

# Orthopedic injuries due to parachute jumping in soldiers and the effect of trauma scoring systems in determining injury level: A prospective observational study

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## Research article

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# Abstract

## Background

During parachute jumping in soldiers, minor or life-threatening major injuries may occur in various parts of the body. Various trauma scoring systems have been developed to determine the severity of these injuries. The aim of this study is to determine orthopedic injuries and other injuries due to parachute jumping for military training who admitted to ED and the severity of their injuries using anatomical and physiological trauma scores (AIS and ISS), to examine applied treatment methods, their hospitalization conditions and the length of hospital stay prospectively over a 44-month period between January 2016 and August 2019.

## Methods

200 military personnel were included in the study, between the ages of 18-52, who were injured as a result of daytime static parachute jumping for military training. Demographic data such as age, gender, ISS trauma region classification, anatomical injury sites, AIS and ISS scores, diagnosis, treatment methods applied, hospitalization status and duration of hospitalization were examined prospectively in a total of 185 patients.

## Results

Among 184 individuals included in the study, 184 were male and 1 was female. The most common injured body site were 33.5% foot. and the most common diagnosis was 64.3% soft tissue trauma. Considering the treatment methods applied, 51.4% was determined as medication cold application, 42.7% as splint plaster, and 5.9% as surgery. The mean ISS of the patients was  $5.16 \pm 3.92$ . The hospitalization rate of patients with a critical AIS score was significantly higher than those with a severe AIS score ( $p < 0.001$ ).

## Conclusions

The use of trauma scoring systems in determining the severity of injury to patients who come to ED due to parachute injury may facilitate treatment selection.

Key words: Parachuting injuries, Abbreviated Injury Scale ve Injury Severity Score

## Introduction

## Background

The idea of jumping from a high place without getting damaged, first appeared in China about 2000 years ago. As a result of human trials throughout history, the first successful parachute jump took place in 1797 by jumping from the balloon and then modern parachuting developed. The word parachute

is derived from the Greek word "money", that is, "protection", and the French word from "chute", that is "fall" (1,2).

With the Second World War, parachuting was used and developed for military purposes. In line with the developments in military technology and aviation, some countries still use parachute dropping actively today as part of the air defense system and for the deployment of troops quickly to a narrow area (2,3). Military or hobby parachute jumps are widely used today.

## Importance

Parachuting requires high concentration and physical performance. During these jumps, various injuries may occur both in the air and during landing, and in some cases, fatal accidents may occur. In the literature, it has been reported that the rate of injuries as a result of parachute jumping is between 3 to 24 per thousand per person (4,5). In these injuries, it is known that the factors such as the altitude, performing the jump at night, the equipment and technique used, the factors about the plane, the selected parachute type, the weather and environmental factors, the personal factors (age, weight, height, experience, aircraft leaving technique, loss of control, etc.) and the ground are effective (3,6–10). Most of the parachuting accidents and fatal injuries are known to occur at low altitude and sudden turns (3,4,8).

## Goal of This Investigation

Due to its geographical structure, air sports such as paragliding, military training or hobby parachuting and balloon tour are performed intensely in Central Anatolia and its surroundings. Various injuries may occur while performing these sports. Especially for military training purposes, more than 30.000 parachute jumps occur annually and as a result of these jumps, the number of applications to the emergency service increased in recent years. In literature reviews, parachute injuries are usually in the form of case reports or retrospective (10,11). In this study, we aimed to determine orthopedic injuries and other injuries due to parachute jumping for military school training applied by ambulance or outpatient to Kayseri City Education and Resources Hospital Emergency Medicine Clinic Trauma Unit, the severity of their injuries by anatomical and physiological trauma scores (Abbreviated Injury Scale (AIS) and Injury Severity Score (ISS)), to examine applied treatment methods, their hospitalization conditions and the length of hospital stay prospectively over a 44-month period between January 2016 and August 2019.

Injury Severity Score (ISS) Abbreviated Injury Scale (AIS), New Injury Severity Score (NISS), Anatomic Profile Score (APS), Organ Injury Scale (OIS), Glasgow Coma Scale (GCS), Revised Trauma Score (RTS), Trauma and Injury Severity Score (TRISS Various scoring systems such as), A Severity Characterization of Trauma (ASCOT), Trauma and Injury Severity Score Comorbidity (TRISSCOM) are used in the literature(12–17). We preferred to do trauma scoring with AIS and ISS due to its easy and fast calculation.

## Methods

# Study Design and Setting

This study was conducted at a tertiary center, Kayseri City Education and Resources Hospital in Kayseri, Turkey. A total of 86.787 trauma patients were admitted to our ED in 2019. Ethical approval was obtained through the Kayseri City Education and Resources Hospital Research Committee(16.11.2016/09) and Erciyes University Ethics Committee (96681246/340) and adhered to Declaration of Helsinki(18).

This study was a prospective observational clinical study. All patients who were injured by parachuting were examined by the emergency medicine specialist and consultation was requested from the relevant departments in the patients deemed necessary. Consultations were performed by specialist or assistant doctors.

## Selection of Participants

200 military flight school personnel, women and men were included in the study, among 371.324 patients who applied by ambulance or outpatient between January 2016 and August 2019 between the ages of 18–52, who were injured as a result of daytime static parachute jumping for military training purposes.

