ORIGINAL ARTICLE

Effect of the presence of rib fracture on mortality and morbidity in blunt thoracic traumas

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ABSTRACT

BACKGROUND: The aim of this study was to determine the effect of the presence of rib fracture on mortality and morbidity in blunt thoracic trauma (BTT).

METHODS: Records of patients aged over 18 and admitted with BTT between January 2017 and October 2019 dates were retrospectively evaluated. Only patients with both BTT and rib fracture were included in the study. Age, gender, trauma mechanism, additional organ injuries, and need for intensive care unit of patients were identified. The total length of hospital stay, length of stay in the intensive care unit, treatment modalities, need for mechanical ventilator; blood and blood products, complications, and mortality rates for patients were recorded.

RESULTS: One hundred eighty-six (73.8%) and 66 (26.2%) of 252 included patients were male and female, respectively. The most commonly seen trauma mechanism was motor vehicle accidents (51.4%). The mean age of patients was 52±12 (18–91). We identified that there was a significant association between hemothorax and non-thoracic additional organ injuries (p=0.024). There was no significant association between pneumothorax and additional organ injuries (p=0.067). The number of fractured ribs was significantly different between cases with and without hemothorax (p<0.001). There was also a significant difference between cases with and without pneumothorax in terms of the number of broken ribs (p<0.039). There was a significant difference between cases undergone thoracotomy and cases who did not undergo thoracotomy in terms of mean length of stay in the hospital (p<0.001). There was a positive correlation between the number of broken ribs and length of stay in the hospital (r=320, p<0.001).

CONCLUSION: Increased number of rib fracture in BTTs increases morbidity and length of stay in the hospital.

Keywords: Blunt chest trauma; morbidity; mortality; rib fracture.

INTRODUCTION

Blunt thoracic trauma (BTT) is mostly related to various life-threatening injuries.[1] Thoracic injury is the main cause of death in 25% of all deaths related to trauma and it is a contributing factor to fatal outcomes in the other 25% of cases.[2] BTT generally occurs due to thoracic compression caused by sudden and high-speed deceleration hit.[3] Among all anatomic regions, thorax injuries are the third after cranial and extremity injuries; respectively.[4]

Etiologic causes of thoracic traumas vary worldwide according to social and cultural factors.[5] Penetrating thoracic traumas caused by firearm and sharp penetrating objects are among its most common causes in underdeveloped or developing countries whereas BTT is commonly seen in traffic accidents and in especially elderly patients with mechanisms as falling down from their heights or stairs.[6] Nowadays, the annual number of deaths in patients with thoracic trauma who admitted to the hospital due to multiple trauma has been estimated as about 5.8 million worldwide. BTT is the first place among preventable causes of death.[7]

Increased number of fractured rib is an important indicator

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of trauma severity.[8] Respiratory functions are decreased by pain occurred due to rib fracture.[9] Lung capacity decreases due to pain; and atelectasis, pneumonia, and respiratory failure may occur. Therefore it may cause the need for mechanical ventilator support.[10]

There are many studies analyzing BTTs in the literature. However; literature data related to BTT which is accompanied by rib fractures is limited. The primary aim of this study was to determine the effect of the presence of rib fracture on mortality and morbidity in BTT. The etiological, demographic, and clinical characteristics of the patients were also discussed.

MATERIALS AND METHODS

Our study was conducted in accordance with the Helsinki Declaration and it was approved by the institutional Clinical Research Ethics Committee (Ethics Committee approval number: 2019/22/09).

