ORIGINAL ARTICLE

Relationships of the frailty index and geriatric trauma outcome score with mortality in geriatric trauma patients

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ABSTRACT

BACKGROUND: We aimed to determine the relationships of the trauma-specific frailty index (TSFI) and the geriatric trauma outcome score (GTOS) with 30-day mortality among geriatric trauma patients aged 65 and older.

METHODS: This prospective observational study included 382 patients aged 65 years and older who were admitted to a training and research hospital due to blunt trauma. Informed consent was obtained from them and/or their relatives. In addition to patients' vital signs, information about chronic diseases and drug use was obtained on admission to the emergency service and the results of laboratory examinations, radiological imaging, blood replacements, length of stay in the emergency room and hospital, and mortality were recorded in case forms. Glasgow coma scale, ınjury severity score, GTOS, TSFI, and body mass index (BMI) values were calculated by the researchers. Outcome information was obtained from the patient and/or relatives by phone 30 days later.

RESULTS: When the patients who died and those who survived were compared at the 30th day after trauma, no significant difference was found in terms of BMI or TSFI ($p>0.05$). It was determined that patients with a GTOS of ≥95 at admission would have higher 30-day mortality (the sensitivity was 76%, and the specificity was 72.27% ($p<0.001$)). When correlations were evaluated according to mortality, a correlation was found between the presence of two or more comorbid diseases and mortality ($p=0.001$).

CONCLUSION: We think that a more reliable frailty score can be obtained using these parameters as we have determined that the TSFI as calculated at admission to the emergency department is not sufficient on its own, while the lactate, GTOS, and the length of hospital stay are also effective in mortality. We suggest that it would be appropriate to use the GTOS in long-term follow-up as well as for predictive power for mortality within 24 h.

Keywords: Frailty; geriatric; mortality; score; trauma.

INTRODUCTION

While one-eighth of the population is over the age of 65 years today, this rate is expected to reach one-fifth by 2030. In addition, patients over the age of 65 constitute 23% of all trauma admissions and trauma is the fifth leading cause of death in this population in some settings.[1,2]

In addition to the increase in the geriatric population, more injuries can be seen among geriatric individuals who live more independently and actively. The concept of frailty comes to the fore in terms of determining the preexisting potential for injuries in the geriatric population. Frailty is defined as a state of weakness or poor homeostasis after a stressor and it is the result of a cumulative decline in many physiological systems over the course of a lifetime.[3] The calculation of frailty scores in the evaluation of elderly patients may allow for more complete patient evaluations. Such scores can provide an idea about which patients may be discharged from the hospital in the early period or which patients will need resuscitation earlier. The trauma-specific frailty index (TSFI) (derived from the Rockwood frailty survey) is a frailty tool that was developed and validated for use with older adult trauma patients.[4] The TSFI includes questions that cover the

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patient's overall health, including comorbidities, activities of daily living, health attitude, function (i.e., sexual activity), and nutritional domain that is assessed using total serum albumin levels. TSFI is a remarkable score because it is easy to calculate and is superior to other frailty scores in predicting outcomes patients' mortality.[5] Geriatric trauma outcome score (GTOS) was developed due to the lack of quantitative prognostic tools to assist surrogates in making decisions about care goals in geriatric trauma patients.[6] The GTOS targets to predict inpatient mortality for elderly patients after admission for injury using the patient's age, ISS, and performance of a blood transfusion as variables. GTOS and TSFI are two different tools used to determine post-traumatic mortality and prognosis in geriatric trauma patients. GTOS assesses the physiological and anatomical aspects of trauma, while TFSI assesses patient's current functionality and comorbidities. For this reason, we believe that it is necessary to evaluate these two different spectrums that affect the survival of geriatric trauma patients in the same study and to explain their relationship with mortality.

The role of pre-existing comorbidities in geriatric trauma patients is controversial.[7] There are studies[8] that found that pre-existing medical conditions in blunt geriatric trauma patients cause increased mortality and contribute to the increase in length of stay in the hospital (LOS-h) and intensive care unit.

