

# Incidence and demographic characteristics of Syrian Civil War-related amputations: A multi-center study

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## ABSTRACT

**Objectives:** The aim of this study was to identify the causes, levels, and rates of amputations performed in civilians during the Syrian Civil War and to present epidemiological data of the amputees.

**Patients and methods:** Between August 2017 and February 2019, a total of 363 amputations of 307 amputees (266 males, 41 females; mean age 29.9±13.3 years; range, 6 to 86 years) were retrospectively analyzed in four prosthesis and orthosis centers managed by an international non-governmental organization and serving to individuals who experienced amputation during Syrian Civil War. Level, etiology, number of amputations and distribution of the amputations by years were investigated.

**Results:** Of the patients, 25.4% were under the age of 18 years. A total of 74% of all amputations were of the lower extremities. Transtibial and transfemoral amputations were the most common amputation levels. Of the amputees, 89.3% reported the cause of amputation as bombing.

**Conclusion:** Civil amputations during the Syrian Civil War are different from those in other civil wars due to the high rate of bombing-induced amputations and also the high rate of victims under the age of 18 years. Our study results show a high ratio of both lower and upper extremity amputations in these civilians.

**Keywords:** Amputation, bombing, Syrian Civil War.

Extremity loss is a factor which adversely affects human life physically, psychologically, and vocationally. The causes of amputation in civil life are usually reported as vascular disorders, bone and joint malignancies, traumas and congenital factors,<sup>[1]</sup> while these factors are replaced by others in regions where the war and terrorism are in effect. Currently, wars can cause injuries that endanger civilians rather than the military personnel. In the past, deaths and injuries on battlefields were primarily due to secondary factors such as hunger, infection, or housing problems; however, they happen directly related to the war itself currently.<sup>[2]</sup> High-energy explosions constitute a significant part of trauma-induced amputations in

regions of terrorism and war.<sup>[3]</sup> In previous years, most extensive and serious injuries caused by explosive weapons resulted in deaths; however, developing technologies and surgical techniques have increased the survival incidence.<sup>[4,5]</sup> The decrease in mortality rates has been in parallel with the increase in multiple amputations due to such injuries.<sup>[6]</sup> The majority of lower extremity amputations (LEAs) occurring in war regions are caused by landmines.<sup>[7,8]</sup> Most of the studies investigating injuries and amputations in war zones have involved only the military personnel,<sup>[8-12]</sup> whereas there are few studies including civilians.<sup>[13]</sup> After the onset of the Syrian Civil War, several studies have been conducted in Turkey, mostly involving hosting

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refugees and injured individuals from Syria.<sup>[14-18]</sup> In the present study, we aimed to identify the levels, causes, and rates of civilian amputations related to the Syrian Civil War and to document the epidemiological data of civilian amputees.

## PATIENTS AND METHODS

This retrospective study was conducted in prosthesis and orthosis centers located in Istanbul, Reyhanli district of Hatay, and Sanliurfa provinces from Turkey and Jarabulus province of Syria between August 17<sup>th</sup>, 2017 and February 1<sup>st</sup>, 2019. These centers managed by an international non-governmental organization (NGO) were established to provide prosthesis and orthosis services to the Syrians injured during the civil war. The NGO has operated through branches in all cities of Turkey. These branches conducted screening in their provinces and reached Syrian amputees living in the city and camps. Amputees in need of prosthesis were transferred to one of the four centers by the institution. Also, settlements, camps and border gates, which were far away from the centers, were visited and measurement-prosthesis service was provided in these places.

A total of 363 amputations of 307 amputees (266 males, 41 females; mean age 29.9±13.3 years; range, 6 to 86 years) were retrospectively analyzed. Hundred

and fifty nine amputees who were rehabilitated in these centers for any reason other than the civil war were excluded. The study protocol was approved by the Ethics committee of Marmara University Medical Faculty. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Data including demographic (age, sex, educational level, marital status, occupation, distribution of the amputations by years etc.) and clinical characteristics (amputation level, cause of amputation, with/without a chronic disease) of the patients were recorded.

### Statistical analysis

Statistical analysis was performed using the IBM SPSS for Windows version 21.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency.

## RESULTS

Baseline demographic and clinical characteristics of the amputees are presented in Table 1. The majority of the amputees (59.9%) had an educational level of middle school or below (Table 1).

A considerable amount of the amputees (23.1%) were students and only 10.1% of them were unemployed before the war (Table 2).