Records of patients aged over 18 and had BTT admitted to the emergency department of a university hospital between January 2017 and October 2019 dates were retrospectively evaluated. Penetrating thoracic injury cases, cases aged under 18, patients without rib fracture were excluded from the study. Detailed information about patients was obtained from the electronic database of the hospital. Age, gender, and trauma mechanisms (traffic accident, falling down from a height, animal attack, entrapment under the debris, acts of violence, farming injuries, etc.) were recorded. The number of broken ribs, hemothorax, pneumothorax, thoracic injuries such as lung contusion and additional organ injuries (intra-abdominal injuries, limb fractures, intracranial injury, other bone fractures, etc.), and the need for an intensive care unit were identified. Length of stay in the hospital, length of stay in the intensive care unit, treatment modalities, need for blood and blood product and mechanical ventilator, complications, and mortality rates of patients were also recorded.

Statistical Analysis

Statistics for social sciences version 20 (SPSS 20) was used for statistical analysis. Numeric data were presented as mean ± standard deviation, frequency, and percentage. The Chi-square test was used for categorical data in the inter-group analysis. Mann–Whitney U or independent samples t-test as appropriate was used for numeric data in inter-group comparisons. Spearman correlation analysis was used for the identification of correlation.

RESULTS

A total of 252 cases which was consisted of 186 males (73.8%) and 66 females (26.2%) with both BTT and rib fracture was included. The mean age of patients was 52±12 years (range 18–91 years). Motor vehicle accidents with 132 (52.3%) cases were the most frequent type of trauma mechanism. 102 (77%), 17 (12.8%), and 13 (9.8%) of motor vehicle accidents were in-vehicle traffic accidents, out of vehicle traffic accidents, and motorcycle accidents; respectively (Fig. 1).

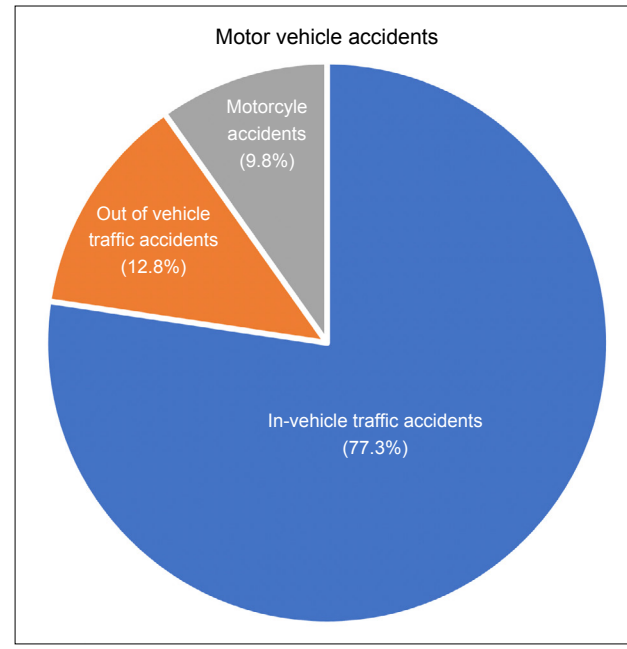

Figure 1. Distribution of traffic accidents.

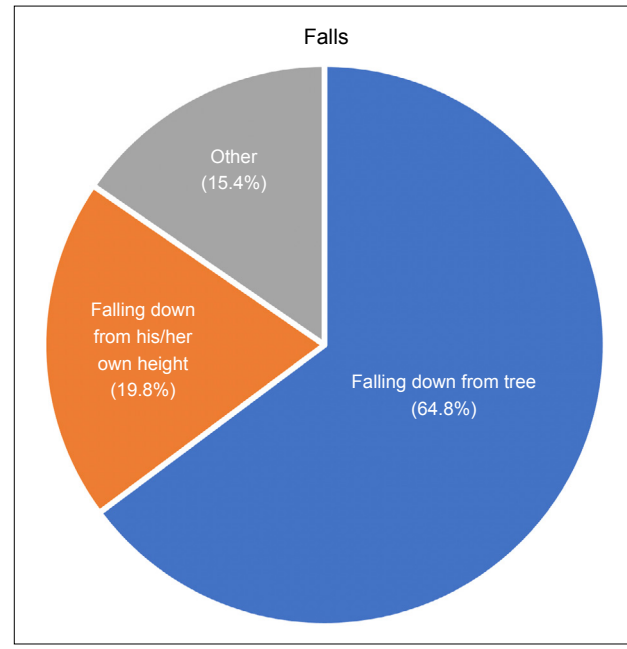

Figure 2. Distribution of fall accidents.

