

## Etiology and Outcome of Open Fractures of the Extremities: A Single Center, Retrospective Study of 287 Patients

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### Abstract

#### Objectives

To retrospectively evaluate the incidence, mechanism of injury and outcome of all consecutive open fractures of the extremities in patients treated in Ndjamen (Chad) at Hôpital de l'Amitié Tchad-Chine, a single medical center between August 1, 2013, to August 31, 2014.

#### Materials and methods

In 1 year interval, 287 patients (198 males and 89 females) with open fractures were admitted in this trauma center. A retrospective analysis was conducted on data obtained from the medical records, including patient's age, sex, mechanism of injury, types of fractures, grades of fractures, surgical interventions and complications.

#### Results

Among 302 patients admitted with fractures of the extremities during 1 year of the study period, 287 patients had open fractures with an incidence rate of 95.03%. Road traffic accidents were the commonest injuries with 50.52%, followed by interpersonal violence 14.98%, construction site 12.54%, falls from height 11.50% and sports injury 10.45%. Upper limb injuries were 39.38% and Lower limb 60.62%. Surgical debridement, plaster mobilization, external and internal fixation were used in the management of those patients. Only 1 patient was amputated.

#### Conclusion

As lower limb was the most injured part, an early surgical debridement with frequent use of external fixators devices can definitely minimize the rate of complications in such patients. Road safety awareness should be instilled in order to reduce the rate of mortality and morbidity.

**Keywords:** Open fracture; Upper extremity; Lower extremity; Single trauma center

### Introduction

#### Background

Open fractures injuries are the most frustrating cases in orthopedic and trauma field. The most reported causes of these injuries include road traffic accident, interpersonal violence [1], falls from a height [2,3] and sports injuries. Data from literature revealed that up to 90% of the population reported road rage victimization in the United States [1], while road traffic accidents are the main cause of global morbidity and mortality. The road traffic injuries were the 10<sup>th</sup> leading cause of death worldwide in 2002, 9<sup>th</sup> in 2012 and have been expected to become the 8<sup>th</sup> by the year 2030 [4]. According to the World Health Organization, the estimated road traffic deaths rate per 100000

population is 24.1 in Chad [5]. According to the National speed limit law in Chad, the maximum urban speed is 60 km/h, while the maximum rural speed is 110 km/h. For the drink-driving law, the random breath testing is not in place, but the Blood Alcohol Concentration (BAC) is  $\leq 0.08$ g/dl (young or novices drivers  $\leq 0.08$ ). These data are related to the highest rate of road traffic injuries in Chad.

As the open fractures are directly exposed to the external environment, the risks of infection are significantly higher than in closed fractures. In the light of the literature, open fractures should be assessed by the Gustilo Anderson classification. According to the severity of injuries, management should include surgical debridement, delayed wound closure and external fixator device [6]. The study carried out by Godina et al. showed that the successful management of open fractures necessitated immediate debridement and fracture stabilization which definitive soft tissue cover being undertaken within 72 hours [7]. Despite the effort made by surgeons, complications still

occur with the management of open fractures, including infections/osteomyelitis, mal-union or non-union [8].

The purpose of this present study was to retrospectively evaluate the incidence, mechanism of injury and outcome of all consecutive open fractures of the extremities in patients treated in a single trauma center. The management for open fractures of the extremities in the clinical setting depends on the individual case and surgeons experience.

Although road traffic accident and interpersonal violence are among the commonest injuries in this present study, their complications differ significantly. Despite the fact that road traffic accident can lead to external injury, if the internal organs are injured, the patient could bleed from vital organs and can lose a life. Interpersonal violence can lead to external and internal injury as well as mental health. Among the patients who have been exposed to domestic violence, the rate of mental disorder and depression was higher compared to road traffic accident victims.

## Methods

This retrospective study was conducted in a single trauma center (Chad). All medical data of the participants who underwent surgical debridement, plaster of Paris, external/internal fixation or amputation were recorded and kept as confidential documents. Further eligibility assessment was performed based on the following inclusion and exclusion criteria. The time limit was set from August 1, 2013, to August 31, 2014.