**TABLE 1**  
Baseline demographic and clinical characteristics of amputees

	Single extremity amputation			Multiple extremity amputation			Total		
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD
Amputees	255	83.1		52	16.9		307	100	
Current age			30.5±14.3			26.6±10.1			29.9±13.3
Age of amputees			26.54±13.7			22.5±10.1			25.8±13.2
Sex									
Female		14.5			7.7			13.4	
Male		85.5			92.3			86.6	
Educational level									
Illiterate								7.2	
Pre-school								0.7	
Middle school or below								59.9	
High school								17.3	
University								8.2	
Under the age of 18		24.3			30.8			25.4	
Married		39.2			50			56	
Those already using a prosthesis		41.6			63.5			45.3	
Those with a chronic disease		3.2			1.9			3	

SD: Standard deviation.

**TABLE 2**  
Pre-war and current occupations of the amputees

	Pre-war	Current
	%	%
Student	23.1	10.1
Worker	21.2	7.8
Trades people	16.3	4.2
Housewife	7.8	7.8
Unemployed	10.1	59.9
Others	21.5	10.2

Transtibial amputations (TTAs) and transfemoral amputations (TFAs) were found to be the most common amputation levels with a similar rate to each other in both single extremity amputees and in the total of the amputees (Table 3).

Of a total of 363 amputations in 307 amputees, 255 had single extremity, 48 had bilateral extremity, and four had triple extremity amputations. The TTA and TFA were the most common amputation levels (Table 4).

Bombing was reported to be the most common etiology of amputation in 89.3% of patients (Table 5).

**TABLE 3**  
Distribution of the amputations by amputation levels

Single	The level and number of amputations		(n)	Within single extremity amputations	Within multiple extremity amputations	Within the total of amputations
	Double	Triple		%	%	%
Hip disarticulation			2	0.8		0.7
Transfemoral			88	34.5		28.7
Knee disarticulation			6	2.4		2
Transtibial			85	33.3		27.7
Ankle disarticulation			1	0.4		0.3
Chopart			9	3.5		2.9
Shoulder disarticulation			2	0.8		0.7
Transhumeral			20	7.8		6.5
Transradial			26	10.2		8.5
Wrist disarticulation			7	2.7		2.3
Partial hand			9	3.5		2.9
Hip disarticulation	Hip disarticulation		1		1.9	0.3
Transfemoral	Hip disarticulation		3		5.8	1
Transfemoral	Transfemoral		9		17.3	2.9
Transtibial	Transfemoral		8		15.4	2.6
Knee disarticulation	Transtibial		3		5.8	1
Transtibial	Transtibial		10		19.2	3.3
Transtibial	Chopart		1		1.9	0.3
Chopart	Chopart		2		3.8	0.7
Transhumeral	Transhumeral		1		1.9	0.3
Transradial	Transhumeral		2		3.8	0.7
Transradial	Transradial		2		3.8	0.7
Transradial	Partial hand		2		3.8	0.7
Transfemoral	Transradial		1		1.9	0.3
Transtibial	Transradial		2		3.8	0.7
Transfemoral	Wrist disarticulation		1		1.9	0.3
Chopart	Partial hand	Partial hand	1		1.9	0.3
Transtibial	Transtibial	Transhumeral	1		1.9	0.3
Transfemoral	Transfemoral	Transhumeral	1		1.9	0.3
Transtibial	Transtibial	Transradial	1		1.9	0.3

**TABLE 4**  
The distribution of amputated extremities according to amputation levels

	n	%
Hip disarticulation	7	1.9
Transfemoral	121	33.3
Knee disarticulation	9	2.5
Transtibial	123	33.9
Ankle disarticulation	1	0.3
Chopart	15	4.1
Shoulder disarticulation	2	0.6
Transhumeral	26	7.1
Transradial	38	10.5
Wrist disarticulation	8	2.2
Partial hand	13	3.6
<i>Total</i>	363	100

Most of the amputations occurred in the period of 2015 and 2016 (Table 5).

## DISCUSSION

It has been reported in regions affected by terror or war, namely Turkey, Iran, Iraq and Pakistan, that the mean age of amputees is low ranging from 17.6 to 29.15 years<sup>[8,19-23]</sup> and the ratio of male amputees is very high ranging from 87 to 92%.<sup>[19,20,24,25]</sup> These studies mostly included the military personnel, which greatly skewed the results toward one direction in terms of age and sex. On the other hand, the mean age of amputations increases in regions where there

is no terror or war ( $\geq 36.5$  years)<sup>[26-29]</sup> and the ratio of male amputees decreases relatively ranging between 75 and 86%.<sup>[27,29-31]</sup>