59 (64.8%), 19 (19.8%), and 14 (15.4%) of 92 (36.5%) injuries occurred as falling were falling down from a tree, falling down from their own height, and falling down due to other reasons; respectively (Fig. 2). The mean age of our cases fallen down from the tree was 57±15 years (52–81 years). The mean age of our cases fallen down from their own heights was 78±12 years (68–90 years) whereas cases fallen down due to other reasons was 45±7 years (21–80 years).

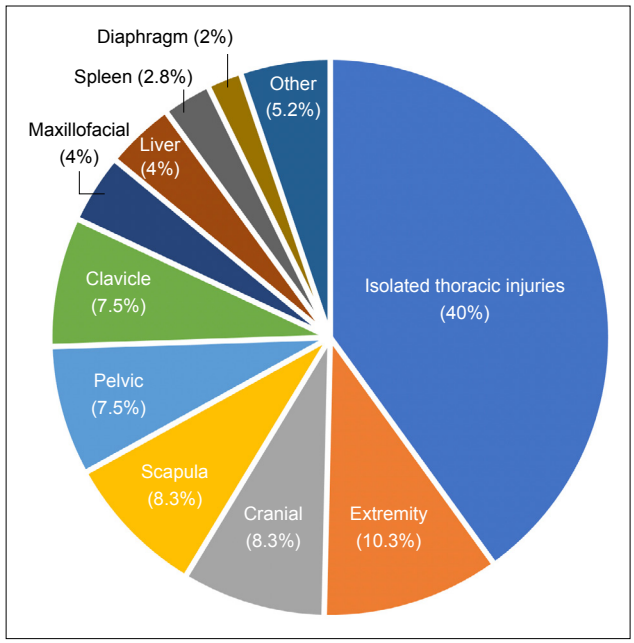

Figure 3. Type of injuries.

Animal attack, occupational injuries, and other reasons were the trauma mechanisms of 10 (3.9%), 6 (2.3%), and 12 (4.8%) cases; respectively. Other reasons were consisted of being crushed under a heavy object (3 cases), an act of a violence (3 cases), collusion (2 cases), bicycle accidents (1 case), parachute failure (1 case), being after cardiopulmonary resuscitation (1 case), and entrapment under the debris (1 case).

Each of our cases had a minimum of 1 and maximum of 14 fractured ribs. A total of 939 fractured ribs were present in all of our 252 cases (mean 3.7±2). 124 (49.2%), 101 (40%), and 27 (10.8%) of cases had rib fractures at left hemithorax, right hemithorax, and both hemithoraces; respectively. 153 (60.7%) cases had 1–3 fractured ribs, 68 (27%) cases had 4–6 fractured ribs, and 31 (12.3%) cases had 7 and more fractured ribs.

Table 1. Distribution of intrathoracic injuries

Type of injury	n	%
Lung contusion	98	38.9
Hemothorax	56	22.2
Hemopneumotorax	23	9.1
Sternum fracture	23	9.1
Subcutaneous emphysema	21	8.3

Types of intrathoracic injuries are presented in Table 1. These injuries were alone or combined with other organ injuries. 151 cases with non-thoracic additional organ injuries had extremity fracture (26/10.3%), various types of intracranial injuries (21/8.3%), scapula fracture (21/8.3%), pelvis fracture (19/7.5%), clavicle fracture (19/7.5%), maxillofacial injury (10/4%), liver injury (10/4%), spleen injury (7/2.8%), diaphragm injury (5/2%), and injuries of other tissues and organs (13/5.2%) (Fig. 3).