A total of 15 patients who were not recorded to hospital information management system (HIMS), whose trauma scoring system (AIS and ISS) was not calculated, who applied for parachute and balloon injuries, who could not obtain consent and who have missing parts in the patient observation form were excluded. Verbal or written consent of all participants was obtained.

## Measurements

For a total of 185 patients, demographic data such as age, gender, ISS trauma region classification, anatomical injury sites, AIS and ISS scores, diagnosis, treatment methods applied, hospitalization status and duration of hospitalization were interviewed prospectively with the patients and information was obtained from HIMS and patient registration forms and processed with consent. The injured were classified according to age and trauma scoring scores. The injury rate was stated as a percentage. The patients were divided into 3 groups according to age groups; 19–23 years group (n = 81), 24–29 years group (n = 58) and 30 years and older (n = 46).

## Outcomes

AIS scores are calculated as 1 point minor, 2 points moderate, 3 points serious, 4 points severe, 5 points critical, 6 points maximal (currently untreatable) maximum 6 points, and the ISS the sum of the squares of the three sites with the most serious injury ( $ISS = a^2 + b^2 + c^2$ ) with minimum 1 maximum 75 points. ISS trauma exposure site was divided into 6 sites, and anatomically injured sites were divided into 17 different sites and recorded on the patient registration form.

## Data Analysis

In summarizing of the data obtained from the study, descriptive statistics were given as the mean  $\pm$  standard deviation, median (width between quarters) and minimum-maximum for continuous variables.

Categorical variables were summarized as numbers and percentages. The normality test of numerical variables was checked with Kolmogorov-Smirnov. In the comparison of two independent groups, Mann Whitney U test was used in cases where numerical variables did not show normal distribution. Pearson Chi-Square or Fisher Freeman Halton test was used for comparison of categorical variables. Descriptive and frequency analysis were used in the analysis of intergroup distributions. While comparing the ISS score averages by age groups, in One-way ANOVA and Spearman correlation tests.

Statistical analysis was made with Jamovi project (2019), Jamovi (Version 1.0.7) [Computer Software] program (Retrieved from <https://www.jamovi.org>) and in statistical analysis, significance level was taken as 0.05 (p-value). Microsoft Office Excel 2016 software was used to create the graphics.

## Results

A total of 185 patients were included in the study between January 2016 and August 2019, in a 44-month period, following the exclusion criteria.

Among 184 individuals included in the study, 99.5% (n = 184) were male and 0.5% (n = 1) were female. The mean age of the patients was  $26.7 \pm 6.2$  years (youngest: 19, oldest: 51). When analyzed as age groups, 48.8% were 19–23 years old, 31.4% were 24–29 years old and 24.9% were 30 years old and older. Patients who applied to the emergency department in years 2016 (7%), 2017 (39.5), 2018 (24.3) and 2019 (29.2%) were evaluated. Distribution of patients who came to our emergency clinic with the complaint of injury due to parachute jumps by years were; 13 people in 2016, 73 people in 2017, 45 people in 2018 and 54 people in 2019 (in the first 8 months) (Table 1).

**Table 1.** Distribution of patients by age groups, gender and years of application

<b>Age Mean <math>\pm</math> SS</b>	26,7 $\pm$ 6,2
<b>Age n (%)</b>	
between ages 19-23	81 (43,8)
between ages 24-29 yaş	58 (31,4)
30 years and over	46 (24,9)
<b>Gender n (%)</b>	
Male	184 (99,5)
Female	1 (0,5)
<b>Application by years</b>	
2016	13 (7)
2017	73 (39,5)
2018	45 (24,3)
2019	54 (29,2)

*Descriptive statistics are given as number (%) for categorical variables and mean  $\pm$  standard deviation for numerical variables.*

When we evaluate patients in terms of injury site, the most common were foot 33.5% (n = 62), ankle 29.1% (n = 54), spine 18.3% (n = 34) and head 12.4% (n = 23), respectively. When the trauma sites exposed according to ISS are examined; pelvis (75.7%), extremity (67.6), head and neck (13.5) and chest (13.5%) injuries were observed to be the majority. Similarly, when the injury sites are examined, generally foot (33.5%), ankle (29.2%), spine (18.4%), pelvis (14.1%), head (13.5%), leg (13%), knee (7.6%), thigh (6.5%) and shoulder (5.9%) injuries were determined to be intensive. Diagnoses made to the patients applied to the emergency department were most commonly soft tissue trauma (strain and stretching) (64.3%). This diagnosis was followed by lower limb fracture-dislocation (15.1%), head trauma (10.3%) and spinal injury (5.4%), respectively. Considering the treatment methods applied, 51.4% (n = 95) medication cold application, 42.7% (n = 79) splint plaster, and 5.9% (n = 11) surgery (Table 2, Fig. 1–3).