Although some studies have also explored the relationship between body mass index (BMI) and mortality in the elderly,[9] we did not find data on the relationship of BMI with trauma mechanism, severity, and outcome in the geriatric population. Most of the studies that we reviewed evaluated the geriatric population from a single perspective, but it is important to evaluate the growing geriatric population with a multidimensional perspective.

In the present study, we investigate the relationship between TSFI (which indicates patient reserve), GTOS (which indicates the anatomical and physiological effects of trauma), and BMI (which causes patients to change trauma exposure) with mortality in trauma patients over 65 years of age who were admitted to the emergency department after trauma.

MATERIALS AND METHODS

Study Design

This study was a prospective observational study conducted with the Local Ethics Committee approval no. 2020/71 and including trauma patients aged ≥65 who were admitted to a training and research hospital between April 1 and October 1, 2020.

Patient Population

The patient group consisted of patients aged 65 and older who were admitted to the emergency department (ED) due to blunt trauma. Patients who provided signed consent themselves or whose relatives provided signed consent were included in the study.

Outcomes

The primary outcome of the study was determining the effect of TSFI and GTOS scores to predict on mortality in trauma patients over the age of 65 who were admitted to the ED. The secondary outcome of the study was to determine the effect of BMI, length of stay, and patients' comorbidities on mortality in the same population.

Data Collection

Demographic data, vital signs, Glasgow coma scale, and clinical, laboratory, and radiological imaging findings of the patients were recorded on study forms. GTOS, TSFI, and BMI values were calculated with the information given by patients and/or their relatives and recorded on study forms. The length of stay of the patients in the ED and the hospital and mortality at the 30th day after hospital admission were learned by phone calls and recorded. Patients whose data could not be accessed through the automation system, patients who were unconscious and not accompanied by first-degree relatives, trauma patients who were admitted after a burn, patients who were admitted more than once for the same trauma or for penetrating trauma, patients for whom blood analysis was not performed, and those who wanted to leave the study were not included in the study (Fig. 1). After the study was completed, the data from the study forms were recorded in electronic format for statistical analysis.

Statistical Analysis

Continuous variables were expressed as mean±standard deviation or median (minimum–maximum) relative to nor-

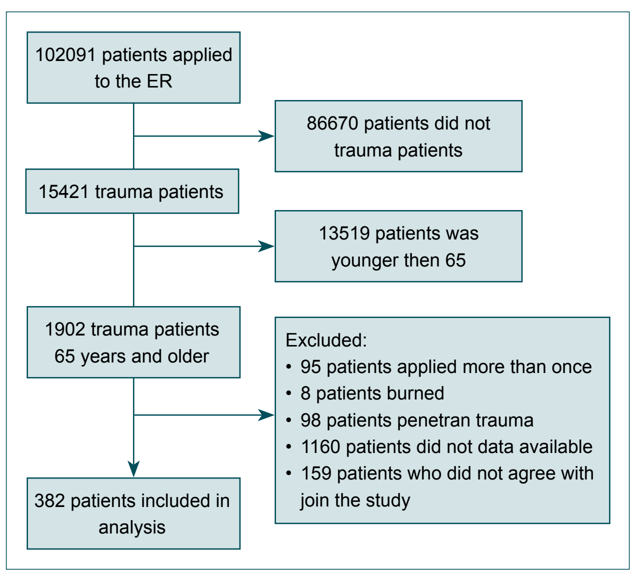

Figure 1. Flow chart of patient selection process.

mal or non-normal distributions. Categorical variables were presented as absolute values and percentages. Kolmogorov–Smirnov and Shapiro–Wilk tests were used to evaluate the distributions. In correlation analysis, the Pearson test was used for parametric data and the Spearman rho test was used for non-parametric data. Mann–Whitney U and Wilcoxon W tests were used for continuous variables while considering relationships between groups. The Pearson Chi-square test and Fisher exact test were used for categorical variables. Diagnostic adequacy, sensitivity, and specificity were determined by receiver operating characteristic (ROC) curve analysis. The statistical alpha significance level was accepted as $p<0.05$. Statistical analysis was performed with IBM SPSS Statistics 22. Results found to be significant in univariate analyses which were included in multivariate analyses performed with the MedCalc program.

