



# Evaluation of Spine and Spinal Cord Injuries Related to Military Personnel

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## Abstract

**Introduction:** War injuries vary in severity, ranging from minor injuries to severe damage to tissues and structures. This study investigates the etiology, intricacies, and interventions for war injuries in patients admitted to the trauma emergency department of Baqiyatallah Hospital.

**Methods:** A retrospective analysis was conducted on patients injured in the war and treated at Baqiyatallah Hospital between April 2016 and March 2019. The study encompassed patients with spinal cord injury (SCI) and all injured patients, except those with insufficient medical records or those that were inaccessible due to death or other conditions. Collected data includes demographic characteristics, etiology, location of the injury, severity, surgeries performed, length of hospital stay, and any associated injuries or complications. The data was analyzed using the SPSS version 26.0 software.

**Results:** The study included patients with a mean age of  $28.73 \pm 9.10$  years and a mean BMI of  $24.56 \pm 2.67$ . Cervical damage was the most prevalent spinal injury, occurring in 13 individuals (25%), whereas sacral damage was the least prevalent, affecting only two patients (3.8%). Gunshot wounds were the primary etiology of SCI in 44 cases (84.6%), and surgical complications were observed in 27 patients (51.9%). Most injuries (67.3%) were classified as open wounds, with GUSTILO 2 being the most common type (65.4%). The treatment options included no surgery in 15 patients (28.8%), anterior spinal fusion (ASF) in 6 patients (11.5%), posterior spinal fusion (PSF) in 16 patients (30.8%), and a combination of ASF and PSF in 4 patients (7.7%). Among the patients, the most prevalent form of spinal injury was a burst fracture, which was detected in 12 individuals (23.1%). A significant complication decrease was observed following the treatment ( $P < 0.05$ ).

**Conclusion:** Gunshot wounds to the cervical spine can result in burst fractures and neurosensory problems. PSF surgery is the most common treatment, which has demonstrated a substantial reduction in complications.

**Keywords:** Spinal Cord Injury, Military, War.

## Introduction

War injuries are a distinct form of penetrating injury that can result in varying degrees of tissue damage, ranging from moderate to severe, including destruction of muscle, bone, tendon, nerve, and vascular structures. Due to the destruction of functional buildings, these injuries are considered a challenge in surgery<sup>1</sup>. War trauma is a significant subject of study in the field of traumatology. The significance of war trauma is mainly

attributed to the substantial disparities in diagnosing, treating, and transporting injured individuals from frontline medical facilities to more secure hospitals located beyond the battle lines, particularly in instances of injuries sustained in urban settings<sup>2</sup>. In general, injuries and penetrating wounds that occur on the battlefield are the result of war projectiles hitting the warrior's body. These wounds may develop as a result

of direct bullet impacts or the scattering of shrapnel by explosive weapons like mines, grenades, mortars, bombs, etc.<sup>3</sup>. Gunshot or shrapnel injuries to any organ or anatomical region of the body have various effects. These injuries have the potential to result in either immediate or delayed fatality or disability in the affected individuals<sup>4</sup>. Various factors affect the kinetic energy of a projectile, which in turn determines the impact it generates. These parameters include the bullet's velocity and mass, the weapon type employed, and the anatomical properties of the affected tissue<sup>3</sup>. The fatality rate associated with head and neck trauma is below 1% in developed countries and 3% in developing countries<sup>5</sup>. However, it is crucial to mention that head and neck injuries significantly impact the facial structure and can result in permanent damage to one's appearance and, therefore, affect one's psychological state. These injuries impose significant costs on individuals and the healthcare system, highlighting the necessity of injury prevention measures<sup>6,7</sup>.

Globally, between 250,000 and 500,000 patients each year suffer from SCI. Most of these cases are due to preventable causes such as violence and motor vehicle accidents. Males represent the majority of patients with SCI related to a sports injury. The age group with the highest risk of SCI is from 16 to 30 years of age<sup>8</sup>. SCI is a severe condition that can have unpredictable consequences for the individual, their close acquaintances, and society. It is considered one of the most financially burdensome diseases due to the numerous disorders that individuals with SCI experience over their lifetimes. These disorders, in addition to the sensory and motor impairments resulting from the injury, might exacerbate their level of disability. SCI can arise from a multitude of circumstances, including warfare, accidents, falls, hazardous occupations, sports injuries, wounds inflicted by sharp objects, disease progression, and congenital abnormalities<sup>9</sup>. The annual economic impact of SCI is anticipated to exceed 4 billion dollars<sup>10</sup>. It is estimated that over 70,000 people in Iran will experience spinal cord injuries. According to statistics from Tehran University, the number of veterans with this specific form of injury in the country is currently over 2,100. Iran is expected to have around 70,000 individuals with spinal cord injuries who are disabled<sup>11</sup>. As the frequency of accidents continues to rise, it

