Original Article

Extremity War Injuries: A Retrospective Study of the Iran–Iraq War

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Abstract

Background: Warfare is an immense destruction of human life and infrastructure. Wide-scale trauma is a gigantic problem, and the latest war trends are toward targeting more civilians. Injuries in war are multifactorial depending mostly on arms engaged. The objective of this study was to examine the characteristics of extremity injuries in the Iran–Iraq war. The important principle is recognizing injury types, mechanism of trauma, and factors influencing complications in extremity injuries of war. **Methods:** In this retrospective study, we reviewed documents of 8437 patients who were transported and treated in Imam Khomeini Hospital, Tehran, during 8-year Iran–Iraq war from 1980 to 1988. 7352 patients with physical injuries were selected as a sample. Data collection form included type, mechanism, and location of the injury, associated lesions, and the treatment given. Data were analyzed by descriptive statistics (frequency and mean) using SPSS software. **Results:** Medical archive review identified 8437 patients, 7352 sustaining physical trauma and 4926 among them had 6601 extremity injuries. Mean age of the patients sustaining extremity injury was 23 years. 74% (4885) of the injuries were caused by shrapnel fragments, 12% (792) were caused by bullets and rest 14% were due to various other causes. There were 53.9% (3561/6601) fractures among the total injuries, most commonly involving femur (19.9%). Fracture fixation with 66.3% (1394/2103) was the most common type of orthopedic treatment provided. In addition, 20.6% (1359/6601) injuries were related to arterial lesions and 32% (2112/6601) were accompanied with nerve damage. **Conclusion:** Extremity injury is a major trauma in war zones and leads to high rate of morbidity; however, if appropriate care and timely assistance are provided, it has low risk of death. Understanding type, frequency, and mechanism of injury and factors influencing trauma is of extreme importance in appropriate management and avoiding unnecessary amputations.

Keywords: Extremity injuries, Iran–Iraq war, trauma management, warfare

Introduction

Warfare is an immense destruction of human life and infrastructure. A single war can catapult any nation into global burden of injuries. Wide scale trauma is a gigantic problem to deal with, and injuries in war are multifactorial depending mostly on arms used. There is no exact statistics available about the civilian mortality and morbidity in war; previous studies suggest that about 30%–65% of total injuries and deaths in war are civilians.[1] However, as the latest war trends are toward targeting civilians, there are huge number of civilian casualties apart from injured military personals.[2,3]

Notably, mechanism of injury in civilians is different compared to military and the part of the body involved in trauma is as well diverse.[4] War injuries are generally by two mechanisms, one resulting from collision of projectiles such as bullets to the body and other being shrapnel fragmentation of explosive weapons such as mines, grenades, mortars, and bombs.[5]

Access this article online

Quick Response Code:

Website: www.archtrauma.com

DOI: 10.4103/atr.atr_10_18

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How to cite this article: Zarei M, Farzan M, Firoozabadi MJ, Khan FM, Tavakoli M. Extremity war injuries: A retrospective study of the Iran–Iraq war. Arch Trauma Res 2019;8:28-32.

Received: 06-02-2018, **Accepted:** 02-06-2019.

Trauma in war is influenced by various factors, such as velocity of the projectile, type of weapon used, and the physical characteristics of hit texture.[5] In addition, depth and type of injuries caused are not the same in different anatomical areas of human body and may lead to disability with delayed death or even immediate death.[6]

After more than 30 years, thousands of people are still suffering from disabilities. Extensive studies to examine the types of injuries and treatment applied can help minimizing complications. This study aims to examine the volume, mechanism, and complications of extremity trauma and to compare it with other previous large-scale wars.

Methods

In this retrospective study, we reviewed documents of 8437 patients who were transported and treated in Imam Khomeini Hospital, Tehran, during the 8-year Iran–Iraq war. 7352 patients with physical injuries were selected as a sample. Transmission of information to the data collection form was carried out by studying the medical documents of these patients. Data collection form included age of the patient, characteristics of injury such as type, mechanism, and location, associated lesions, and the treatment given. Data were used for analysis of variables such as frequency and mean. All analyses were conducted by using IBM SPSS Statistics for Windows, version 20 (IBM Corp., Armonk, N.Y., USA).