Inclusion criteria of the study participants were adults, eligible and with complete data for investigation. Exclusion criteria included: pediatric fractures; incomplete data; fractures of both sides; multiples fractures; femoral neck fractures; scapula and clavicle fractures; Patella fractures and pathological fractures.

The statistical analysis was performed using the SPSS 25 software (SPSS Inc, Chicago, IL). Two independent-samples t-test was performed to evaluate the differences between 2 age groups and gender. Statistically, a significant difference was defined as a P value of <0.05. Graphical representations of data were performed using GraphPad Prism 7 (GraphPad, USA).

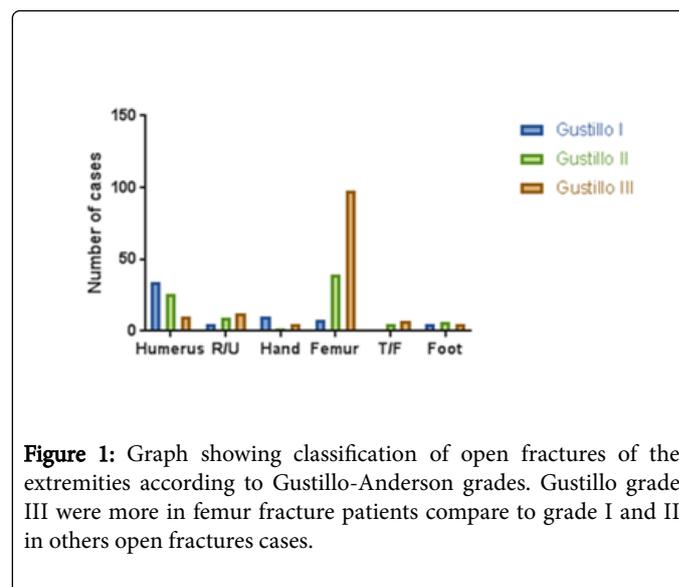
Ethical approval and written consents from the participants were waived due to the retrospective design of our present study. However, their personal information was anonymized and de-identified before analysis. The present study was approved by the ethical medical committee of Hôpital de l'Amitié Tchad-Chine. The study was conducted according to the Declaration of Helsinki.

## Results

A total of 287 patients (198 males and 89 females) were included for the investigation. The average age for all was  $27.88 \pm 7.35$  years (range,

18-49 years). The mean age for males and females was  $28.58 \pm 7.72$  years (range, 18-49 years) and  $26.35 \pm 6.22$  years (range, 18-44 years) respectively.

Among 302 patients presented with fractures of the extremities during the study period, only 287 patients were eligible, with 198 males and 89 females. According to the age distribution of all patients by gender (Figure 1), we found that young adults (18-24 years old, 39.37%) were the most affected by the open fractures of the extremities, with 25.43% (73 patients) of young males and 13.93% (40 patients) of young females, while older people (45-49 years old, 2.44%) were the less affected population.



**Figure 1:** Graph showing classification of open fractures of the extremities according to Gustillo-Anderson grades. Gustillo grade III were more in femur fracture patients compare to grade I and II in others open fractures cases.

Road Traffic Accidents (RTA) were the most common cause of injuries with 50.52% (Vehicle Accident 30.66% and Motorcycle Accident 19.86%) followed by the interpersonal violence representing 14.98%, construction site 12.54%, falls from height 11.50%, sports injuries 10.45%. According to the mechanism of injuries by patients gender, 37.63% (108 patients) of road traffic injuries were males, while 12.89% (37 patients) were females; 11.15% (32 patients) of Interpersonal violence were females, while 3.83% (11 patients) were males; 9.41% (27 patients) of falls from height injuries were males, while 2.09% (6 patients) were females; 12.2% (35 patients) of construction sites injuries were males, while 0.35% were females (Table 1).