RESULTS

Of the geriatric blunt trauma patients included in the study, 201 (52.6%) were female and 181 (47.4%) were male. The mean age was 77.65±8.42 years.

Regarding comorbidities, 223 (58.4%) of 382 patients had hypertension, 115 (30.1%) had diabetes, 88 (23%) had coronary artery disease, 74 (19.4%) had rhythm disorders, 65 (17%) had Alzheimer disease, and 11 (2.9%) had Parkinson disease.

Of the 382 patients included in the study, 286 (74.9%) had suffered a simple fall, 51 (13.4%) had fallen from a height of <6 m, 7 (1.8%) had a traffic accident, 29 (7.6%) had a pedestrian accident, 1 (0.3%) had fallen from a height, 1 (0.3%) had been injured by a falling object, and 7 (1.8%) had been assaulted.

The median stay in the ED was 254 (range: 10–2160) min and the median hospital stay was 336.50 (range: 30–36000) min. In the ROC analysis performed for the predictive power of 30-day LOS-h for mortality, when the cutoff value was taken as 535 min, the area under the curve (AUC) was 0.731 (95% CI: 0.684–0.775), the sensitivity was 72%, and the specificity was 64.71% (Fig. 2).

While 116 patients (30.4%) were hospitalized, 266 patients (69.6%) were discharged from the ED. Of the hospitalized patients, 14 (11.5%) were admitted to the intensive care unit and 14 (11.5%) were referred to other hospitals. When the mortality of the patients after 30 days was examined, it was determined that 20 (16.5%) of the hospitalized patients died. In addition, it was found that 357 (93.5%) patients had survived and 25 (6.5%) patients had died.

When we analyzed these blunt trauma patients over 65 years of age according to BMI groups, ten patients (2.6%) were underweight, 103 (27%) were of normal weight, 156 (40.8%) were Class I obese, 82 (21.5%) were Class 2 obese, and 8 (2.1%) were Class 3 obese. There was no significant difference in terms of BMI between patients who had survived and died at the 30th day after trauma (Table 1). The median age-related shock index (A-SI) was 48.54 (range: 16.07–93.33) in the group of patients surviving at the 30th day after trauma and it was 55.03 (range: 28.66–148.08) in the group of deceased patients. There was a significant difference between these two groups in terms of A-SI.

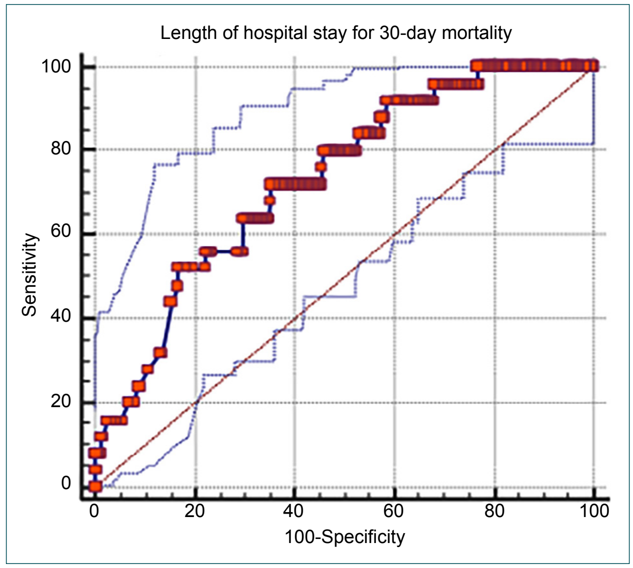

Figure 2. Receiver operating characteristic analysis of predictive power of length of hospital stay for 30-day mortality.