Table 2  
 Distribution of trauma site, injury site, diagnosis and  
 treatment method applied according to ISS

	n (%)
ISS exposed trauma site	
Pelvic, yes	140 (75,7)
Extremities, yes	125 (67,6)
Head neck, yes	25 (13,5)
Chest, yes	25 (13,5)
Subcutaneous superficial, yes	8 (4,3)
Face, yes	4 (2,2)
West, yes	3 (1,6)
Injury Site	
Foot, yes	62 (33,5)
Ankle, yes	54 (29,2)
Spine, yes	34 (18,4)
Pelvis, yes	26 (14,1)
Head yes	25 (13,5)
Leg, yes	24 (13)
Knee, yes	14 (7,6)
Thigh, yes	12 (6,5)
Shoulder, yes	11 (5,9)
Thorax, yes	6 (3,2)
Cervical, yes	5 (2,7)
Wrist, yes	4 (2,2)
Abdomen, yes	3 (1,6)
Hand, yes	3 (1,6)
Elbow, yes	2 (1,1)

Descriptive statistics are given as numbers (%).

	n (%)
Arm, yes	2 (1,1)
Forearm, yes	1 (0,5)
Diagnosis	
STT, yes	119 (64,3)
Lower limb fracture, dislocation, yes	28 (15,1)
Head injury, yes	19 (10,3)
Spinal injury, yes	10 (5,4)
Upper limb fracture, dislocation, yes	4 (2,2)
Cervical injury, yes	4 (2,2)
Facial trauma, yes	4 (2,2)
Abdominal injury, yes	2 (1,1)
Thoracic injury, yes	3 (1,6)
Pelvis fracture, yes	1 (0,5)
Treatment method applied	
Medication cold application	95 (51,4)
Splint plaster	79 (42,7)
Surgery	11 (5,9)
Descriptive statistics are given as numbers (%).	

The patients' Glasgow Coma Scores (GKS) were  $\geq 13$ . The mean ISS of the patients was  $5.16 \pm 3.92$  (minimum: 1, maximum: 25). The exposed ISS trauma region was most frequently extremity and the pelvis was 67.6% (n = 125). This was followed by head and neck 8.6% (n = 16) and chest 7.0% (n = 13), respectively. The least injury was observed in the abdomen (n = 3) with 1.6%. According to the ISS classification, the most common shoulder injury (50%) (n = 9) was observed in the upper extremity group. This was followed by whole upper extremity, arm, elbow, hand and wrist injuries, respectively (n = 18). In the lower extremity group, the most common was foot injury (24.1%) (n = 32). This was followed by ankle (13.5%) (n = 18), leg (7.5%) (n = 10), knee (5.3%) (n = 7), thigh (3.8%) (n = 5), whole lower extremity (31.6%) (n = 42) and pelvis (14.3%) (n = 19) injuries, respectively. Similarly, according to ISS, in the head and neck spinal group, the most common injuries were found to be spine (18.4%) (n = 34), head (13.5%) and cervical (1.1%). Again, according to ISS, the most common injuries in the body group were thoracic (66.7%) (n = 6) injuries. This was followed by abdomen (33.3%) (n = 3) and cutaneous-subcutaneous superficial (11.1%) (n = 1) injuries, respectively (Table 3).

Table 3

Injury rates of upper-lower extremity, head and neck spinal and body group according to ISS

	n (%)
ISS Upper Extremity group	
Hand	1 (5,6)
Wrist	1 (5,6)
Elbow	2 (11,1)
Arm	2 (11,1)
Whole upper extremity	3 (16,7)
Shoulder	9 (50)
ISS Lower Extremity group	
Foot	32 (24,1)
Ankle	18 (13,5)
Leg	10 (7,5)
Knee	7 (5,3)
Thigh	5 (3,8)
Whole lower extremity	42 (31,6)
Pelvis	19 (14,3)
ISS head and neck spinal group	
Head yes	25 (13,5)
Cervical, yes	2 (1,1)
Spine, yes	34 (18,4)
ISS Body group	
Thorax, yes	6 (66,7)
Abdomen, yes	3 (33,3)
Skin, subcutaneous superficial, yes	1 (11,1)
Descriptive statistics are given as numbers (%).	

While 22.2% (n = 41) of the patients were observed as mild, 62.2% (n = 115) as moderate, 15.1% (n = 28) as severe, 0.5% (n = 1) as critical, the fatal AIS score was not observed in any patient. The median of the ISS score was 4. The mean ISS of the patients was  $5.16 \pm 3.92$  (minimum: 1, maximum: 25) (Table 4).

Table 4  
AIS score level rates and ISS score

AIS score n (%)	
Mild	41 (22,2)
Moderate	115 (62,2)
Severe	28 (15,1)
Critical	1 (0,5)
ISS score Median [IQR] Min.-Max	4 [4-8] 1-25
Descriptive statistics were given as number (%) for categorical variables and mean $\pm$ standard deviation and minimum - maximum for numerical variables.	

When the average of ISS scores by age groups (Minimum ISS score = 1, maximum ISS score = 25) examined, although the ISS score increased with age, there was no statistically significant difference (One-way ANOVA). There was no statistically significant relationship between patients' age values and ISS values (Spearman Correlation,  $p = 0.108$ ) (Table 5).