becomes increasingly crucial to prioritize attention and planning for health services and rehabilitation in cases of SCI. In military-medical strategies, assessing the potential number of casualties, the frequency of various injuries, and the specific body regions affected is crucial. This information accurately predicts the resources needed, such as personnel and medical equipment, for potential future conflicts. By conducting research, we can estimate the number of injuries and casualties in military fights. This information determines the workforce and medical equipment needed in various combat scenarios. Ultimately, analyzing the recovery rate and the subsequent problems can guide us in attaining the quality standard in the military healthcare system. To date, research has been carried out on the challenges faced by Iranian veterans who have had spinal amputations. The Health and Treatment Foundation of the Martyr Foundation of Iran has reported that there are currently 80,000 individuals in Iran with SCI, including 2,000 veterans who acquired this disability during the forced war<sup>9</sup>. This study aimed to investigate and summarize the etiology, complications, and interventions for injuries sustained during the war by wounded patients admitted to the trauma department at Baqiyatallah Hospital.

## Methods

### Study design

This study employed an analytical retrospective design, examining the medical records of patients admitted to Baqiyatallah Hospital with war-related injuries between April 2016 and March 2019.

### Inclusion and exclusion criteria

The inclusion criteria were meticulously defined to encompass any cases of war-wounded individuals who presented at Baqiyatallah Hospital with spinal trauma from 2016 to 2019, as well as all patients who sustained injuries. The exclusion criteria were equally stringent, ruling out cases where complete patient file information was absent or where the patient was inaccessible, possibly due to situations like death that hindered the collection of necessary information.

### Data collection

The study employed a comprehensive standardized registration form that has received approval from three researchers. This form included a wide range of variables, including the patient's age, the cause and

location of damage, the severity of the injury, surgical procedures conducted, the duration of hospitalization, and any related injuries or complications. The paper needs to include a comprehensive mention of the status at discharge. Open fractures are categorized into three groups according to the Gustilo-Anderson categorization system. Group I fractures are characterized by a wound length of less than one centimeter, a wound free from contamination, and minimal muscle injury. These fractures are uncomplicated. Group II fractures exhibit a wound length ranging from one to ten centimeters, accompanied by the presence of muscle and soft tissue injury, albeit not of a severe kind. The fracture may be multi-piece. Group III fractures were characterized by a wound length exceeding ten centimeters, an infected wound, and significant damage to soft tissues and muscles. The fractures in this group were characterized by being composed of many pieces. Occasionally, there may also be a diminished blood supply to the bones and organs <sup>12</sup>.

### Data analysis

Upon gathering the information from the patients involved in the study, the data was entered into SPSS version 26 software and underwent advanced statistical analysis. The data was analyzed using descriptive statistics, including mean, standard deviation (SD), frequency, and percentage. To evaluate hypotheses and research questions, we employed inferential statistical parametric methods, such as the independent t-test, one-way analysis of variance, and chi-square test, for variables that exhibited a normal distribution. Non-parametric statistical approaches, such as the Mann-Whitney, Kruskal-Wallis, and Fisher's exact test, were employed to analyze variables that did not follow a normal distribution. A p-value below 0.05 was considered statistically significant.

### Results

The mean age of the patients was  $28.73 \pm 9.10$  years. Their average height was  $1.71 \pm 0.05$  meters, their mean weight was  $71.83 \pm 9.31$  kilograms, and their mean BMI was  $24.56 \pm 2.67$  (Table 1).

Table 1: Characteristics of the demographic data.

variable	Mean $\pm$ SD
Age (years)	$28.73 \pm 9.10$
Height	$1.71 \pm 0.05$
Weight	$71.83 \pm 9.31$
BMI	$24.56 \pm 2.67$

### Types and sites of injuries

Thirteen patients (25%) exhibited damage in the cervical region, which was the most common, while just two patients (3.8%) had damage in the sacral region, which was the least frequent. The most common causes of damage to the spine and SCI in patients were investigated. It was found that gunshot wounds were observed in forty-four patients (84.6%). Complications commonly associated with general surgery, such as lung rupture, liver rupture, and pneumothorax, were reported in twenty-seven patients (51.9%). Orthopedic complications were observed in seven patients (13.5%), while other complications were observed in eighteen (34.6%). Investigation revealed that burst fracture was the most typical form of injury to the spine and SCI, occurring in 12 cases (23.1%). Subsequently, the occurrences were as follows: foreign body in the spine (21.2%), distraction of post element (17.3%), compression fracture (11.5%), disk herniation (11.5%), transverse process fracture in 3 patients (5.8%), facet fracture (5.8%), and sacral fracture (3.8%). Most injuries were classified as open wounds (67.3%). Among these, the most common type was Gustilo grade 2, which accounted for 65.4% of the cases (Table 2).