The median GTOS was 88 (range: 67.5–109.5) in the group of patients surviving at the 30th day after trauma and 105.5 (range: 76.50–291.50) in the group of deceased patients. There was a significant difference between the two groups in terms of GTOS. There was no significant difference between the two groups in terms of TSFI scores ($p=0.208$). The median injury severity score (ISS) was 2 (range: 1–43), and 9 (range: 1–75) in the group of patients who survived and deceased patients at the 30th day, respectively. There was a significant difference between the two groups in terms of ISS (Table 1).

When the patients with three or more comorbid diseases were evaluated between the groups of surviving and deceased patients at the 30th day, there were 8 (32%) such patients in the deceased group and 149 (42%) patients in the surviving group, with a significant difference between the two groups (Table 2).

The 30-day survival of the patients and laboratory values was evaluated. Between the groups of surviving and deceased patients at the 30th day, it was seen that white blood cell (WBC) and neutrophil counts, base excess, lactate, and osmolarity in laboratory values were statistically different (Table 1).

In the ROC analysis of the power of the GTOS to predict 30-day mortality, when the cutoff value was taken as 95, the

Table 1. Comparison of patient groups according to 30-day mortality

	Surviving patients (n=357)	Deceased patients (n=25)	p	t
	Mean±SD	Mean±SD		
Age, years	77.49±8.41	79.88±8.38	0.171	1.372
Height, cm	163.41±7.55	166.24±8.34	0.073	1.796
Weight, kg	74.66±14.54	73.68±13.44	0.744	-0.327
BMI	27.98±5.41	26.73±4.95	0.266	1.115
Systolic blood pressure	135.81±24.791	140.52±41.777	0.582	0.557
Diastolic blood pressure	81.25±0.74	87.76±5.06	0.215	-1.272
Heart rate	84.88±15.025	97.08±21.610	0.010	2.776
SpO_2	97.13±2.139	96.56±3.203	0.388	-0.879
TSFI	0.315±0.238	0.378±0.243	0.208	1.262
	Surviving patients (n=357)	**Deceased patients (n=25)**	**p**	**z**
	Median (Min-Max)	**Median (Min-Max)**		
Shock index	0.630 (0.21–1.33)*	0.677 (0.39–1.92)*	0.220**	-1.277
Age-related shock index	48.54 (16.07–93.33)*	55.03 (28.66–148.08)*	0.04**	-2.054
GTOS	88 (67.5–179.5)*	105.5 (76.50–291.50)*	<0.001**	-4.787
ISS	2 (1–43)*	9 (1–75)*	<0.001**	-4.430
Base excess (mmol/L)	0.8 (-17.8–9.50)*	-1.2 (-13.8–5.7)*	0.006**	-2.766
Lactate (mmol/L)	1.8 (-2–6.20)*	2.4 (1.3–10.9)*	<0.001**	-3.504
Bicarbonate (mmol/L)	24.4 (10.6–33)*	22.9 (13.8–29)*	0.003**	-2.995
Osmolarity (mOsm/kg)	287 (250–309)*	290.83 (276.44–307.5)*	0.043**	-2.023
Creatinine (mg/dL)	0.88 (0.27–8.61)*	1.15 (0.6–2.04)*	0.001**	-3.451
WBC count (10^3/µL)	9 (3.54–102)*	13.14 (4.61–26.4)*	<0.001**	-3.525
Neutrophil count (10^3/µL)	6.24 (2.25–23.21)*	9.39 (2.16–22.12)*	0.007**	-2.682

SD: Standard deviation; BMI: Body mass index; GTOS: Geriatric Trauma Outcome Score; TSFI: Trauma-Specific Frailty Index; ISS: Injury Severity Score; WBC: White blood cell. **Mann-Whitney U test.