Injury sites rates were compared according to the age groups of the patients admitted to the emergency department. Accordingly, the rate of leg injury in patients 30 years and older was found to be statistically more significantly than patients between the ages of 24–29 ( $p = 0.043$ ). In addition, in patients between the ages of 19–23, the knee injury rate was statistically more significant than those between the ages of 24–29 and those over 30 years old ( $p = 0.006$ ). In other comparisons, there was no statistical difference between foot, ankle, thigh, pelvis, spine, abdomen, thorax, shoulder, hand, ankle, forearm, elbow, arm, cervical and head injury rates by age groups (for each  $p > 0.05$ ) (Table 6).

**Table 5. Average ISS score by Age Group**

Tukey HSD<sup>a,b</sup>

Age groups	N	Subset for alpha = 0.05(ISS mean score)
		1
Between 19–23 years old	81	4,6667
Between 24-29 years old	58	5,0862
30 years old and above	46	6,1304
Sig.		,108

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 58,450.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Table 6  
Comparison of injury sites in terms of age groups of patients

	Between ages 19–23	Between ages 24–29	30 and older	p
Injurt Site				
Foot, yes	31 (38,3)	21 (36,2)	10 (21,7)	0,144*
Ankle, yes	27 (33,3)	19 (32,8)	8 (17,4)	0,127*
Leg, yes	11 (13,6)a,b	3 (5,2)b	10 (21,7)a	0,043*
Knee, yes	12 (14,8)a	1 (1,7)b	1 (2,2)b	0,006**
Thigh, yes	7 (8,6)	2 (3,4)	3 (6,5)	0,504**
Pelvis, yes	8 (9,9)	11 (19)	7 (15,2)	0,304*
Spine, yes	13 (16)	14 (24,1)	7 (15,2)	0,390*
Abdomen, yes	2 (2,5)	1 (1,7)	0 (0)	0,789**
Thorax, yes	4 (4,9)	2 (3,4)	0 (0)	0,428**
Shoulder, yes	3 (3,7)	6 (10,3)	2 (4,3)	0,266**
Hand, yes	1 (1,2)	1 (1,7)	1 (2,2)	0,999**
Wrist, yes	1 (1,2)	1 (1,7)	2 (4,3)	0,463**
Forearm, yes	1 (1,2)	0 (0)	0 (0)	0,999**
Elbow, yes	2 (2,5)	0 (0)	0 (0)	0,500**
Arm, yes	0 (0)	1 (1,7)	1 (2,2)	0,318**
Cervical, yes	4 (4,9)	1 (1,7)	0 (0)	0,316**
Head, yes	8 (9,9)	6 (10,3)	11 (23,9)	0,059*
Descriptive statistics were given as numbers (%).				
*. Pearson Chi-Square test was used.				
**. Fisher Freeman Halton test was used.				

There was a statistically significant difference in hospital admission rates according to AIS score levels in patients admitted to the emergency department ( $p < 0.001$ ). The hospitalization rate of patients with a critical AIS score was significantly higher than those with a severe AIS score. Similarly, the difference between the median scores of ISS was statistically significant according to their hospitalization status ( $p$

< 0.001). Accordingly, the median ISS score of the hospitalized patients was significantly higher than those who were not hospitalized (Table 7).

Table 7  
Comparison of hospitalization rates according to AIS score levels and ISS score medians in terms of hospitalization.

		Hospitalization Status		p
		Yes	No	
AIS score	Mild	0 (0)	41 (100)	< 0,001*
	Moderate	0 (0)	115 (100)	
	Severe	10 (35,7)	18 (64,3)	
	Critical	1 (100)	0 (0)	
ISS score		9 [9–18]	4 [4–6]	< 0,001**
*. Fisher Freeman Halton test was used. Descriptive statistics are given as numbers (%).				
**. Mann-Whitney U test was used. Descriptive statistics are given as median [IQR].				

While 5.9% (n = 11) of the patients received inpatient treatment, 94.1% (n = 174) were discharged with outpatient treatment. The average length of hospitalization of inpatients was found to be  $3.45 \pm 2.20$  (minimum: 1, maximum: 7). Also, in Table 7.1, the median day of hospitalization of patients with a severe AIS score level was 3 days, while the median day of hospitalization of critical patients was 6 days.

Table 7.1  
Hospitalization duration according to AIS score \*

		Hospitalization days
AIS score	Mild	-
	Moderate	-
	Severe	3 [1–4]
	Critical	6 [6–6]
* Duration was taken in days.		

## Discussion

The average age of the patients included in the study is  $26.70 \pm 6.24$ . According to A. Ekeland's study, the average age is  $24.5 + 3.6$  and has a similar range. Similarly, in our study, the rate of injury increases with

increasing age (3,4). Serious and critical patient rates were higher than previous studies (15.1% and 0.5%, respectively)(3,4). We think that the reason for this difference may have been due to the higher average age of the people included in our study.

Jumping with a static parachute from the plane at an altitude of approximately 400 m (1200 feet), it was learned from the participants that the cases included in our study, used 5 points technique with a self-opening mushroom-shaped parachute at 1–2 knots wind speed, 5.9–7.1 km/h landing speed, and landed on the flat ground. In addition, the equipment of all jumpers was complete and suitable for jumping. In literature studies, it was reported that the injury rate increases when wind speed exceeds 9 knots and high altitude jumps (7). In our study, although the wind speed was not high, we think that the rate of injury was high due to inappropriate falling during landing.