The total length of hospitalization of all patients was 2056 (mean 8.1±4 days; range 1–56 days). 83 (32.9%) cases had hospitalization indication to intensive care units and the total length of hospitalization of patients in the intensive care unit was 549 days (mean 2.2 days; range 1–25 days). Mechanical ventilator support was needed in 36 (14.2%) cases. 45 (18%) cases received blood and blood product transfusions.

Medical treatment was sufficient for 158 (62.7%) cases. 55 (41.3%) of a total of 133 cases with hemothorax, pneumothorax, or hemopneumothorax did not need any surgical intervention. An analysis of 78 cases that needed surgical intervention is presented in Table 2.

We identified a significant association between hemothorax and non-thoracic additional organ injuries (p=0.024). There was no significant association between pneumothorax and additional organ injuries (p=0.067). The number of fractured ribs was significantly different between cases with and without hemothorax (p<0.001). The mean number of fractured ribs was 4±2 in cases with hemothorax whereas the mean number of fractured ribs was 3±1 in cases without hemothorax. There was also a significant difference between cases with and without pneumothorax in terms of the number of fractured ribs (p<0.039). The mean number of fractured ribs was 4±3 in cases with pneumothorax whereas the mean number of fractured ribs was 3±1 in cases without pneumothorax. There was a significant difference between cases who underwent thoracotomy and cases who did not undergo thoracotomy in terms of length of hospitalization (p<0.001).

Table 2. Number of patients underwent surgical intervention

Injury	Number of cases	Medical treatment	Tube thoracostomy	Thoracotomy
Hemothorax	56	24	20	12
Pneumothorax	54	21	21	2
Hemopneumothorax	23	0	19	4
Total	133	55	60	18

The mean length of stay in hospital was 17±3 and 7±2 days in cases undergone thoracotomy and cases that did not undergo thoracotomy; respectively. There was a positive and significant correlation between the number of fractured ribs and length of stay in the hospital (r=320, p<0.001).

Complication occurred during monitoring and treatment in 20 (7.9%) of our cases. Complications were pneumonia (8 cases), total atelectasis (3 cases), acute kidney failure (2 cases), prolonged air leakage (2 cases), sepsis (1 case), empyema (1 case), multiorgan failure (1 case), ARDS (1 case), and pulmonary thromboembolism (1 case).

Mortality occurred in 10 (3.9%) cases due to non-thoracic organ injuries. No death directly caused by thoracic injury was observed. Deaths occurred due to cranial causes in 6 (2.3%) cases, uncontrollable retroperitoneal hemorrhage due to pelvic fracture in 1 (0.4%) case, intra-abdominal multiorgan rupture in 1 (0.4%) case, spinal shock due to complete transection of medulla spinalis at cervical level in 1 (0.4%) case, and sepsis in 1 (0.4%) case.

DISCUSSION

BTT is a frequently seen clinical condition in general body traumas and motor vehicle accidents are its most frequent trauma mechanisms.[11,12] Similar to the literature, motor vehicle accident was also the most frequent trauma mechanism in BTT with a rate of 52% in our study.[6,13] When motor vehicle accidents were examined in detail, it was observed that 102 (77%), 17 (12.8%), and 13 (9.8%) of them were in-vehicle, out of the vehicle, and motorcycle accidents; respectively. In our study, traumas caused by motorcycle accidents and vehicle collisions were less frequent. These types of traumas are high-energy traumas. Organ injury correlates with the severity of trauma. We think that cases of out of vehicle traffic accidents as motorcycle accidents and vehicle collisions are more likely to die at the accident scenes or during transport to our hospital due to severe injuries.[14]

The second most frequent trauma mechanism was fall cases with 92 (36.5%) cases. It has been reported in the Major Trauma Outcome Study that 16.5% of BTTs are caused by fall injuries. A higher rate of thoracic trauma caused by falls in our series than literature was probably caused by a higher rate of agricultural working as a primary job in this region and high numbers of cases fallen down from tree due to especially prevalent walnut, apple, and olive farming. It was observed that 59 (64.8%) patients had injured by falling down from trees in our study.