In reports by a NGO operating in Syria, it was stated that injured individuals were mostly males (83%)<sup>[32]</sup> and 17% of were children.<sup>[33]</sup> Similarly, 18% of the individuals treated in Turkish hospitals due to Syrian Civil War-related injuries between 2013 and 2014 were reported to be children.<sup>[18]</sup> The low mean age of the amputees (25.8 years) and the high ratio of the male amputees (86.6%) in the present study are compatible with the studies conducted in regions where there was war or terror.<sup>[8,19-25]</sup> In the present study, the rate of amputees below the age of 18 years (25.4%) was higher than those of other Syrian Civil War-based studies.<sup>[18,33]</sup> The high rate of child/adolescent amputees in the present study may be associated with the type of the war, i.e., the residential area bombings. These findings indicate that a substantial number of children and adolescents face with the amputation trauma, as well as war-induced trauma and stigma of being a refugee.

In general, war amputations occur in young and healthy individuals.<sup>[22,34]</sup> which increase the importance of medical and rehabilitation interventions.<sup>[12]</sup> The desire of active young individuals with high physical conditions to return to the productive lifestyle after amputation imposes a different function on the social support efforts geared toward young civilian amputees.<sup>[12]</sup> In this study, 23.1% of the amputees were students in Syria before the war and of whom 10.1% were able to continue their education after they left the war zone, revealing the magnitude of the

**TABLE 5**  
Etiology and distribution of the amputations by years

	Single extremity amputation	Multiple extremity amputation	Total
	%	%	%
<b>Etiology of amputation</b>			
Firearms	2	-	1.6
Bombing	87.4	98.1	89.3
Landmines	10.2	1.9	8.8
Terror	0.4	-	0.3
<b>Distribution of the amputations by years</b>			
$\leq 2012$	7.5	5.7	7.2
2013	17.3	19.2	17.6
2014	15.3	7.7	14.0
2015	24.7	21.2	24.1
2016	20.0	32.7	22.1
2017	7.8	7.7	7.8
2018	6.3	5.8	6.2

need for occupational therapy besides psychological and physical rehabilitation. In addition, most of the amputees were workers or tradesmen, while a very low portion of them were unemployed before the war; however, most of them were unemployed in their new lives away from the war zone. Although support is provided in Turkey for the Syrian refugees to get employed easily, the high rate of unemployment among the amputees, possibly caused by their disability and/or refugee status, increases the magnitude of the trauma they experience. Those residing in refugee camps cannot possibly be employed due to conditions in the camps. This finding highlights the importance of the need for unorthodox approaches by the international aid organizations in the long run toward issues, such as employment problems faced by the Syrian refugee amputees.

The low rate of chronic diseases in the present study is a natural outcome of the low mean age of the amputees. However, a very high rate of young amputees in the present study indicates the immense need for prosthesis and orthosis by these individuals in the future which, in turn, highlights the need for a careful planning in this regard.

In studies including United States (US) and United Kingdom (UK) military personnel in various war zones, LEA rates have been reported between 77.5 and 86%.<sup>[10,23,35,36]</sup> The rate of unilateral LEAs induced by traumatic injuries during the Iran-Iraq War was also reported to be high (84%).<sup>[22]</sup> In a study carried out 20 years after the Bosnia-Herzegovina War, where civilians were heavily targeted, amputation was needed in 83.3% of the individuals injured by landmines and most of these amputations (85.7%) involved the lower extremities.<sup>[13]</sup> In another study, 56% of the injuries induced by the Syrian Civil War involved extremities.<sup>[17]</sup> In the global Handicap International (HI) report, it was estimated that amputation was needed in 15% of the injuries induced by explosive weapons.<sup>[33]</sup> In the present study, the rate of LEAs was found to be higher, compared to a study reporting that the rate of amputations occurred in Syrian Civil War-related injuries was 54.5%.<sup>[24]</sup> The reasons for the difference may be the fact that the amputees in the present study were from a wider residential area and the other study included rate only from the period between 2012 and 2015. On the other hand, the rate of single extremity amputations in the present study (74.9%) is lower than that of LEAs occurred in other war zones, including the Bosnia-Herzegovina War.<sup>[10,13,23,35,36]</sup> In studies including Pakistani military personnel, terror

victims in Turkey, and UK/US military personnel in the Iraq and Afghanistan Wars and veterans from the Iraq-Iran War, LEAs have widely been reported and TTA appears to be the most common amputation level reported in these studies (34.6 to 60.9%).<sup>[3,10,19,21,23,35]</sup> In few studies, on the other hand, TFA has been reported to be the most common amputation level (27 to 55%).<sup>[35,37]</sup> In civilian amputations occurred in the Bosnia-Herzegovina War, TTA was reported to be 65.7%.<sup>[13]</sup> In the present study, the rates of TFA and TTA were found to be close, which is a noteworthy difference of the present study compared to the results of previous studies. This outcome is considered as a result of the heavy damage caused by the bombardment methods used in the Syrian Civil War. Landmines used in war zones or in residential areas such as Bosnia-Herzegovina cause foot or TTAs, whereas bombings cause wider injuries in upper parts.