Static jump, free fall or HALO (high altitude-low opening) in the American army is specified as a jumping technique used by private forces. However, 141 injuries were detected in 134 parts in the HALO jumping (3,8). In addition, in two different studies conducted in the American and British army, the total injury rate in parachute jumps, the majority of which are minor injuries, is about 2.5% (1,8). The injury rate in the static jump is specified as 8.1/1.000 (3). In our study, the way of jumping is usually self-opening and low-altitude jumping. Since it is not known how many people jumped in total, the injury rate could not be determined.

In our study, the most common injury site was foot 33.5% (n = 62) when we evaluate patients in terms of injury site. This is followed by ankle 29.1% (n = 54), spine 18.3% (n = 34) and head 12.4% (n = 23), respectively. The rate of foot injury is higher than previous studies (4,7,10). In a comprehensive study conducted by A. Ekeland, the injury rate is the most common ankle with 36%. In our study, when the foot and ankle are evaluated together, the injury rate reaches to 62.6%. When the two injuries are evaluated together, similar to this study, the rate of foot and ankle injury is most common. Similarly to a retrospective study examining Ball V. L. et al. examined injuries due to static parachute jump, lower extremity was the most frequently injured body region in our study (19).

In emergency departments, scoring systems such as GCS, AIS, ISS, Trauma and Injury Severity Score (TRISS) and Revised-Trauma Score (RTS) are used to determine the severity of trauma patients (20,21). In our study, the participants' GCS was  $\geq 13$ , and we chose to determine the severity of the patients according to AIS and ISS scoring systems due to the ease of application in a crowded emergency. In addition, we aimed to determine the severity of the injury by dividing the body into 17 different regions anatomically, noting the injury areas, evaluating them together with AIS and ISS.

The purpose of performing trauma scores of patients is to determine the severity of injury in patients; the mean ISS was determined to be  $5.16 \pm 3.92$ . According to the study of Sozuer EM et al, the mean ISS was lower than our study ( $8.15 \pm 4.29$  to  $5.16 \pm 3.92$ ) (22). We think that the reason for this difference is that the number of patients included in our study was more and the more severe patients came to the emergency department.

Compared to the ISS trauma region exposed, in our study, the most frequent was extremity and pelvis with a rate of 67.6% (n = 125). This was followed by head and neck 8.6% (n = 16) and chest 7.0% (n = 13). The least number of injury was observed in the abdomen (n = 3) with 1.6%. In our study, it was determined that trauma region separation rates are higher than ISS (3–5,7,22).

In terms of diagnosis, it was observed that the patients were most frequently diagnosed with soft tissue trauma (sprain and stretching) (n = 119) and lower extremity fracture dislocation (n = 28). The percentage of these diagnoses is 64.3% and 15.1%, respectively. These rates are higher compared to the study of Craig et al.(3). We think that this may be due to the landing ground selection and the lack of experience of the soldiers.

In our study, when the fracture rates of the patients were examined, 28 patients had lower extremity fractures, 4 patients had lower extremity fractures and 1 patient had pelvic fractures. In the literature, it is generally in the form of a case report, and extensive studies are generally conducted by scanning and summarizing the literature. In a case reported by A. Bourghli et al., a clavicle fracture was observed (11). In our study, no clavicle fracture was found. Although the fractures of the upper extremity are generally reported in the study of J.G. Bonnin as a humeral surgical neck fracture or stable humerus fracture, in our study, the most common shoulder injury was observed in the upper extremity and fracture was found in 4 people. In the same study, it was observed that the most common foot and ankle injuries were similar to our study (23). In another study, the ankle injury rate was calculated as 4.5/1000 (10). In a study by G. B. Farrow, 63 of 8886 jumps reported that death was seen and the injury rate was 7.1/1000 (5). In a retrospective study by B Zakowski et al., the injury rate was determined as 1.48–3.76/1000 jumps (24). In the study where A. Westman et al. examined the deadly events due to free fall between 1981–2006, Building-Antenna-Span-Earth jumping(BASE), due to reasons related to human, environment and equipment (parachute-related problems, due to reverse airflow, loss of vision due to weather, or acrobatic movements), deaths have been reported (6). Similar factors have been reported to be effective in injuries, as well as high rates of injury during nighttime jumps (9). In the literature studies, the wrong landing technique was mentioned as the most common cause of injury (4,19). Similar to these studies, we think that the most common cause of injury is inappropriate landing technique. Since the night jump was not performed in our study, the rate of injury in the night jump could not be calculated. It is pleasing that no fatal case was encountered in our study. This may be due to the preference of jumping when the wind speed is low, the preference of jumping in the open air, and good training before jumping.

Although there is no statistically significant difference in our study, it is interesting to see an increase in ISS score with age. We think that the reason for this is that as the age increases, the attention may decrease due to the increase in self-confidence with the experience of the person and this may cause an increase in injury.