BTTs are more frequently seen in males and at ages between 20 and 50.[2] The mean age of our cases fallen down from trees was 52±15 and it varied between 52 and 80 age which was not in accordance with the literature. It can be explained as the tendency of males at physically active ages in our region toward injuries in motor vehicle accidents or occupational accidents. The male population aged between 50 and 80 in our study works primarily in agriculture. Injuries related to fall mechanisms are more likely to be falling down from trees in our region. We think that comorbid factors such as uncontrolled hypertension, diabetes, and neurologic disorders which all increase with advanced age may trigger falls by affecting patients' balance. BTTs in the elder population of developed countries usually occur as traumas due to falling down from their heights or from stairs.[6] Similar to the literature, the mean age of patients fallen down from their own heights was 78±12 (65–90 years) in our study. We identified that cases in that age group are prone to be injured even in the low-energy traumas which are disproportional to their trauma severity because of the decreased bone density due to comorbid factors.

The most frequently seen pathologies as thoracic trauma in our study were lung contusion (38.9%), hemothorax (22.2%), and pneumothorax (21.4%); respectively; however, it was not in accordance with the literature.[5,15] Patients with and without rib fractures were evaluated together in previous studies. In a study performed by Tekinbaş et al.,[16] it was reported that the most frequent thoracic injuries are pneumothorax (20.1%), hemothorax (12.3%), and lung contusion (11.3%); respectively. Lung contusion was the most frequent intrathoracic injury accompanying rib fracture in our series due to exclusion of cases without rib fracture.

Similar literature studies have reported that extremity injuries were the most frequent non-thoracic additional organ injury with a rate of 19%.[17] Similar to the literature, 26 (10.3%) and 21 (8.3%) of non-thoracic additional organ injuries in our study were extremity fractures and intracranial injuries, respectively.

Non-operative approaches are mostly sufficient for the treatment of thoracic traumas. In the study of Hasbahçeci et al.,[11] 48.7% of cases received non-operative methods. In another study, 90% of cases underwent surgical methods.[6] Medical treatment was also sufficient for 158 (62.7%) cases in our study. There has been no consensus about the medical approach to the BTT in literature. In our series, different results from the literature were observed. Close clinical monitoring, frequent lung radiography, and thoracic computed tomography if necessary were performed and all vital signs were recorded in our patients treated with medical therapy. Appropriate surgical methods were performed if it was clinically necessary for our monitored patients. 3 and 2 of our cases underwent tube thoracostomy due to increasing hemothorax and pneumothorax levels; respectively, whereas bleeding control was obtained by thoracotomy in 1 of our cases due to sudden deterioration in hemodynamic findings.

Fifty-five (41.3%) of a total of 133 cases with hemothorax, pneumothorax, and hemopneumothorax did not require any surgical intervention; and close clinical monitoring and med-

ical treatment were sufficient. However, advanced trauma associations have suggested prophylactic tube thoracostomy for all traumatic pneumothorax cases due to the risk of turning into tension pneumothorax; and drainage of all hemothoraces for preventing possible empyema development.[1] In our study, cases with hemothorax and pneumothorax without tube thoracostomy had no complications during their long-term follow-ups. We observed that invasive intervention was not required with proper monitoring in minimal hemothorax and minimal pneumothorax cases which even were due to blunt trauma. We also identified that decreasing the number of surgical interventions could prevent complications related to surgery. The number of invasive interventions and length of stay in hospital were reduced when careful monitoring and correct algorithm were performed.