Results

Medical archive review identified 8437 patients transferred to our facility, 7352 sustaining physical trauma and 4926 among them had extremity injuries (4759 male and 167 female). Patients' age ranged from 14 to 48 years with a mean of 23. However, 57.8% (2580/4926) of extremity-injured patients were aged between 21 and 25 years.

Among the 4926 patients, there were 6601 extremity injuries as some of the patients had sustained multiple injuries. Regarding the causes of trauma, 4885 (74%) were due to shrapnel fragments, 792 (12%) were due to bullets, and the rest of the injuries were due to different causes such as accidents and debris. Regarding location, 2376 (36%) of them were in the upper extremities (13% in proximal and 23% in distal) and other 64% were related to lower extremities (39% proximal and 25% distal).

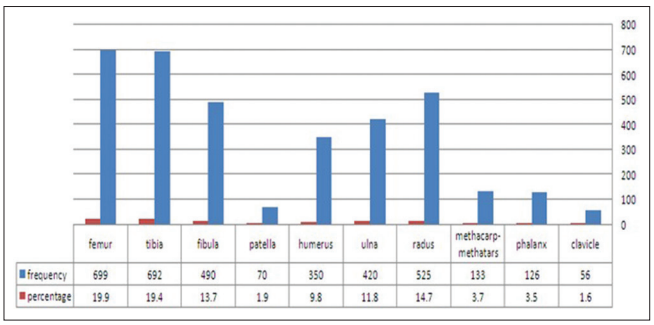

Figure 1: Frequency distribution of bone fractures

There were 3561 (53.9%) fractures reported among the 6601 injuries, and the frequency and percentage of every bone involved are demonstrated in Figure 1. Femur has been most common bone injured with 19.9% rate of fracture followed by tibia.

Among 3561 reported fractures, the causes of 3218 of them were known and shrapnel fragment injury (mortar and cannon trauma) was the most common cause with 58.7%. The frequency distribution of other causes of trauma including bullets, mines, missiles, and other accidents is listed in Figure 2.

Table 1 demonstrates the type of orthopedic treatment given to extremity injuries. Among the 3561 fracture cases, 2103 records were found with orthopedic treatment. Fixation with

Table 1: Frequency distribution of orthopedic treatment

Type treatment	*n* (%)
Conservative	431 (20.5)
Clavicle	51 (11.8)
Hand	60 (13.9)
Foot	90 (20.9)
Leg	12 (2.8)
Femur	74 (17.2)
Forearm	102 (23.7)
Humerus	42 (9.7)
Fixation	1394 (66.3)
External	312 (22.4)
Internal	1082 (77.6)
Fusion	190 (9)
Wrist	31 (16.3)
Elbow	51 (26.8)
Shoulder	18 (9.5)
Ankle	30 (15.8)
Knee	41 (21.6)
Hip	19 (10)
Arthroplasty	88 (4.2)
Knee	38 (43.2)
Hip	24 (27.3)
Elbow	20 (22.7)
Shoulder	6 (6.8)

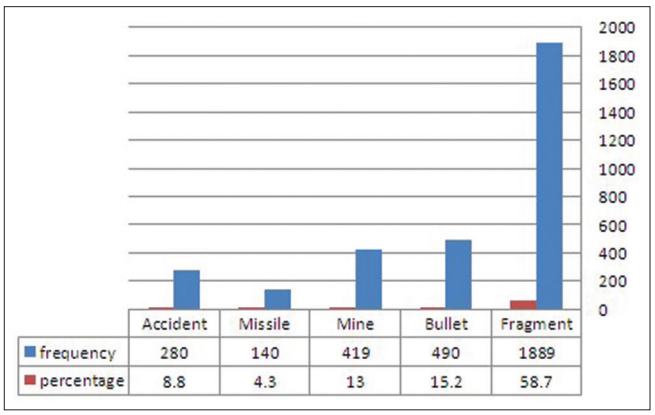

Figure 2: Frequency distribution of fracture causes

66.3% (1394/2103) was the most common treatment given followed by conservative management in 431 (20.5%) patients.