Table 2. Comparison of 30-day patient mortality according to gender, comorbidities, and transfusion status

	Surviving patients	Deceased patients	p
	n (%)	n (%)	
Female	194 (54.3)	7 (28)	0.011
Hypertension	203 (56.9)	20 (80)	0.034
Diabetes	100 (28)	15 (60)	0.001
Coronary artery disease	77 (21.6)	11 (44)	0.01
Alzheimer disease	56 (15.7)	9 (13.8)	0.009
CVD	24 (6.7)	3 (12)	0.405*
CKD	22 (6.2)	2 (8)	0.664*
Rhythm disorders	68 (19)	6 (24)	0.545
Psychiatric disorders	30 (8.4)	3 (12.0)	0.466*
Two or more comorbidities	230 (64.4)	24 (96)	0.001
Three or more comorbidities	149 (42)	8 (66.7)	0.018
Blood transfusion	4 (1.1)	6 (24)	<0.001*

*Fisher exact test. CVD: Cerebrovascular disease; CKD: Chronic kidney disease.

AUC was 0.786 (95% CI: 0.742–0.826), the sensitivity was 76%, and the specificity was 72.27% (p<0.001). In the ROC

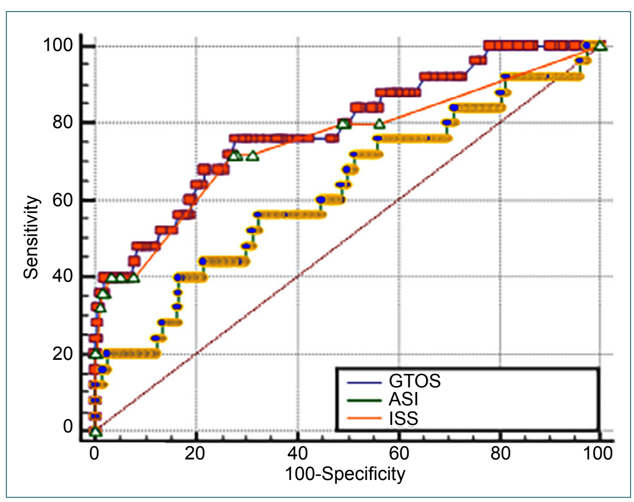

Figure 3. Receiver operating characteristic analysis of predictive power of trauma scores for 30-day mortality (GTOS: Geriatric trauma outcome score; ASI: Age-related shock index; ISS: Injury severity score).

Table 3. Multivariate logistic regression analysis for predictors of mortality

	p	OR	95% CI	
Enter method				
Lactate	0.0337	1.3795	1.0251	1.8565
Heart rate	0.4643	1.0143	0.9764	1.0537
Length of hospital stay	0.0108	1.0001	1.0000	1.0001
Age-related shock index	0.5469	1.0141	0.9688	1.0616
ISS	0.0220	1.0734	1.0103	1.1405
Backward method				
Lactate	0.0184	1.4262	1.0617	1.9157
Length of hospital stay	0.0149	1.0001	1.0000	1.0001
ISS	0.0049	1.0777	1.0229	1.1354

ISS: Injury Severity Score; OR: Odds ratio; CI: Confidence interval.

analysis for the predictive power of the A-SI for 30-day mortality, when the cutoff value was taken as 54,196, the AUC was 0.623 (95% CI: 0.572–0.672), the sensitivity was 56%, and specificity was 67.51% ($p<0.001$). In the ROC analysis for the predictive power of 30-day mortality of the ISS, when the cutoff value was taken as 8, the AUC was 0.753 (95% CI: 0.706–0.795), the sensitivity was 72%, and the specificity was 72.55% ($p<0.001$) (Fig. 3).

Lactate, heart rate, LOS-h, A-SI, and ISS showed statistically significant differences with mortality in this study. Therefore, they were examined with the multivariate logistic regression backward elimination method, and lactate, LOS-h, and ISS were found to be independent predictors of mortality (Table 3).

DISCUSSION

In Turkey, injuries ranked sixth among the causes of death for people older the age of 65 in 2019.[10] Accidents and environmental injuries rank eighth among the causes of death for people older the age of 65 in the world.[11] Due to the increasing proportion of the elderly population and their increased activity levels thanks to developments in health practices and care strategies, trauma is no longer a problem for only younger patient populations.