Sixty (76.9%) and 18 (23.1%) of our 78 cases requiring surgical intervention underwent tube thoracostomy and thoracotomy interventions; respectively. Tube thoracostomy was required and sufficient in 20 (35.7%) of 56 hemothorax cases and 21 (38.9%) of 54 pneumothorax cases. As different from the literature, we decided to monitor minimal hemothorax and minimal pneumothorax cases whereas we performed invasive intervention in hemopneumothorax cases without considering volumes. Nineteen (86.9%) of 23 cases with hemopneumothorax underwent tube thoracostomy. Literature data have suggested tube thoracostomy in BTTs without considering hemothorax volume for preventing empyema and fibrothorax.[18] In our series, we observed that unnecessary invasive interventions and complications due to these interventions can be avoided with careful monitoring. The remaining four hemothorax cases needed bleeding and leakage control by thoracotomy. There was a significant association between hemothorax and non-thoracic additional organ injuries. There was no significant association between pneumothoraces and additional organ injuries. In conclusion, it may be suggested that hemopneumothorax cases are more complicated injuries and medical treatment along with monitoring may be risky in these cases. In the study of Lin et al.[19] in 2015, it was found that additional organ injuries significantly increase as the number of fractured rib increases. We found that cases with hemothorax had more fractured ribs than cases without hemothorax. The mean number of fractured ribs in cases with pneumothorax was more than in cases without pneumothorax. In our study, the number of fractured rib and length of stay in the hospital were positively and significantly correlated. There has been no sufficient study for demonstrating whether there is an association between the number of fractured ribs and hemothorax, pneumothorax, and length of stay in the hospital. We aimed to highlight the clinical pictures needed to be considered during both transportation and treatment/monitoring in these cases by demonstrating an association between the number of fractured ribs and intrathoracic other injuries. In the light of this perspective, our study is an important contribution to the literature and there had been no similar study as far as we know.

The total length of stay in hospital was 2056 days, the mean length of stay in hospital was 8.1±4 days (range 1–56 days) and these were longer than the data in the literature.[5] We considered this as a result of the higher mean age of our cases with blunt trauma occurring in our region than cases in the literature.[11] We identified that the advanced age group had a longer length of stay and care in the hospital when their comorbid diseases cross with the trauma. Length of stay in hospital was longer in cases undergone thoracotomy than cases who did not undergo thoracotomy. Thoracotomy is also a planned and controlled trauma. We observed that pain due to surgery, impaired respiratory physiology caused by pain, and the healing process were all contributors to prolonged stay in the hospital.

In a conducted study, the rate of cases requiring intensive care was reported as 8.6%, and the mean length of stay was reported as 7.2±6 days.[5] Although rates of the intensive care indication in our study were quite higher than the literature, the mean length of stay in hospital was lower. We concluded that placing our cases without mechanical ventilator support in the intensive care unit was the main reason for this difference. High rates of stay in the intensive care unit were caused by the practice of monitoring multi-trauma patients in the intensive care unit for the first 24 h due to lack of sufficient monitorization system in our clinics. Similar literature studies reported the rate of need for mechanical ventilation as 11–15% in BTT cases.[18] In our study, 36 cases (14.2%) needed mechanical ventilator support and it was in accordance with the literature. 45 cases (18%) received blood and blood product transfusion. However; there is no study related to this finding in the literature.

Complication rates are about 20% in similar studies.[7,20] 20 (7.9%) of our cases had complications during monitoring and treatment; however, our complication rates were quite lower than the rates in the literature. We especially related this result with the practice of monitoring multi-trauma patients in the intensive care unit for the first 24 h under a multidisciplinary approach.

Rates of mortality in BTTs vary between 4.2% and 16.6%.[1] Mortality occurred in 10 (3.9%) cases and they were due to non-thoracic organ injuries. Our mortality rates were lower than the literature and it was due to a low rate of complication, loss of severely injured patients before reaching the hospital, and our multidisciplinary approaches conducted together with trauma clinics in the management of our cases with multiple organ injuries. No death directly caused by thoracic injury occurred.