A total of 635 injuries were reported with articular damage with highest trauma occurring at the knee (30.4%) and then to the elbow (22.1%), ankle (12.6%), wrist (12.1%), hips (11.8%) and shoulders (11%).

Among the 3561 fracture injuries, there were reports of 1318 (37%) cases of infection, 600 (17%) cases of vascular lesion, and 712 (20%) cases of nerve lesions.

Of 6601 extremity injuries, 985 (15%) amputations were performed pertaining to severe damage. 76% of amputation was done on lower limb (35% distal and 41% proximal) and the rest 24% was in the upper extremity (14% distal and 10% proximal).

Among 6601 extremity injuries, 1359 (20.6%) cases of arterial lesions were observed. Superficial femoral artery was the most commonly involved (40%) followed by popliteal artery injury (22%). 216 (34.4%) amputations were performed due to severed artery that, in most cases, injury to popliteal artery or superficial femoral (118 cases) was the cause of amputation. The most common site of pseudoaneurysm formation was noted to be at superficial femoral artery (164 cases) and the most common site of arteriovenous fistula formation was femoral artery (64 cases). The type of treatment carried out in these vascular lesions is shown in Figure 3.

There were reports of 2112 cases of nerve damage that is about 32% of entire injuries. A thorough history, examination, description of surgery, and results of electromyographic nerve conduction velocity (EMG-NCV) of these patients were reviewed. In respect to kind of lesion to the nerve, 13% were complete amputations (neurotmesis), 48% incomplete amputations (axonotmesis), 16% compressive lesions (neurapraxia), and other 23% uncertain. Ulnar and sciatic nerves were the most commonly injured, with 21% each [Figure 4]. Location of nerve injuries in the upper and lower limbs is shown in Tables 2 and 3. The elapsed time between nerve injury and surgical intervention ranges from 1.5 months to maximum of 4 years.

Among all the injuries, 40% of the wounds were reported to be infected with microorganisms such as *Staphylococcus* and *Clostridia* and were treated with antibiotics, mostly ampicillin and cefazolin.

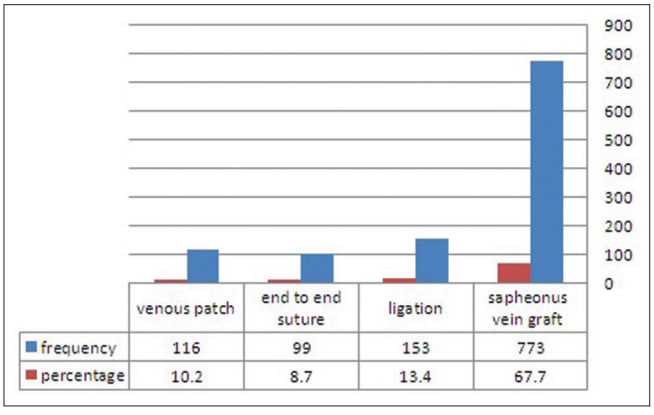

Figure 3: Frequency distribution of treatment of vascular injury

Discussion

Studies on extent of war injuries are important to countries that were previously or currently at war or engaged in potential conflict. Appropriate planning for managing traumatic injuries in war should be of outmost importance. If trauma management can be executed in proper method, chaos can be minimized and lessen the huge economic burden of the country.