There are studies proving that comorbidity increases mortality in blunt trauma patients over the age of 65.[12] The nomogram developed by Min et al.[13] shows that the comorbidities that may cause death with a 30% probability as a result of geriatric-related complications. In our study, it was determined that the presence of hypertension, diabetes mellitus, coronary artery disease, and Alzheimer disease and having more than two comorbid diseases increased mortality. Therefore, the presence of additional comorbid diseases in the geriatric population increases mortality regardless of gender. It should be kept in mind that trauma among geriatric patients who have additional comorbidities can be fatal and the arrangement of living spaces with appropriate designs should be considered to prevent domestic accidents.

In the study of Durgun et al.,[14] 4328 patients were evaluated and it was determined that the mortality rate increased as the BMI increased. However, in the study of Milzman et al.,[15] there was no relationship between BMI and mortality. Similarly, no significant correlation was found between BMI and mortality in our study. The reason for this difference may be the small number of obese patients in our study.

In the study by Zarzaur et al.,[16] determined that patients older 55 years of age with an A-SI above 50 were more likely to have life-threatening shock. In our study, a relationship was found between A-SI and blood transfusion and mortality. In the ROC analyses performed in our study, when the cutoff value of the A-SI was taken as 54,196, the predictive power of mortality was determined as 56% and specificity was 67.51%. Based on these results, we think that the A-SI of patients presenting with trauma in the geriatric population is an important parameter for quickly calculating the need for transfusion in the ED and for recognizing the importance of early intervention in patients with a high A-SI during in-hospital triage among geriatric trauma patients.

In the study conducted by Ahl et al.,[17] who evaluated 1080 geriatric trauma patients over 65 years of age, it was found that the GTOS was successful in predicting 24-h deaths. Similarly, in our study, the GTOS yielded the most successful results in predicting mortality (AUC: 0.786, 95% CI: 0.742–0.826). In the ROC analysis that we conducted, it was found that when the GTOS cutoff value was above 95, that score had the power to predict mortality with 76% sensitivity and 72.7% specificity. Since the GTOS is calculated based on the ISS, it is a parameter based on adding the severity of injury at admission and the amount of transfusion within 24 h and showing the mortality value corresponding to the GTOS value in a nomogram. Based on the results of our study, we conclude that this parameter is also effective in 30-day survival.

In the retrospective cohort study of Davidson et al.,[18] 1-year and 3-year mortality rates of trauma patients were examined and it was determined that 9.9% died within 1 year and 16% within 3 years following the injury. Increased LOS-h may cause nosocomial infections in elderly patients, and the development of thrombosis due to immobility in the geriatric population and delirium due to lack of stimuli may also increase mortality. In our study, a relationship was also found between the LOS-h and mortality.

In the retrospective cohort study of Hamidi et al.,[5] four different frailty indices were examined with the aim of determining a universal frailty criterion. It was suggested that the TSFI be used as a universal frailty criterion since it can be easily calculated and it is successful in terms of prognosis and prediction. In the study of Tejiram et al.,[19] however, no correlation was found between the frail and non-frail groups in terms of mortality. In our study, as well, no relationship was found between the TSFI and mortality. We suggest that calculations made by combining lactate, GTOS and LOS-h will be more useful in predicting mortality. In our study, when the patients whose GTOS was calculated as 95 and above and who were considered frail in terms of TSFI were evaluated together a statistically significant difference was found in terms of mortality. However, we think that large patient groups are needed to clarify factors affecting mortality. Therefore, the search for a test to determine mortality more precisely should be continued by evaluating patients in terms of both exposure to trauma and current functionality.

In the study of Siegel et al.,[20] it was stated that base excess and lactate may be early markers in predicting mortality. In our study, base excess, lactate, and bicarbonate were found to be associated with mortality in blood gas analysis. We believe that being able to perform blood gas analysis quickly, and even having kits available in most ED to work quickly there, would be valuable in terms of preventing bad patient outcomes.