Age groups	18-24	25-29	30-34	35-39	40-44	45-49	Total
Males							
VA	27(9.4)	11(3.83)	11(3.83)	6(2.09)	4(1.39)	3(1.05)	62(21.6)
MA	17(5.92)	8(2.78)	0	15(5.23)	2(0.7)	4(1.39)	46(16.03)
IV	5(1.74)	4(1.39)	1(0.35)	1(0.35)	0	0	11(3.83)

SI	7(2.43)	4(1.39)	2(0.7)	2(0.7)	2(0.7)	0	17(5.92)
FH	10(3.48)	8(2.78)	5(1.74)	3(1.05)	1(0.35)	0	27(9.41)
CS	7(2.43)	12(4.18)	13(4.53)	2(0.7)	1(0.35)	0	35(12.2)
Females							
VA	9(3.13)	6(2.09)	5(1.74)	4(1.39)	2(0.7)	0	26(9.05)
MA	3(1.05)	7(2.43)	0	1(0.35)	0	0	11(3.83)
IV	19(6.62)	7(2.43)	3(1.05)	3(1.05)	0	0	32(11.15)
SI	6(2.09)	4(1.39)	2(0.7)	1(0.35)	0	0	13(4.53)
FH	3(1.05)	2(0.7)	1(0.35)	0	0	0	6(2.09)
CS	0	1(0.35)	0	0	0	0	1(0.35)
VA: Vehicle Accident, MA: Motorcycle Accident, IV: Interpersonal Violence, SI: Sport Injury, FH: Fall From Height, CS: Construction Site, numbers in brackets are in percentage							

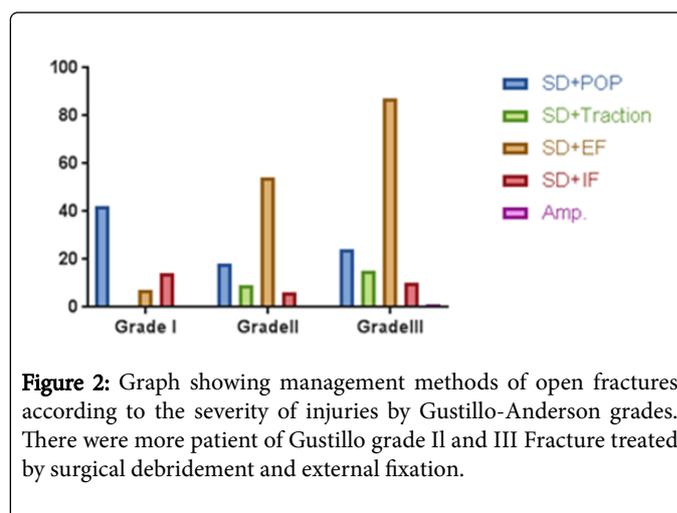
**Table 1:** Mechanism of Injuries according to age group and gender.

Table 1 shows that males are the most injured of road traffic accident among participant (37.63%). While females accounted for 12.89%, Interpersonal violence as a cause of injury accounted for 11.15% (males) and 3.83% (females), Construction site injuries with 12.2% (males) and 0.35% (females). Young males adults (18-24years old) are the most predisposing to the road traffic accident (15.32%), while young females adults (18-24years old) accounted for 4.18%.

The lower limb was the most affected site with 60.62%, while the upper limb was only 39.38%. On the lower limb, femur injuries were 50.54%, followed by the bones of foot (ankle, talus, calcaneus, midfoot, metatarsus, toes) injuries 5.56% and Tibia/Fibula injuries were 4.52%. On the upper limb, humerus injuries were 24.38%, Radius/Ulna 9.08% and bones of hand (carpus, metacarpus, fingers) 5.92%.