### Cases management

The average length of hospitalization was 12.8 days, with a minimum of 1 day and a maximum of 28 days (Table 3).

A surgical procedure was not conducted on fifteen patients (28.8%). ASF was administered to six patients (11.5%). Sixteen patients were treated with PSF) and 30.8%. Additionally, four patients (7.7%) underwent both ASF and PSF. Five patients (9.6%) underwent kyphoplasty, and six patients (11.5%) had shrapnel removed (Fig.1).

Comparing the complications observed before and after treatment revealed a statistically significant reduction (Table 4).

The study did not find a statistically significant correlation between the Severity of injury and

complications, as well as injury site and complications ( $P > 0.05$ ). The information is shown in (Table 5).

There was no statistically significant relationship between demographic characteristics and complications ( $P > 0.05$ ). The information is shown in (Table 6).

Table 2: Investigation of the prevalence of spine injuries and SCI in referred war wounded.

Variable		Frequency	Percentage (%)
Location of damage	Cervical	13	25
	Thoracic	10	19.2
	Thoracolumbar	11	21.2
	Lumbar	10	19.2
	Lumbosacral	6	11.5
	Sacral	2	3.8
Reason of damage	Gun Shot	44	84.6
	Shot Gun	1	1.9
	mortar-shell	1	1.9
	Motor vehicle	7	11.6
Types of complications	General surgery	27	51.9
	orthopedics	7	13.5
	Other	18	34.6
Types of injuries to the spine and spinal cord	Transvers process fracture	3	5.8
	Compression fracture	6	11.5
	Burst fracture	12	23.1
	Distraction of post elements	9	17.3
	Disk herniation	6	11.5
	Sacral fracture	2	3.8
	Foreign body in spine	11	21.2
	Facet fracture	3	5.8
Severity of injury	GUSTILO 1	1	1.9
	GUSTILO 2	34	65.4
	GUSTILO 3	0	0
	Close	17	32.7

Table 3: displays the mean days of hospitalization.

