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Case Report

Characteristics and outcomes of traumatic major extremity amputations in Chinese population

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Abstract: Objective: The purpose of this study was to elucidate the epidemiological characteristics of amputations caused by trauma in Chinese civilians and provide a reference for clinical work. Methods: A retrospective study of all major extremity amputations in Third Hospital of Hebei Medical University sustained by Chinese civilians from January 2009 to December 2013 was conducted. Data from the medical record system were queried to obtain injury characteristics, demographic information, and treatment characteristics. Results: In total, 71,569 trauma patients who sustained 651 amputations (668 extremities) were identified, with a 0.91% traumatic amputation rate; 238 of these 668 extremities underwent upper extremity amputation. The patients who underwent amputations (n = 651) ranged in age from 10 months to 77 years; most were aged 41 to 50 years. Of these 651 patients, 525 (80.65%) were male. Upper extremity amputations were mainly caused by machinery injuries (171/235, 72.77%), while lower extremity amputations were mainly caused by traffic accidents (297/433, 70.67%). Of all 651 patients, 614 sustained open injuries, and only 37 sustained closed injuries. Of the 668 extremities among the 651 patients, 528 extremities underwent closed amputation and 140 underwent open amputation requiring secondary debridement to close the wound. Conclusion: The overall rate of traumatic major extremity amputation among Chinese civilians of Hebei province was 0.91%. This detailed epidemiological description will be helpful for clinical prevention and treatment.

Keywords: Extremity amputation, trauma, Chinese

Introduction

Traumatic extremity amputation is the last resort for patients who have sustained severe, irreversible limb injury [1, 2]. Numerous studies have analyzed the injury patterns and amputation rates of injured military service members [3-6]. However, the current literature does not adequately address the characteristics of major traumatic extremity amputation among civilians. To the best of our knowledge, only a few such reports have been published in India and Korea [7, 8]. China is the most populous country in the world and has experienced a long period of peacetime. Therefore, the characteristics of major extremity amputation in Chinese civilians will be helpful to establish an understanding of the basic features of such amputations and to facilitation effective prevention and treatment. The purpose of this study was to characterize the epidemiological characteristics of amputations caused by trauma in Chinese civilians and provide a reference for clinical work.

Patients and methods

Using a protocol approved by our institutional review board, all amputations sustained by Chinese civilians from January 2009 to December 2013 were examined. Eligible patients who had undergone major traumatic extremity amputations were identified using the diagnosis and operative code system. The medical notes and X-rays of each patient were retrospectively reviewed.

Patients who had undergone amputation due to cancer, peripheral vascular disease, and congenital malformations were excluded. Patients who had undergone digital and toe amputation were also excluded. The age, sex, mechanism

Table 1. Amputation rate of each year

Year	Traumatic cases	Amputees	Amputation rate
2009	11966	122	1.02%
2010	12337	122	0.99%
2011	13662	130	0.95%
2012	15548	141	0.91%
2013	18056	136	0.75%
Total	71569	651	0.91%

Table 2. Age and gender distribution of amputees

Age group	Gender	Cases	Total (n=651)
≤10	Male	18 (90.0%)	20 (3.1%)
	Female	2 (10.0%)	
11-20	Male	48 (94.1%)	51 (7.8%)
	Female	3 (5.9%)	
21-30	Male	112 (86.2%)	130 (20.0%)
	Female	18 (13.8%)	
31-40	Male	114 (79.7%)	143 (22.0%)
	Female	29 (20.3%)	
41-50	Male	118 (75.2)	157 (24.1%)
	Female	39 (24.8%)	
51-60	Male	66 (70.2%)	94 (14.4%)
	Female	28 (29.8%)	
61-70	Male	39 (90.7%)	43 (6.6%)
	Female	4 (9.3%)	
>70	Male	10 (76.9%)	13 (2.0%)
	Female	3 (23.1%)	

