30.7)
▪ Corpus	9 (7.7)
▪ Spinous process	5 (4.3)
▪ Transverse process	28 (23.9)
▪ More than one site	6 (5.1)
Thoracic CT findings, (n=99)	n (%)
▪ Rib fracture	57 (57.5)
▪ Hemothorax	15 (15.1)
▪ Pneumothorax	22 (22.2)
▪ Pulmonary contusion	6 (6.2)
▪ Sternum fracture	1 (1.1)
▪ Scapula fracture	1 (1.1)
▪ More than one pathology	64 (64.6)
Abdominal and Pelvic CT findings, (n=99)	n (%)
▪ Liver injury	3 (3.0)
▪ Spleen injury	2 (2.0)
▪ Kidney injury	2 (2.0)
▪ Ureter injury	2 (2.0)
▪ Multiorgan injury	2 (2.0)
Pelvic CT findings, (n=99)	n (%)
▪ Pelvic fracture	17 (17.2)
▪ Ramus pubis	6 (6.1)
▪ Ischium,	1 (1.0)
▪ Ilium	2 (2.0)
▪ More than one site	11 (11.1)

CT, computerized tomography

Examination of trauma scores: No difference was determined between drivers and passengers in terms of trauma scores (Table 5).

Table 5. A comparison of drivers' and passengers' trauma scores

Trauma Score	Total (n=165)	Driver (n=69)	Passenger (n=96)	p
GCS, median (min-max)	15 (3-15)	15 (3-15)	15 (10-15)	0.076
RTS, median (min-max)	9 (3-75)	11 (3-75)	6 (3-57)	0.218
ISS, median (min-max)	12 (0-12)	12 (0-12)	12 (11-12)	0.079
PTS, median (min-max)	10 (6-12)	9 (6-9)	10 (6-12)	0.569

GCS, Glasgow Coma Scale; ISS, Injury Severity Score; RTS, Revised Trauma Score; PTS, Pediatric Trauma Score.

GCS and RTS results were significantly lower in the exitus victims than in the survivors ($p < 0.001$ and

< 0.001 , respectively), while ISS results were significantly higher ($p < 0.001$) (Table 6).

Table 6. A comparison of exitus and surviving patients' trauma scores

Trauma Score	Total (n=165)	Exitus (n=6)	Surviving (n=159)	p
GCS, median (min-max)	15 (3-15)	9 (3-15)	15 (10-15)	<0.001
RTS, median (min-max)	9 (3-75)	10 (0-12)	12 (11-12)	<0.001
ISS, median (min-max)	12 (0-12)	60 (44-75)	7.5 (3-66)	<0.001
PTS*, median (min-max)	10 (6-12)	-	10 (6-12)	N/A

GCS, Glasgow Coma Scale; ISS, Injury severity score; RTS, Revised trauma score; PTS, Pediatric trauma score.*p value could not be investigated due to the absence of any pediatric exitus patient. N/A: non applicable

DISCUSSION

Tractors are frequently employed, particularly in developing countries, both in agriculture and for human transportation. Members of all age groups, including the pediatric age group, and of both genders can therefore be involved in tractor accidents (5). However, studies have shown that the majority of victims consist of middle-aged men, who are more suited to working in the agricultural sector (7-9). In the present study, 82.4% of the victims were male, and the mean age of all the victims was 46.48 ± 23.24 years, findings consistent with previous research.

The times of the greatest activity in the agricultural sector are during sowing and harvesting (10). The presence of daylight is also highly important for agricultural activities. Tractor accidents may therefore be expected to occur more frequently in the summer and fall and during daylight hours when work is most intensive (11). A study from Kentucky in the USA reported that tractor accident-related injuries frequently occurred between June and August, while Erkol et al. reported that such accidents increased more in June and

July (12,13). Goodman et al. reported that tractor accidents can be encountered at any time between 07:00 and 12:00 a.m., but that they peak between 04:00 and 05:00 p.m., with a marked decrease around mid-day (11). In the present study, and consistent with the previous literature, tractor accidents were most common in July and between 04:00 and 08:00 p.m.

Due to their different designs to those of other vehicles, the disproportion between their front and rear wheels, the deficient nature of accident-prevention safety systems, and the uneven nature of the terrain on which they are used, tractors involve a high risk of accidents when not employed with due care (14-16). These accidents can assume the form of hitting another vehicle and/or object and can also involve the driver or passengers falling from the tractor (4). "Tractor rollover" is noteworthy as the most common accident mechanism in studies from different countries examining tractor accidents (9,10,17-19). The most frequent mechanism in the present study; however, was "falling from the tractor", followed by rollover in second place. This may be associated with passengers

representing the great majority of victims in this study. These may have fallen from the tractors due to fatigue after work, carelessness, or a lack of safety equipment, thus resulting in the variation in our results.