Variable	Mean	SD	Min	Max
Days of hospitalization	12.8	6.18	1	28

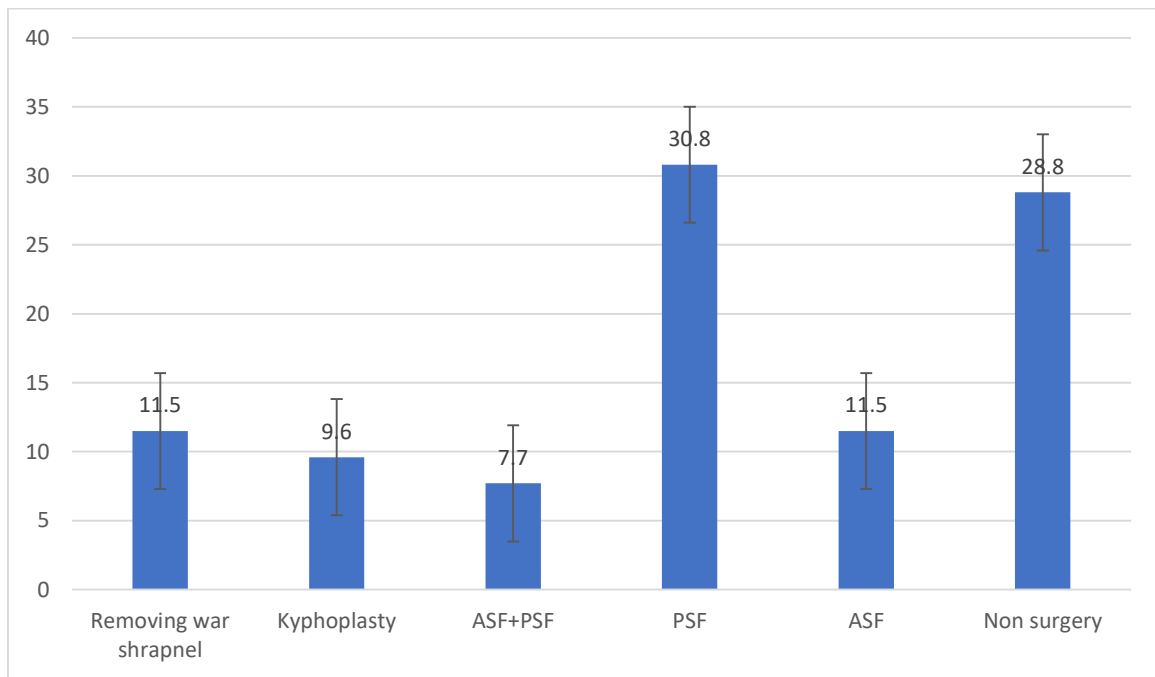


Figure 1: Displays the distribution of complication frequencies for different orthopedic surgical treatments in patients.

Table 4: Relationship between complications before and after treatment.

	Variable	Frequency	Percentage (%)
Complications after surgery	Decrease	23	44.2
	Increase	4	7.7
	No change	25	48.1

Table 5: Relationship between Severity of injury / injury site and complications.

location of injuries	Complications (%)				Total	P value	
	sensory nerve	Movement injury	both	No complications			
CERVICAL	0 (0)	1 (1.9)	1 (1.9)	11(21.2)	13 (25)	0.054	
TORACIC	0 (0)	2 (3.8)	5(9.6)	3 (5.8)	10 (19.2)		
TORACOLUMBAR	1 (1.9)	4 (7.7)	3 (5.8)	3 (5.8)	11 (21.2)		
LUMBAR	0 (0)	2 (3.8)	0 (0)	9 (17.3)	10 (19.2)		
LUMBOSACRAL	0 (0)	1 (1.9)	0 (0)	6 (11.5)	7 (13.5)		
SACRAL	0 (0)	0 (0)	0 (0)	1 (1.9)	1 (1.9)		
					<b>Total</b>	<b>P value</b>	
Severity of injury	GUSTILO 1	0 (0)	0 (0)	0 (0)	1 (1.9)	1 (1.9)	0.220
	GUSTILO 2	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
	GUSTILO 3	0 (0)	8 (15.4)	8 (15.4)	18 (34.6)	34 (65.4)	
	Close	1 (1.9)	1 (1.9)	1 (1.9)	14 (26.9)	17 (32.7)	

Table 6: Relationship between demographic characteristics and complications.

demographic characteristic	complications	Number	Mean(age/height/weight)	Standard deviation	P value
age	sensory nerve	1	25	.	0.699
	Movement injury	9	29.5	10.92	
	both	9	25	3.46	
	No complications	33	29.06	10.74	
	Total	52	28.36	9.79	
height	sensory nerve	1	182	.	0.116
	Movement injury	9	169.5	4.58	
	both	9	171.8	6.25	
	No complications	33	170.69	4.57	
	Total	52	170.92	5.05	
weight	sensory nerve	1	74.32	.	0.875
	Movement injury	9	71.1	8.52	
	both	9	73.77	8.36	
	No complications	33	70.18	6.34	
	Total	52	71.82	9.31	

## Discussion

This study involved the examination of 52 male patients. The mean age of the patients was  $28.73 \pm 9.10$  years. Comparisons with existing literature revealed similarities and differences in patient demographics and injury characteristics. The study conducted by Sedghi Goy Aghaj (2016) involved the examination of 248 patients with SCI. Most of the patients were male, averaging  $42.00 \pm 11.3$  years<sup>9</sup>. Additionally, Mousavi et al. (2011) examined 201 cases of spinal cord amputation in veterans of the Tahami War at Al-Zahra (S) Hospital in Isfahan. The study found that all patients were male and had an average age of  $42.3 \pm 5.7$  years<sup>13</sup>. The prevalence of sexual impotence and fertility was determined by Soroush et al. (2009) in 1429 veterans with SCI. The participants had an average age of  $37.5 \pm 8.5$  years, and 98.4% were male<sup>14</sup>. Mohebi et al.'s (2007) study documented the mean age as 21.9 years<sup>15</sup>. The current study did not investigate the educational level or occupation of the patients. However, the study by Mousavi et al. (2011) revealed that most patients had completed secondary education (42.3%), and 72.6% were unemployed. Furthermore, the current study did not include information about the patient's marital