Cases with BTT must be followed under monitorization. Prophylactic antibiotherapy was given to cases if necessary because it has been known that pneumonia is the complication with the highest rate in the literature. This approach had an important role in preventing pneumonia which is the

most frequent complication of BTTs. We think that especially giving wet lung treatment in cases with lung contusion and avoiding long-term mechanical ventilator support significantly decreased our mortality rate.

It must be kept in mind that BTTs are caused by high-energy traumas. It directly causes 25% of trauma-related deaths and is responsible for facilitating reasons in another 25% of trauma-related deaths.[6] Preventable part of trauma-related deaths with proper management belongs to this group. There have been many conducted studies on this issue. However, they have been resulting in different outcomes. We aimed to contribute the literature with our BTT cases.

Conclusion

We presented that fractured ribs have significant effects on morbidity and it is different from present studies in the literature. We identified that both intrathoracic and non-thoracic injuries statistically significantly increase as the number of fractured ribs increases. We saw that rib fractures are important injuries even when they are not accompanied by any other injuries. Length of stay in hospital and complications were prone to increase as the number of fractured ribs increased. Ribs are important anatomic structures of respiratory physiology. Respiratory physiology may be impaired even when only a single rib fracture is identified if the case is not properly managed. Therefore, it may cause pain, secretion stasis, atelectasis, pneumonia, and even death due to the vicious cycle of these complications.

Ethics Committee Approval: This study was approved by the Kahramanmaras Sutcu Imam University Faculty of Medicine Ethics Committee (Date: 27.11.2019, Decision No: 2019/22/09).

Peer-review: Internally peer-reviewed.

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Conflict of Interest: None declared.

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ORİJİNAL ÇALIŞMA - *ÖZ*

Künt toraks travmalarında kaburga kırığı varlığının mortalite ve morbidite üzerine etkisi

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AMAÇ: Bu çalışmanın amacı, künt göğüs travmalarında kaburga kırığı varlığının mortalite ve morbidite üzerine etkisini tespit etmektir.
GEREÇ VE YÖNTEM: Ocak 2017–Ekim 2019 tarihleri arasında künt toraks travması ile başvuran 18 yaş üzeri hastaların dosyaları geriye dönük olarak incelendi. Sadece künt toraks travması ve kot fraktürünün birlikte olduğu hastalar çalışmaya dahil edildi. Hastaların yaşı, cinsiyeti ve bu hastalardaki travma mekanizması, ek organ yaralanmaları, yoğun bakım ihtiyacı, yatış süreleri, yoğun bakım ünitelerinde yatış süreleri, tedavi şekilleri, mekanik ventilatör, kan ve kan ürünü ihtiyaçları, komplikasyonları ve mortalite oranları kaydedildi.
BULGULAR: Çalışmamıza alınan 252 olgunun 186'sı erkek (%73.8), 66'sı (%26.2) kadındı. Motorlu taşıt kazaları %51.4 oranıyla en sık görülen travma mekanizmasıydı. Hastaların yaş ortalaması 52±12 (18–91) yıl idi. Hemotoraks ile toraks dışı ek organ yaralanmaları arasında anlamlı ilişki olduğunu tespit ettik (p=0.024). Pnömotorakslar ile ek organ yaralanmaları arasında anlamlı ilişki yoktu (p=0.067). Hemotoraks olanlar ve olmayan olguların kırık kaburga sayısı anlamlı olarak farklıydı (p<0.001). Pnömotoraks olan ve olmayan olguların da kırık kaburga sayıları anlamlı olarak farklı bulundu (p<0.039). Torakotomi yapılan olgularla yapılmayan olgular arasında hastanede yatış günü olarak anlamlı fark vardı (p<0.001). Kaburga kırığı sayısı ile hastanede yatış süresi arasında pozitif yönde anlamlı ilişki mevcuttu (r=320, p<0.001).
TARTIŞMA: Künt toraks travmalarında artmış kot fraktürü sayısı morbiditeyi ve hastanede yatış süresini arttırır.
Anahtar sözcükler: Kaburga kırığı; künt göğüs travması; morbidite; mortalite.

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