Injuries in war depend mainly on the type of war being fought and on the type of military equipment used. Injuries sustained by civilians in urban warfare as in civil war are different from injuries sustained by military personals fighting in war zones. In the study on the Syrian civil war injuries, 18% of injured

Table 2: Location and frequency of nerve injury in the upper limb

Nerve	Wrist	Elbow	Arm	Axilla
Ulnar	221	271	-	82
Median	265	82	-	63
Radial	-	89	165	44

Table 3: Location and frequency of nerve injury in the lower limb

Nerve	Blow knee	Thigh	Pelvis
Sciatic	-	144	312
Peroneal	-	197	-
Tibial	101	32	-

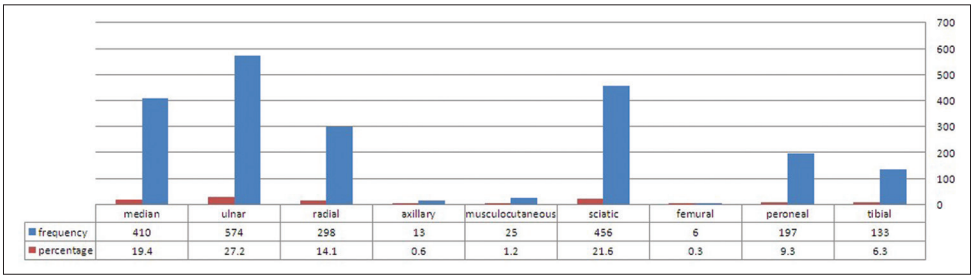

Figure 4: Frequency distribution of damaged peripheral nerves

were children with head trauma; however, in adults, extremity and abdominal trauma were more common. A total of 23.3% extremity injury was reported in this study; however, head injury was the most common cause (42.5%) of death in trauma patients.[7] This study reports the nature of civil wars fought in urban areas, making civilians vulnerable mostly children and women.

The war between Iran and Iraq is one of the longest wars of the twentieth century that lasted for 8 years leaving more than one million people dead and wounded. Few studies reported earlier, discussing the injuries of Iran–Iraq war. One of these studies on medical documents of 1000 war-wounded individuals reported by the Supreme Medical Commission stated extremity injuries as major concerned trauma in war for both military and civilians. Comprising 54.4% of all injuries, 24% in upper extremity and 30.5% involving lower extremity. 75% of those injured were in the age range of 15–24 years, with a mean age of 21.9.[8]

In any war, extremity injuries cover a large percentage of trauma. In this present study, 67% had extremity injuries that the most involved were men between 21 and 35 years old. This shows the fact that young men are most vulnerable and have a significant role in terms of physical fitness. In case of trauma to military personals, 85%–88% are combat wounds, and in civilians, it is about 20%–23%.[9]

In Croatian War of Independence fought between 1991 and 1995, extremity injury was reported to be as high as 83%.[10,11] In the study related to America's war in Iraq and Afghanistan, 70.5% of trauma was extremity injury.[12] However, in another study related to American military invasion in Iraq, 54% extremity injury was reported.[9] The rate of extremity injury in the American war in Korean Peninsula was 65%[13] and in the Vietnam war was 61%.[14] In the Second World War, extremity trauma was reported to be 71% of all injuries.[15]

High rate of extremity injuries in wars, i.e. more than 50% in all studies, it is necessary to have clear plan of management specifically for extremity trauma in case of such events. According to Table 4, the rate of lower extremity injury in most wars has been reported higher than the upper extremity. In addition, Table 4 compares extremity fractures of Iran–Iraq conflict with other wars.

There are different figures on the rate of fractures in war. In our study, 53% of extremity trauma had fractures, not much different (54%) compared with another study on the same war.[8] However, the rate of fractures in this study is much more than American war with Korea,[13] Vietnam,[14,16] World War II,[15] and Iraq–Afghanistan.[9] It is less than what is reported in German war study, with 86% of fracture rate.[17]

In addition to fractures, articular damage is also noted in number of war-injured population. In this study, knee was the most injured joint (30.4%). Another study conducted on the same war as well concluded knee as the most injured joint (31.3%). In the upper extremity, the most injured joint is reported to be interphalangeal joint, 10.8%.[18]