Table 3. Amputation patterns

Position	Quantity (n=?)	Proportion
Hip joint	5	0.75%
Femoral shaft	108	16.17%
Knee joint	48	7.19%
Tibial shaft	245	36.68%
Ankle joint	24	3.59%
Shoulder joint	11	1.65%
Upper-arm	82	12.28
Forearm	119	17.81%
Wrist joint	26	3.89%

of injury, type of injury (open or closed), degree of injury, surgical treatment (open or closed amputation), and amputation patterns were recorded and analyzed. The degree of injury was evaluated with the Mangled Extremity Severity Score (MESS) [9] and Gustilo classification [10] (only for open injuries). The amputation patterns were classified based on the level of the amputation. Generally speaking, an upper extremity amputation included all upper extremity amputation subtypes ranging from wrist disarticulation to shoulder disarticulation, and a lower extremity amputation included all lower extremity amputation subtypes ranging from ankle disarticulation to hip disarticulation. SPSS 19.0 (IBM Corp., Armonk, NY, USA) was used for data analysis and statistical description. No special statistical method was needed in this study.

Results

A total of 71,569 trauma patients who sustained 651 amputations (668 extremities) were identified from January 2009 to December 2013, with a 0.91% traumatic amputation rate. The rate of each year is shown in **Table 1**.

Among the 651 patients who underwent amputations, 525 (80.65%) were male and 126 (19.35%) were female; the male: female ratio was 4.17:1.00. Ages ranged from 10 months to 77 years, with an average age of 39.02 ± 15.12 years. All of the patients were divided into eight groups by 10-year intervals as shown in **Table 2**. Most patients were aged 41 to 50 years.

With respect to amputation patterns, there were 238 upper extremity amputations (35.63%) and 430 lower extremity amputations (64.37%) among all 668 amputations. The most common amputation pattern was a tibial shaft amputation (**Table 3**).

The mechanism of injury is shown in **Table 4**. Upper extremity amputations were mainly caused by machinery injuries, while lower extremity amputations were mainly caused by traffic accidents.

In this study, 614 patients sustained open injuries, accounting for 94.32% of all cases. Gustilo typing and MESS were used to assess the severity of 528 open injuries (**Table 5**). The severity could not be assessed in 86 patients because sufficient data were lost during the long transfer from the local hospital.

Of the 528 open injuries, there was 1 case of type 2A, 5 cases of type 3A, 28 cases of type 3B, and 494 cases of type 3C (95.45%). The MESS of each amputee is shown in **Table 5**. Most of these patients (95.45%) had a MESS of

Table 4. Mechanism of injury

Cause	Upper extremity	Lower extremity	Total
Traffic accident	27 (11.49%)	294 (70.67%)	321 (49.31%)
Machine injury	171 (72.77%)	33 (7.93%)	204 (31.34%)
Crushing	10 (4.26%)	60 (14.42%)	70 (10.75%)
Blast injury	17 (7.23%)	7 (1.68%)	24 (3.69%)
Falling	2 (0.85%)	10 (2.40%)	12 (1.84%)
Sharp injury	5 (2.13%)	1 (0.24%)	6 (0.92%)
Shooting	0	1 (0.24%)	1 (0.15%)
Electrical injury	3 (1.28%)	0	3 (0.46%)
Burn	0	4 (0.96%)	4 (0.61%)
CO poisoning	0	2 (0.48%)	2 (0.31%)
Frostbite	0	1 (0.24%)	1 (0.15%)
Penetration	0	1 (0.24%)	1 (0.15%)
Strangulation	0	2 (0.48%)	2 (0.31%)
Total	235	433	668

Table 5. MESS of amputees with open injuries

MESS	Quantity	Proportion
4	3	0.57%
5	7	1.33%
6	14	2.65%
7	93	17.61%
8	131	24.81%
9	67	12.69%
10	50	9.47%
11	61	11.55%
12	55	10.42%
13	28	5.30%
14	19	3.60%
Total	528	100.00%

MESS: Mangled Extremity Severity Score.