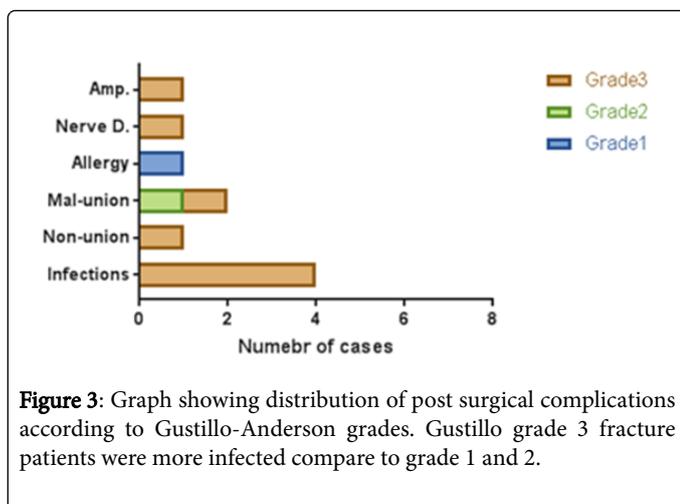
According to the extremities injuries by side, we found that 51.21% (147 patients) of injuries were located on right side, while 48.79% (140 patients) of injuries were located on left side. Our result revealed that 47.73% of fractures injuries were Gustilo III (Femur 34.15%, Humerus 3.48%, Radius/Ulna 4.18%, bones of hand 1.74%, bones of foot 1.74% and Tibia/Fibula 2.44%), Gustilo II injuries were 30.32% (Femur 13.59%, Humerus 9.06%, Radius/Ulna 3.13%, bones of hand 0.7%, Tibia/fibula 1.74% and bones of foot 2.1%), while 21.94% of the injuries were Gustilo I (Femur 2.78%, Humerus 11.85%, Radius/Ulna 1.74%, Tibia/Fibula 0.35%, bones of foot 1.74% and bones of hand 3.48%). Briefly, grade III was the most recorded cases in our study (Figure 1).

Surgical debridement and external fixator device were the most used technique in the management of open fractures in this study under the use of prophylactics antibiotics in all cases (51.56%), seconded by surgical debridement and the use of Plaster of Paris with 29.27%. The surgical debridement and Open Reduction with Internal Fixation (ORIF) were the third options in all the treatment of open fractures with 10.45%, followed by surgical debridement and traction with 8.36%, surgical debridement and amputation were 0.35% (Figure 2).



**Figure 2:** Graph showing management methods of open fractures according to the severity of injuries by Gustillo-Anderson grades. There were more patient of Gustillo grade II and III Fracture treated by surgical debridement and external fixation.

In this study, various complications of open fractures have been observed. According to the classification of Gustilo-Anderson, 2.44% of complications were Grade III, followed by Grade I (0.35%) and Grade II (0.35%). The most common complications were Infections (osteomyelitis) with 1.39% (4patients), Non-union and Mal-union were 0.35% respectively, followed by allergy 0.35% (1 patient) due to the use of Plaster of Paris, nerve injury (1 patient, 0.35%) and amputation (1 patient, 0.35%) (Figure 3). According to post-surgery complications regarding the type of fractures, Tibia/Fibula injuries were the most common complications (4 patients, 1.39%), followed by Femur injuries (2 patients, 0.7%).



**Figure 3:** Graph showing distribution of post surgical complications according to Gustillo-Anderson grades. Gustillo grade 3 fracture patients were more infected compare to grade 1 and 2.

## Discussions

Open fractures injuries continue to register significant complications in the field of orthopedic and trauma surgery. In this single-center retrospective study of 287 fractures, the rate of infections and Gustilo III grade injuries were associated with non-union, mal-union and delayed bones healing. As we know, the incidence of open injuries according to patients age and gender differs considerably among countries or regions. In our study, the most recorded gender exposed to open injuries was males population with 68.99%, while females population were 31.01% during the study period. Even in accordance with the causes of injuries, our data showed that males populations were the commonest gender victims of road traffic accidents. Data from literature revealed that men are more involved in outer activities occupations predisposing them to accidents [9]. Similar findings have been reported in Uganda, Kenya and Ethiopia males outnumber females by a factor of 2-7, and 70% of road traffic accident injuries are in males in Barcelona, Spain [10] and 71% in the United States [11]. In Saudia Arabia, a road traffic accident has been recorded as the third leading cause of death [12]. However, the most listed factors involving road traffic accident in Chad are incivism, driving under the influence, traffic violation, driver fatigue, speeding, using mobile phones when driving, driving under 18 years old.