In a study in which only the upper extremity amputations (UEAs) were examined, most of the UEAs occurred in the US military personnel in a 10-year time period were transradial amputations (TRAs).<sup>[34]</sup> On the other hand, in another study, transhumeral amputation (THA) was reported to be the most common amputation level in the US military personnel fought in Iraq and Afghanistan<sup>[35]</sup> and also in the UK military personnel.<sup>[23]</sup> In the Bosnia-Herzegovina War, in which the civilians were targeted, UEAs were reported to be lower than LEAs.<sup>[13]</sup> In this study, the upper UEA rate (24.1%) was also higher than that of previous studies from other war zones.<sup>[13]</sup> The high rate of TRAs among the Syrian Civil War victims reported in this study is similar to the results by Tennent et al.<sup>[34]</sup> however, it contradicts with other studies.<sup>[13,23,35]</sup>

Lower extremities are more susceptible to trauma, as it maintains the relationship between the body and the ground. In war conditions, damages on lower extremities caused by ground-launched explosives are inevitable.<sup>[10]</sup> Landmines usually cause foot or TTAs and they cause relatively less damage. Bombs, on the other hand, may cause greater damage on extremities or the body, and they cause amputations involving knee or hip joints due to their direct damages, as well as due to the damages caused by the secondary effects of the damaged structures.<sup>[10]</sup>

In previous wars where civil casualties were mostly caused by landmines, the UEA rates were also relatively low. Although an extra-effort is put to save upper extremities due to the insufficiency of the upper extremity prostheses in mimicking human

joint functions,<sup>[10]</sup> the high rate of UEAs in this study is noteworthy. In regular wars, the skills of military hospitals for war surgeries result in better abilities in attaining minimal amputations, which cannot be maintained in the Syrian Civil War and, thus, UEAs were observed more in the Syrian Civil War. In this respect, again, the Syrian Civil War is different from other wars of the century.

Multiple extremity amputations in the World War I and Korean War were 2 to 8%<sup>[10]</sup> and multiple LEAs were reported to be higher (18 to 47%) among US military personnel during the Vietnam and Iraq-Afghanistan Wars and in UK military personnel deployed in various war zones.<sup>[10,23,35,37]</sup> This rate among the Turkish military personnel subjected to terrorist attacks was reported to be 13%<sup>[19]</sup> and it was lower (3.5 to 6.5%) among the Pakistani military personnel and also among Iran-Iraq War veterans.<sup>[21,22]</sup> It was reported that bilateral UEA rates ranged between 5 and 5.7% in Iraq and Afghanistan Wars.<sup>[10,35]</sup>

Multiple amputation rate was found to be high in the present study (16.9%). The most common multiple amputations involved lower extremities. Bilateral TTAs and TFAs were the most common amputation levels with similar rates. The rate of multiple amputations involving only bilateral upper extremities was found to be 15.4% of all multiple amputations. With developing technologies, the damaging capabilities of the explosives have been dramatically increased, resulting in an increased rate of mortal bodily injuries. On the other hand, improvements in protective measures and the faster and easier access to surgery centers in battlefields increased the survival rate of mortal extremity injuries by amputation.<sup>[6,10]</sup> The increase in the rate of multiple amputation in parallel with the greater access of war technologies supports this hypothesis. The scarcity of hospitals and surgeons in Syria increased the rate of extremity amputations in cases where the extremity could have been saved. Furthermore, bombings of the residential areas in the Syrian Civil War caused substantial damages in buildings, which might have increased the rate of multiple extremity amputations. In the present study, the most common cause of multiple amputations was found to be bombing (98.1%), which supports this hypothesis. In 2016, the rate of multiple amputations dramatically increased parallel with the intensity of the war. The higher number of single individuals in the multiple amputation group may be associated with their relatively lower mean age.