>7, for which amputation is considered obligatory.

Although most patients in this study sustained open injuries, 37 underwent amputations because of closed injuries, accounting for only 5.68% of all cases. Most amputations due to closed injuries were caused by vessel injuries. All were confirmed by angiography in our hospital. These patients had been treated in local hospitals, but the vessel injuries were misdiagnosed. Upon arrival at our hospital, the time from injury was >12 hours, and amputation was the only treatment choice (**Figure 1**). Of the 668 extremities of 651 patients, 528 extremities underwent closed amputation and 140 underwent open amputation requiring secondary debridement to close the wound.

Discussion

The main findings of this study are as follows. The general major traumatic extremity amputation rate among Chinese civilians is 0.91%. These amputations mainly occurred in men aged 41 to 50 years, and the most common amputation pattern was a tibial shaft amputation. Upper extremity amputations were mainly caused by machinery injuries, while lower extremity amputations were mainly caused by traffic accidents. The reason for amputation in patients with closed injuries was misdiagnosis of vascular injuries at the primary hospital. These epidemiological characteristics will be helpful for clinical prevention and treatment.

To the best of our knowledge, this study included the largest sample (n = 71,569) of trauma patients in China. Because our hospital is the trauma center of Hebei province, the patients are well represented. In Chinese culture, major amputation is considered an extremely important personal event; thus, amputation is rarely conducted at the primary hospital. Almost all doctors at the primary hospital will advise their patients to undergo amputation at larger hospitals. These cultural characteristics also increase the representativeness of the study population. We can reasonably hypothesize that the overall amputation rate of Chinese civilians is approximately 0.91%.

Most patients who undergo traumatic amputation are male, and most range in age from 21 to 50 years; these patients accounted for 66.06% of all patients in our study. The reason for this trend was related to the various job specifications among patients of different sexes and ages. Physical and dangerous work is always undertaken by men in this period; thus, the incidence of injury was much higher than in other patient groups. The most common amputation pattern was tibial shaft amputation; this is consistent with similar studies in other countries [7, 8]. The tibial shaft is the most easily injured in traffic accidents, and the increase in the number of private cars in China each year also

Figure 1. Typical case of amputation in a patient with a closed injury. A and B: The patient was 30 years old and had sustained a fracture of the right femoral condyle and left floating knee injury after a traffic accident. C and D: An emergency operation comprising open reduction and internal fixation was performed at a local hospital. E: Both feet had hypoesthesia and a low skin temperature postoperatively; however, this was not addressed at the local hospital until postoperative day 9, at which time the patient was transferred to our hospital. F and G: Angiography showed a double femoral artery injury. H: Double leg amputation.

increases the risk of traffic accidents. Uniquely, however, the forearm amputation rate is still relatively high (17.81%) in Hebei province. The main reason for this phenomenon is machinery injuries. This is becoming more common in China with increasing numbers of young men

working with industrial machinery [11]. Most industrial machinery is present in small paper mills, cement plants, and other small industrial workshops.

During the 5-year period of this study, there were 20 amputations in patients younger than 10 years. Most were caused by firework blast injuries. Fireworks are lit during February and March, which is the time of the Spring Festival in China. More attention should be given to potential injuries during these months. Thirty-seven patients underwent amputations because of misdiagnosed vessel injuries. **Figure 1** presents a typical case illustrating that the skill level of primary care doctors should be further improved, increasing the chance of achieving an early diagnosis of vascular injury to ensure effective limb salvage.

The limitations of this study include its retrospective nature and lack of detailed description of surgical treatment, post-traumatic stress disorder, and disability rating. The retrospective nature of the study was inevitable; however, the lack of the above-mentioned data was because we had inadequate manpower and material and financial resources.

Conclusion

The overall rate of traumatic major extremity amputation among Chinese civilians of Hebei province was 0.91%. The detailed epidemiological description provided in this study will be helpful for clinical prevention and treatment.

Disclosure of conflict of interest

None.

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