## Limitations

We think that our study has some limitations. It was not discriminated that how many of the jumpers were instructors and how many were students. Also, the experience of the jumpers or how many times they had jumped before and how many had been injured in the same day were not questioned. Although it was learned that the vast majority of the jumps are during the day, the day/night jump rate was not documented. It was not questioned whether the injury occurred while leaving the plane, in the air or on the ground. Outpatient follow-up of the victims after discharge from the emergency was not performed. After the emergency treatments, only hospitalized patients continued to be followed, and outpatients were not followed. For this reason, it is not known whether there were any complications next, and what were the complications, if any. In addition, only parachute and related injuries were included in the study, paragliding and balloon accidents were not included. Since all jumps were made in the form of a static line, injury rates due to free jump were not known.

Compared to previous studies, during a 44-week observation period, it performing the study prospectively, high number of cases, the anatomical localization of parachute injuries, the use of trauma scoring systems and the determination of the severity of trauma, the treatment of patients and the use of two different scoring systems, in cases where the scoring system was insufficient, determination of a more detailed classification of injury according to the sites and the determination of the length of hospital stay were the strengths of our study.

## **Conclusions**

Along with jumping from the appropriate height in parachute jumping, we recommend redesigning shoe structures, especially to support the foot and ankle, evaluating the selection of appropriate equipment, making jumps in the appropriate weather conditions, not performing acrobatic movements in the air, determining softer grounds to land, increasing the knowledge of the personnel at the landing site regarding first aid, bringing injured personnel to the hospital for control purposes despite they don't want it, and not letting the personnel jump before they are fully recovered. We also recommend raising the awareness of emergency workers due to parachuting and related injuries.

As a result, various injuries may occur during parachute training and jumping. We think that parachute-related accident rates will decrease by increasing awareness of parachute trainers about injuries that may occur during jumping and first aid for these injuries. Due to the development of parachute equipment and development in landing techniques, parachute injuries tend to decrease day by day. However, although jumping techniques and equipment develop; we think that the most important factor in jumping is the human factor. We think that the knowledge level of the emergency personnel about the parachute injuries should be increased. In particular, we recommend using trauma scoring systems individually or in combination, and if the scoring systems are insufficient, we recommend dividing injuries into 17 different sites according to injury rates like in our study and determining the treatment approach by determining the severity of injury.

## **Abbreviations**

AIS  
Abbreviated Injury Scale  
ISS  
Injury Severity Score  
NISS  
New Injury Severity Score  
APS  
Anatomic Profile Score  
OIS  
Organ Injury Scale (OIS),  
HBYS  
Hospital Information Management System  
STT  
Soft Tissue Trauma  
GCS  
Glaskow Coma Score  
HALO  
High Altitude-Low Opening  
TRISS  
Trauma and Injury Severity Score  
RTS  
Revized- Trauma Score  
ASCOT  
A Severity Characterization of Trauma  
TRISSCOM  
Trauma and Injury Severity Score Comorbidity

## **Declarations**

### **Availability of data and materials**

All data presented in this study were retrieved from Kayseri City Hospital's archive.

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### **Contributions**

Meeting and follow-up of patients in the emergency room was performed by TS. Confirmation of diagnosis of patients was performed by SB. TS and SB determined together what would be the treatment of patients. TS and SB made the literature review together. TS made data collection and analysis. TS and SB read and approved the final format of manuscript. TS drafted the manuscript.

### **Conflict of Interest Disclosure**

TS and SB declared that there is no conflict of interest.

### **Presentations**

We planned to present as an oral presentation at the 7th Intercontinental Emergency Medicine Congress, on 9-12 April 2020 at Antalya, Turkey.

### **Ethics declarations**

#### **Ethics approval and consent to participate**

Ethical approval was obtained for this study from the Kayseri City Education and Resources Hospital Research Committee by ID 16.11.2016/09 and Erciyes University Ethics Committee by ID 96681246/340 and adhered to Declaration of Helsinki.

#### **Consent for publication**

Not applicable.

#### **Competing interests**

The authors declare that they have no competing interests.