Interpersonal violence was the second commonest cause of the open fractures injuries recorded in our study with 14.98% caused by domestic violence (wife beating) and road rage. Similar findings have been reported that men are more likely to show aggressive behavior in road traffic [13,14]. According to the World Health Organization, over 90% of violent offenses in road traffic are caused by males [15].

Femur represents the most common long-bone injury in both genders with 50.54% followed by Humerus 24.38% and the radius/ulna 9.08%. Our findings are in contrast with studies carried out by numerous authors showing that radius was the most common long bone injury [16-18], stating that sporting activities and falls were the main mechanisms of these injuries. We believe that the mechanism of injuries differs among countries. However, a road traffic accident was the main mechanism increasing the high rate of femur injuries in our investigation with the high peak of males population (18-24 years).

Among 287 patients, 1 patient was amputated due to a severe tibial injury (Gustilo IIIC) caused by a road traffic accident in which the

limb was difficult to be saved. In order to preserve patient life, the Mangled Extremity Severity Score (MESS) was clinically assessed.

We found that 9 (3.14%) of 287 patients have developed various post-surgery complications such as infections (4 patients, 1.39%), non-union (1 patient, 0.35%), mal-union (1 patient, 0.35%), allergy (1 patient, 0.35%), nerve injury (1 patient, 0.35%) and amputation (1 patient, 0.35%). The lower limb was the most common complications, tibia, and fibula (1.39%), followed by the femur (0.7%) and the bones of the foot (0.35%). Additionally, gram-negative rods and gram-positive *Staphylococci* were the commonest organisms involving open fractures injuries. Although these complications, pin tract infection observed in 2 of our patients with external fixator was managed, a correction action including relieving Plaster of Paris (POP) cast pressure and physiotherapy to restore normal function of muscle in a patient with nerve damage was undertaken. The nerve damage described after surgery in this present study can be explained by the direct compression of POP cast pressure. We support the findings reported by Date and colleagues [19] stating that the fibula is surrounded by muscles all around and has abundant blood supply from the nutrient branch of peroneal artery and circular anastomosis of musculo-periosteal vessels, which supports the early union of the fibula. In this study, the tibia had undergone non-union because of the early union of fibula bone.

As compared to interpersonal violence, road traffic accident seriousness is visible because it is the most dangerous and life-threatening injury.

Surgical debridement and external fixators were the frequent modes of treatment used in our trauma center. According to our experience, we believe that immediate debridement of lower limb injuries is necessary to avoid infections, and on top of that the speed of the transport of patients to a trauma center is also capital.

This present study had some limitations. Firstly, the sample size of the current study still limited, which may affect the outcomes. Moreover, this study only selected one trauma center and it should be noted that more trauma centers may affect the incidence and outcomes for open fractures of the extremities. However, considering the limited sample of the present study, larger sample sizes should be necessary to realize a more accuracy outcome.

## Conclusion

Open fractures etiology differs among countries or regions as well as management differs among surgeons. In our case, young males adults were the most predisposing to the road traffic accident compared to females. The victims of interpersonal violence are mostly women, and they had a higher rate of mental disorders and depression compared to road traffic accident victims. Surgical debridement, external fixator, and Plaster of Paris protocol were the most used technique in the management of open fractures in this study under the use of prophylactics antibiotics. The authors propose that health professionals and all media are ideally placed to sensitize the population on drinking patterns and the use of health service settings to avoid and reduce road traffic accident as well as violence related injury and alcohol problems.

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