In the US army deployed in various regions in the world, major amputations were reported to be caused by explosive mechanisms such as landmines (87.9 to 97%),<sup>[7,8,10,34-37]</sup> which was followed by gunshot wounds (3.7 to 4.7%) and a very low number of amputations were caused by motorized vehicle accidents.<sup>[10,34,35]</sup>

In terror/trauma-induced amputations occurred in Turkey, landmines were reported to be the primary cause (92.7%).<sup>[19]</sup> Lower extremity amputations in Pakistani army were mainly caused by traumas (96.7%) and the most common cause was reported to be landmines (59.7%).<sup>[21]</sup> The most common cause of amputations in the Iran-Iraq War was also landmines (61 to 66.6%) and explosives devices (bombs) (23.4 to 25.9%), and the gunshot wounds (7.41 to 15.6%) were also reported among the common causes.<sup>[22,33]</sup> In another study investigating the amputations occurred due the Iran-Iraq War, shells (50%) and landmines (34%) were reported as the major causes, whereas bombings, as a cause of amputation, were reported to be lower (9%).<sup>[38]</sup> In Bosnia-Herzegovina War-related amputations, landmines were found to be the leading cause.<sup>[13]</sup> At the beginning of the Iraq War, mainly due to the bombings by airstrikes and suicide attacks, civilian casualties were reported to be much more than military casualties.<sup>[39]</sup>

In 2012, mostly males (91.4%) were killed in the Syrian Civil War and the leading cause of death was reported as explosives and shrapnel injuries (67.2%), followed by gunshot wounds (26.3%).<sup>[14]</sup> In another study including only children in the Syrian Civil War, causes of death were reported as 70% bombing and shrapnel injuries and 13.6% gunshot wounds.<sup>[15]</sup> In Syrian Civil War-related injuries treated in Turkey, gunshot injury was found to be 70.1% in 2011-2012<sup>[16]</sup> and 64.4% in 2012-2013, whereas gunshot injury was 3%, landmines was 5%, and bombings and other exclusives were 92% in 2012-2015 in the same region.<sup>[24]</sup> In another study in which the substantial numbers of children (18%) were reported as injured during the Syrian Civil War in 2013-2014, blunt trauma (55%) was the main mechanism of injury, although it was also reported that more brutal methods, such as firearms, were also used against children (7.2%).<sup>[18]</sup> In the 2016 report of HI, operating in Jordan and Lebanon as well as the northern Syria, mechanisms of injury were listed as explosive weapons (45.6% bombs and 7.4% landmines), gunshot (20%), and accidents (14%).<sup>[33]</sup> In the Syrian Civil War, although gunshot injuries occurred frequently in the beginning, bombing-

induced amputations increased later on. In the present study, the main cause of amputations was found to be bombings (89.3%), which contradicts with the studies including mainly military personnel<sup>[3,7,8,19,21,22,35]</sup> as well as those including civilians.<sup>[13]</sup> Although the reasons for amputation in the present study were different from the ones reported in studies regarding the early years of the Syrian Civil War,<sup>[16,17]</sup> they were similar to those included in analyses made later.<sup>[24]</sup> The reason for the low rates of landmines among the causes of amputation may be due to demining process previously carried out by Turkey. When the progress of the war is considered, a change in the characteristics of the Syrian Civil War is obvious. In a research by the HI investigating the Syrian Civil War longitudinally, injuries caused by gunshot wounds were reported to be 20%.<sup>[33]</sup> At the onset of the war, gunshot wounds were caused by snipers in regions dominated by terrorist organizations,<sup>[16,17]</sup> but later such injuries were reported to be decreased.<sup>[24]</sup> The lower rate of gunshot wounds in the present study agrees with recent studies.<sup>[24]</sup> During the course of the war, bombings by various governments or terrorist organizations and targeting mostly the civilian regions increased. This outcome also supports the idea that the Syrian Civil War presents quite a different picture in terms of the injury-amputation profile, compared to other wars targeting mostly the civilians. The Syrian Civil War is a war in which civilians were injured mostly due to bombings. In the present study, the majority of the amputees were amputated in the period of 2015-2016, which illustrates the gunshot-to-bombing transition.

Nonetheless, there are some limitations to this study. In this study, database of an NGO was used in Turkey, but restricting the access to the amputees in Syria due to the security concerns, it was not possible to obtain a sampling representing the Syria population. Furthermore, those amputees who already had a prosthesis and did not need to change it did not visit these centers and, thus, the sample partially represented the universe.

In conclusion, Syrian Civil War is the first war in which bombing is the most frequent factor causing civilian amputations. Syrian Civil War displays a different profile compared to other civil wars to date with too many adolescent/children amputations and with surprisingly a high number of UEAs and multiple amputations.

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