Equipment attached to the vehicle (such as the steering wheel, driver's mirror, or other equipments in drivers cabin) can result in simple or fatal injuries to both driver and passengers in all body regions, particularly the head, spine, and thorax during tractor accidents (14,20-22). A study from Ireland reported that tractor accidents most frequently resulted in injuries to the extremities, thorax, spine, and head, while Erkol et al. described the thorax (46.4%) as the most frequently injured region (13,23). Franklin et al. reported head trauma, and multiple organ and thoracic injuries in fatal tractor accidents, while Hösükler et al. described injuries to the thorax, neck, and abdomen as the most important causes of mortality (24,25). The most commonly injured region in the present study was the thorax, followed by extremity and head injuries. These findings are compatible with previous studies. However, the noteworthy point is that the rate of injuries to the head and thorax was significantly higher among drivers compared to passengers. This suggested that drivers were more frequently injured due to striking vehicle equipment during accidents and that the tractors possessed insufficient protective equipment (such as seat belts and airbags). In terms of fatal accidents, the rate of abdominal and pelvic injuries in the exitus victims was significantly higher than that in the survivors. In addition, a positive correlation was also determined between mortality and abdominal and pelvic injury. This suggests that injuries to the thorax and head will be frequently observed in patients presenting to the ED due to tractor accidents, but that in terms of preventing mortality it will also be useful to take particular care over hemorrhagic shock-related injuries, such as those to the abdomen and pelvis.

The use of radiological methods is of vital importance in trauma patients (26). Although direct radiography is the first-choice method in the diagnosis of some isolated trauma patients, CT is superior to direct radiography,

and its use is spreading (27). In addition, tractor accidents can involve high-energy traumas, for which reason CT will be of greater use in the evaluation of such patients (28,29). Rates of detection of fracture using direct radiography in tractor accident victims have been reported at 37% by Akdur et al., and 57.2% by Vryhof et al. (8,30). The rate in the present study was 37.6%. In terms of studies examining CT results among tractor accident victims, Cogbill et al. listed the most frequently detected pathologies as rib fracture (22%), pelvic fracture (15%), pulmonary contusion (14%), renal contusion (12%), maxillofacial fracture (12%), and pneumothorax (12%), while Eraybar et al. listed rib fracture (19.3%), pneumothorax (13.6%), maxillofacial fracture (9.1%), intracranial hemorrhage (8%), and pelvic fracture (7.4%) (31,32). The injuries most frequently detected at CT in the present study was rib fracture (57.5%), followed by thoracolumbar fracture (30.7%), pneumothorax (22.2%), maxillofacial fracture (20.8%), pelvic fracture (17.2%), and hemothorax (15.1%). Although these findings are compatible with the previous literature, rates of pathologies involving the thoracic region (such as rib fracture, thoracolumbar fracture, pneumothorax, and hemothorax) and maxillofacial fracture were much higher than in other studies. We think that this may be attributable to the frequent use of CT in patient evaluation during our study or to falls from tractors representing the most frequent injury mechanism.

Trauma scores are calculated based on the patient's responses (neurological status, eye-opening, verbal, and motor response), vital findings, and the anatomical region injured (33). Although none of these scores involve a definitive result regarding the trauma patient's course, they assist diagnosis and treatment management (34). Among previous studies evaluating victims' GCS scores following tractor accidents, Jawa et al. reported a median value of 15, while Eraybar et al. reported a median GCS value of 15 and a median RTS value of 12 (32,35). In terms of studies examining ISS values following tractor accidents, Cogbill et al. reported a mean ISS value of 13.3 in one study and 8.5 in another,

while Sheehan et al. reported a median value of nine (23,31,36). The median trauma scores of all the victims in the present study were GCS: 15, RTS: 9, and ISS: 12, respectively. These results are similar to those of other studies. However, the particularly noteworthy finding was that the GCS and RTS values of the exitus victims were significantly lower than those of the survivors, while ISS was significantly higher. We interpreted this as indicating that the exitus victims being exposed to higher trauma energy than the survivors and to their vital findings and neurological functions being more impaired.

There are a number of limitations to this study, and these affected the results obtained. The first and most important is the retrospective nature of the research. The second is that characteristics of the tractors involved in accidents were not fully known (such as the roll bars, roll cages or presence of rollover protection structures). A third limitation is that the results are based on data from a single center.

Based on the results of this study, tractor accidents are frequently observed in middle-aged men, and the frequency rises during the summer. Falling from tractors was the most frequent trauma mechanism, and thoracic injuries were most frequently observed in both drivers and passengers. Abdominal and pelvic injuries were correlated with mortality in the non-surviving victims, and it may be concluded that these were exposed to higher trauma energy and suffered greater vital finding and neurological impairment. Patients presenting to the ED following tractor accidents must be examined in detail and placed under close hemodynamic follow-up, and care must be taken over injuries to all organ systems, but particularly the thorax.

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