Conclusion

BMI has no effect on mortality among geriatric trauma patients. We suggest that it would be appropriate to use the GTOS in long-term follow-up as well as for predictive power for mortality within 24 h. We recommend that morbidity and mortality among this patient group be prevented with precautions against domestic accidents. The TSFI cannot predict mortality alone among geriatric patients. However, we think that a score that will be formed by TSFI together with LOS-h, GTOS, and lactate will be more effective in estimating mortality.

Ethics Committee Approval: This study was approved by the Bakırköy Dr. Sadi Konuk Training and Research Hospital Clinical Research Ethics Committee (Date: 02.03.2020, Decision No: 2020-05-03).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: H.D., M.A.E.; Design: B.İ., M.A.E.; Supervision: H.D.; Resource: H.D., B.İ.; Materials: H.D., B.İ.; Data: M.A.E.; Analysis: H.D., M.A.E.; Literature search: B.İ.; Writing: M.A.E.; Critical revision: M.A.E.

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ORİJİNAL ÇALIŞMA - *ÖZ*

Geriatrik travma hastalarında kırılganlık indeksinin ve geriatrik travma sonlanım skorunun mortalite üzerine ilişkisinin değerlendirilmesi

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AMAÇ: Çalışmamızda 65 yaş ve üzeri geriatrik travma hastaların Travma Spesifik Kırılganlık İndeksi ve Geriatrik Travma Sonlanım skorunun hastaların 30 günlük mortaliteleriyle ilişkisini incelemeyi amaçladık.

GEREÇ VE YÖNTEM: İleriye yönelik gözlemsel çalışmamıza bir eğitim araştırma hastanesine künt travma sebebiyle başvuran 65 yaş ve üzeri 382 hasta dahil edildi. Hastaların kendilerinden ve/veya yakınlarından onam alındı. Hastaların acil servise başvurularında tespit edilen vital bulguları, kronik hastalık ve ilaç kullanım bilgilerinin yanısıra laboratuvar sonuçları, radyolojik görüntülemeleri, kan replasmanı ihtiyaçları, acil servis ve hastanede kalış süreleri ve mortaliteleri vaka formuna kaydedildi. Glasgow Koma Skalası, Yaralanma Şiddeti Ölçeği, Geriatrik Travma Sonlanım Skoru, Travma Spesifik Kırılganlık İndeksi ve Beden Kitle İndeksi araştırmacılar tarafından hesaplandı. Hastaların 30 günlük sonlanımlarıyla ilgili hasta ve/veya hasta yakınlarından 30 gün sonra telefonla bilgi alındı.

BULGULAR: Travma sonrası 30. günde ölen ve yaşayan hastalar karşılaştırıldığında Beden Kitle İndeksi ve Travma Spesifik kırılganlık indeksi açısından anlamlı fark saptanmadı ($p>0.05$). Başvurusu sırasında Geriatrik Travma sonlanım skoru ≥95 olan hastaların 30 günlük mortalitelerinin yüksek olduğu saptandı (sensivitesi %76, spesifitesi %72.27 ($p<0.001$). İki grup arasında iki veya daha fazla komorbid hastalığa sahip olmakla mortalite arasında korelasyon saptandı ($p=0.001$).

TARTIŞMA: Çalışmamızın sonucunda acil servise başvuruda hesaplanan Travma Spesifik Kırılganlık İndeksi'nin tek başına mortaliteyi belirlemede yeterli olmadığı, hastanın laktat değerinin, Geriatrik Travma Sonlanım Skoru (GTOS)'un ve hastanede kalış süresinin de mortalitede etkili olduğu ve bu parametrelerin kullanılmasıyla daha güvenilir bir kırılganlık puanı elde edilebileceğini düşünmekteyiz. GTOS 24 saatlik mortaliteyi belirlemede kullanılmaktadır, buna ek olarak uzun dönem mortalite öngörme skorlarına dahil edilmelidir.

Anahtar sözcükler: Kırılganlık; mortalite; skor; travma; yaşlılık.

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