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## Figures

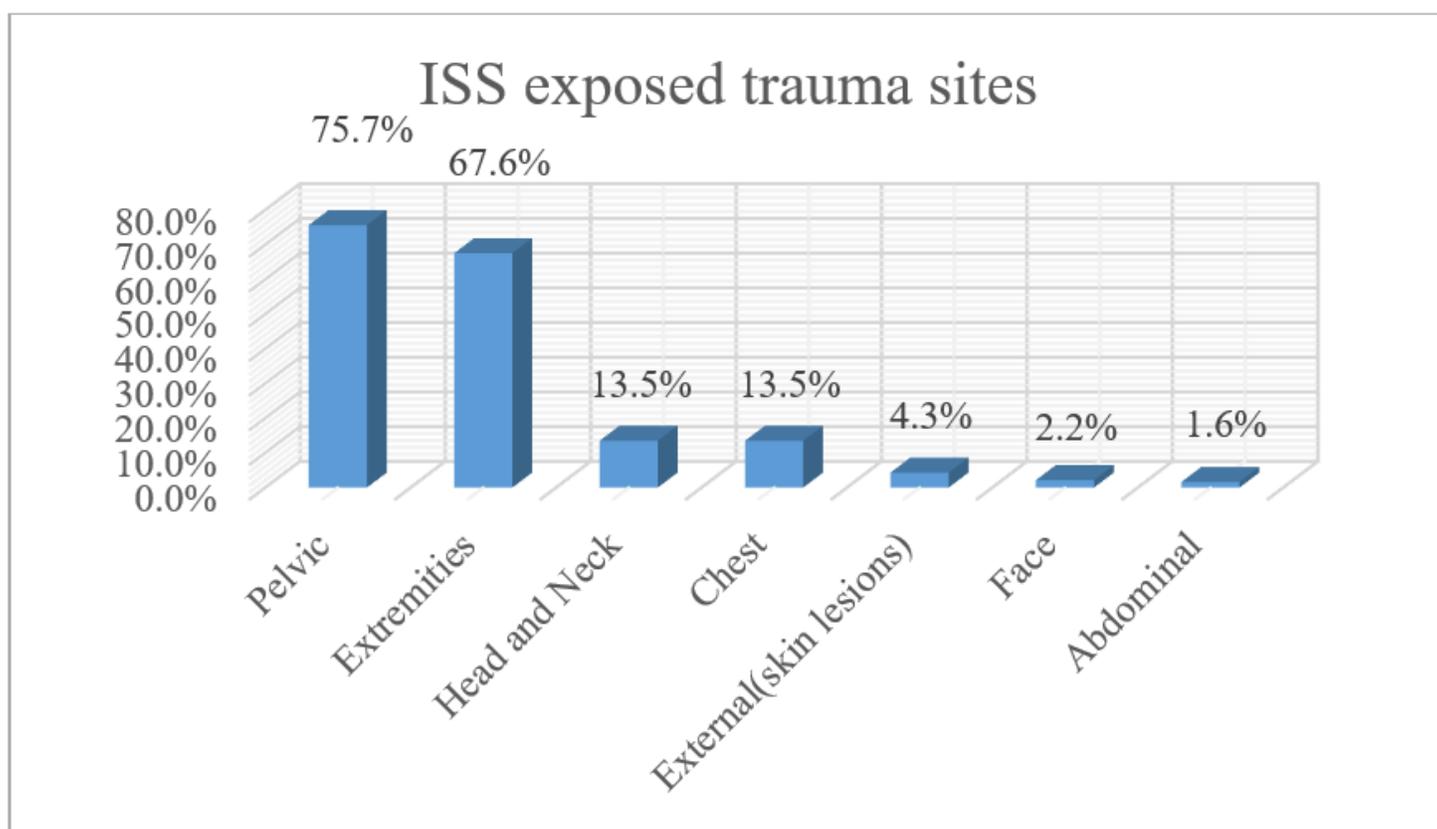
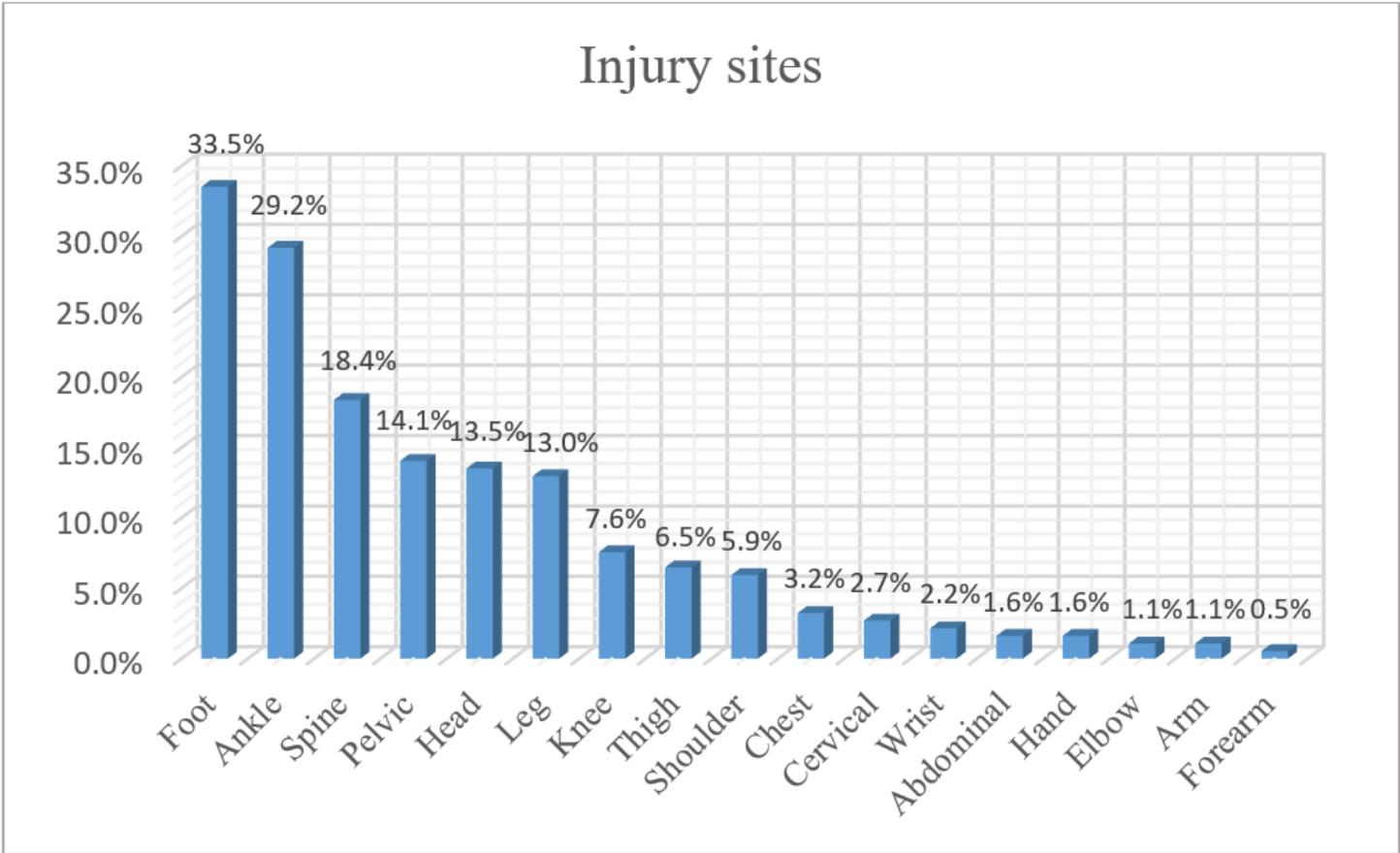