Trauma to extremity may have complications such as nerve damage, vascular injury, and infections leading to amputation. In our study, the amount of amputation was 15%. In American war study, the amount of amputation was reported to be 9.6%, i.e., 7.5% amputations in the lower extremities and 2.1%the in upper extremities. The most reported type of amputation has been below knee amputation. In the same study, the rate of amputation in Vietnam–America war was 8.3%. Our study reports that the rate amputation in Iran–Iraq war was higher than other wars. Lynn *et al*. investigated the mechanisms of injury in war leading to amputations, and they reported that 87.9% amputations were related to explosion devices.[12]

A study was done based on report of EMG-NCV on wounded population in which 30% of injuries have been nerve lesion, mostly of the axonotmesis (48%), and the most involved nerve was ulnar. 20.6% cases of extremity injuries were associated with vascular involvement and the most involved artery was superficial femoral. In a study on American war in Iraq and Afghanistan, the extent of neurovascluar injury was reported to lower than our study. 15.9% and 14.9% in upper and lower extremities, respectively.[12] The difference could be related to different military equipment and logistics used.

Trauma in war hugely depends on kind of weapons used and branch of military personals serving. The distribution of various combat injury mechanisms in various military branches has been examined in a study conducted in 2013; the difference is summarized in Table 5.[19]

Extremity injury is a major trauma in war zones and leads to high rate of morbidity; however, if appropriate care and timely assistance are provided, it has low risk of death. This issue is intriguingly important. If planned properly, a large number of war wounded could be treated at an early stage minimizing complications. In cases of extremity injury, lifesaving measures can be taken by preventing bleeding with primary actions, such as wound dressing and packing. In addition, initial irrigation and dressing of the wound and starting appropriate antibiotics reduce the potential risk of infection. If there is a fracture, immobilizing the extremities with splints and initiating early

Table 4: Compare the distribution of fractures and extremity injury in other wars

	WWII (15)	Korea-USA (13)	Iran-Iraq (8)	Iraq-USA (9)	USA-Vietnam (14)	Current study
Fracture		23		26	27	53
Upper extremity injury	23	29	24	28	27	24
Lower extremity injury	48	36	30.5	26	34	43
Total extremity injury	71	65	54.5	54	61	67

Table 5: Distribution of various combat injury mechanisms in various military branches

	Infantry	Armor	Sea	Air
Ballistic	90	50	25	5
Blunt	2-3	5	10	50
Blast	2-3	5	10	<5
Thermal	2-3	25	30	25
Combined	<5	15	25	10

fracture care such as ice pack and limb elevation can relieve pain and reduce the incidence of compartment syndrome.

According to a study on America's war in Iraq, approximately 30–50 general surgeons and 10–15 orthopedics were in the war zone.[20,21] Although these surgeons were not performing major surgeries, certainly early action in stabilizing wounded lead to reduce morbidity and mortality in these individuals. However, planning might differ for every country at war and is unique to that country. Considering country's economic status, health facilities, divisions of military engaged and the type of weapons used. Nevertheless, conducting studies on warfare are matter of outmost difficulty as many of times collecting untampered data from such events is not possible.

Conclusion

Extremity injury is a major trauma in the war zones and leads to high rate of morbidity; however, if appropriate care and timely assistance are provided, it has low risk of death. Understanding types and frequency of injuries, mechanism, and factors influencing trauma is of extreme importance in appropriate management and avoiding unnecessary amputations. Trauma in war, if not managed in proper planned manner, can create chaos in the country leading to increased morbidity, wide-spread infections, amputations, and complications such as fracture nonunion, neurovascular injuries, and even high rate of mortality. Nevertheless, the most important step is recognizing injuries and managing and preventing further complications that necessitate extensive studies on injuries of war.

Limitations

This was retrospective study. Errors in recording of documents and in interpreting those documents are inevitable. There were also cases of injuries; we could not find type of treatment given in 473 patients as documents relating to their treatment were not able to be traced or readable. However, we tried to minimize the errors to as low as possible by doing extensive revision of documents by separate authors and evaluating them separately.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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