status. However, in the study conducted by Sedghi Goy Aghaj (2016), most of the patients evaluated were married (77.01%), highlighting potential variations in the socio-economic profile of spinal cord injury patients. The mean BMI of the participants assessed in this study was  $24.56 \pm 2.67$ . The value of  $26 \pm 4.7$  was reported in Mousavi et al.'s study, which is almost similar to the findings of the present investigation. It suggested no statistically significant relationship between BMI and patients' jobs. All patients included in the present investigation sustained injuries during the warfare, with gunshot wounds accounting for the most common cause of injury. Among these injuries, burst fractures were the most prevalent (23.1%) in the spine and spinal cord. Furthermore, a statistically significant correlation was observed between the types of injuries and the types of preoperative complications. Nevertheless, no statistically significant correlation was observed between the types of injuries and the occurrence of complications following the surgical procedure. The study by Sedgi Goy Aghaj in 2016 suggested that the predominant factors leading to SCI in patients were warfare (74.19%) and vehicle accidents (19.35%)<sup>9</sup>. Further, Mousavi et al. (2011) indicated that

78.6% of patients experienced SCI as a result of warfare, with shrapnel being the most prevalent cause of injury, accounting for 51.7% of cases. According to Salari et al. (2002), the majority (89.9%) of individuals injured in the Iran-Iraq war experienced penetrating trauma. Shrapnel caused the majority of injuries (72.4%), followed by bullet wounds (10.61%). Thirty individuals (3%) experienced injuries caused by both bullets and shrapnel. Additionally, 38 patients (3.8%) were admitted to the hospital as a result of explosions or shrapnel-related injuries<sup>16</sup>. The latest study's findings indicated that the cervical region experienced the greatest damage. Furthermore, no statistically significant correlation was observed between the location of the injury and the type of complications prior to surgery, as well as the complications following surgery. According to Sedghi Goy Aghaj's (2016) study, the thoracic vertebrae had the highest level of involvement. Pain intensity was assessed in patients during the previous study, but it was not examined in patients during the current study. In the study conducted by Mohebi et al. (2007), the most common anatomical areas damaged were the lower limb and bony pelvis (30.5%), upper limb (24%), head and neck (19%), abdomen, and pelvic contents (10.5%). The chest and brain each accounted for 6.4% of the injuries, while the vertebrae and spinal cord accounted for 3.2%<sup>15</sup>. Salari et al. (2002) found that the limbs, head and neck, spine, chest, and abdomen were the body regions most affected by the most penetrating blows<sup>16</sup>. It is important to mention that the two studies above assessed various injuries; however, our study specifically focused on examining the spine and SCI. Our study revealed that most of the injuries (67.3%) were open, with the highest occurrence being GUSTILO 2 (65.4%) in terms of lesion severity. This factor was not examined in previous similar studies. Botha et al. (2016) reported that spinal nerve injury is a frequent occurrence after gunshot wounds to the spine, with the majority of injuries happening at the chest level. They found that 25–59% of these injuries result in complete spinal cord injuries. The risk of complete injury in chest gunshot wounds is higher than in other regions of the spine<sup>18</sup>. Our study's results indicated that sensory and motor neurologic complications simultaneously comprised the most frequent complications prior to surgery (32.7%) and following surgery (63.5%). The incidence of postoperative complications decreased by 44.2% in

patients and increased by 7.7%. Complications before and after surgery remained unchanged in 48.1% of cases. Furthermore, the results of this study showed that the most surgical treatment performed for the examined patients was PSF (30.8%). A substantial statistical relationship was seen between the type of orthopedic surgery and the type of complications after surgery. However, no statistically significant relationship was found between different types of surgery and the change in complications (decrease, increase, or no change). According to Heiden et al.<sup>19</sup>, the outcome and probability of recovery depend on the initial injury, and surgical intervention does not change the neurological outcomes in both complete and incomplete patients.

### Conclusion

The results of the present study indicate that the cervical region of the spine experienced the most severe damage, specifically in the form of Burst fractures caused by Gunshot injuries. Neurosensory complications were the most prevalent form of injury observed and treated with PSF. A substantial statistical relationship was found between the treatment and complication change.

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### Conflict of Interest Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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### Authors' Contributions

Concepts, data gathering, writing, and editing: Mohammad Kazem Emami Meybodi, Hamid Hesarikia, Mohammad Ghalamfarsa, Mohammad Mahdi Shater, Sadra Haji, Mohammad Hossein Peypar, Mahdi Abdorrashidi.

### Ethical Statement

The present study acquired ethical approval from the Ethics Committee of Baqiyatallah University of

Medical Sciences (ethics code: IR.BMSU.BAQ.REC.1399.037).

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