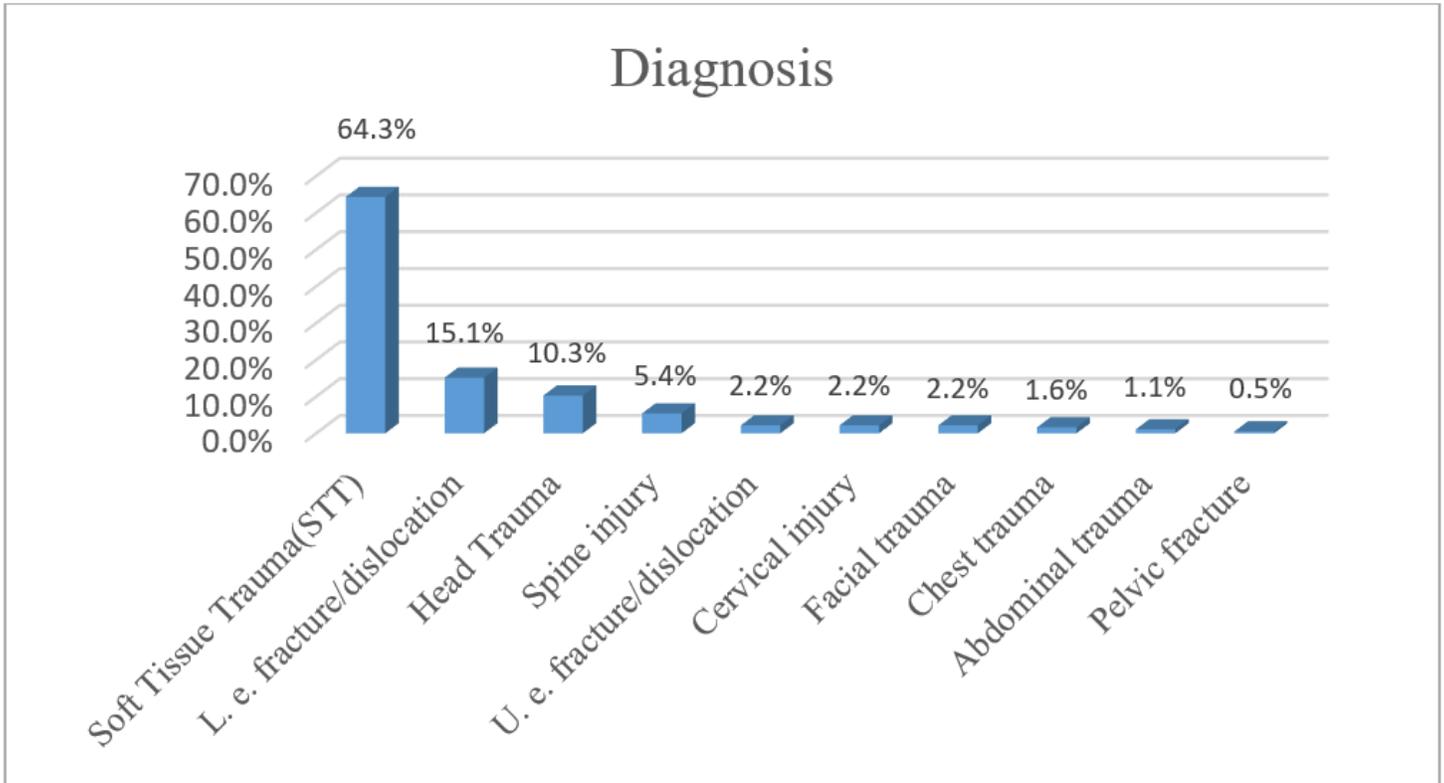
Figure 1

ISS exposed trauma sites



**Figure 2**

Injured sites



*L. e.: Lower extremity, U.e.: Upper extremity*

**Figure 3**

Frequency of patients according to their diagnosis