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Research Article

Gunshot Injuries: Patterns, Presentations, and Outcomes of Civilian Hospital Experiences in a Developing Country Setting

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Abstract

Background: Gunshot injuries are considered a health burden as well as one of the intricate emergencies in civilian medical practice. In this study, we aim to determine the pattern of presentation and management outcome in a general hospital setting in a sub-Saharan African country.

Methods: This is a retrospective, hospital-based study conducted between January 2015 and December 2019 in a general teaching hospital to review the clinical presentation and management outcome of gunshot injuries. All patients' records were reviewed during the study period.

Results: The total number of patients involved in the study was 157 with 83% male predominant. About 50% were from the age group 20–29 years that were most affected. The commonest anatomical site affected in the study was the lower limb (41.4%) and upper limb (22.9%), and most of the patients had been diagnosed with limb fractures (49.7%) and soft tissue injuries (28.7%). Wound debridement is the commonest procedure performed for 91 (58.0%) patients. The site of the pullet has a significant relation to the management outcome with a *P*-value of 0.002. Additionally, about 45% (72 patients) have stayed more than 20 days and it was affected significantly by the types of treatment provided, which has a significant relation to a hospital stay with a *P*-value of 0.00.

Conclusion: Most of the patients in this study were young males. Upper and lower limb fractures were the most common presentations. Wound debridement, bone fixation, and laparotomy were the most common treatments with significant success rates, despite prolonged hospital stays.

Keywords: epidemiology, gunshot injuries, gunshot wound, sub-Saharan countries, Sudan

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1. Introduction

Trauma and accident injuries are a primary health problem worldwide, it affects young people and often lead to premature deaths or disabilities [1]. One of the etiological factors of trauma is gunshot injuries happening worldwide in developed and developing countries with different rates and causes [2]. In the African context, it has been reported in countries such as South Africa [3], Nigeria [2], Tanzania [4], Kenya [5], and Sudan [6].

Gunshot injuries and firearms are considered a major problem and health concern in Africa, especially in sub-Saharan countries because millions of weapons circulate outside the regular military or organized armies [5, 6]. It is now more common than in the past and contributes to significant increases in morbidity and mortality. Prevalent causes of gunshot injuries in Africa include communal clashes, military violence, armed robberies, and political conflicts [2]. Gunshot injuries can be classified anatomically according to the site of the body affected. Such common sites include the head, neck, pelvis, limbs, or multiple regions combined, which have high morbidity and mortality rates [3, 6, 7]. Management outcome and treatment modalities of gunshot injuries depend mainly on the size, severity, and treatment options. In Sudan, the incidence of injuries for different causes was 82.0/1000 people per year, with a low socioeconomic status population placed at an increased risk. There is a lack of reliable resources documenting injury-related deaths [8]. Regarding gunshot injuries in Sudan, there is no study that we know that has documents and reports the incidence, causes, or outcome. So, we look for evidence-based data to plan and promote management and prevention protocols. This study was conducted to investigate the pattern of gunshot injuries and their impact on case management, along with patient morbidity and mortality.

2. Materials and Methods

2.1. Study design

This retrospective, hospital-based study was conducted between January 2015 and December 2019 in Elobeid Teaching Hospital to review the clinical presentation and case management outcomes of gunshot injuries. All the patients' records were reviewed during the study period and were followed up for one year.

2.2. Setting

Emergency and trauma patients were referred to the Elobeid Teaching Hospital emergency department to receive urgent care. Elobeid Teaching Hospital is the oldest and biggest hospital in the Kordofan region and is owned and operated by the North Kordofan state. It provides services for 3,140,177 people (estimated in 2016) who live in an area of 185,302 km^2. Patients included in this study have been referred to the hospital from the states of Kordofan and Darfur. The hospital is comprised of an accident and emergency department, radiological department, laboratory center with a blood bank, surgical specialty department, medical specialty department as well as an operation complex with an intensive care department. However, there is no prehospital referral system to the hospital.

2.3. Inclusion and exclusion criteria

All patients who presented to the hospital with gunshot injuries, resulting from civilian altercations, during the study period and received treatment in the hospital were included. Patients who were dead at the time of presentation were excluded from the study population.

2.4. Clinical assessment

The primary assessment was done for all patients presented to the emergency department through the Advanced Trauma Life Support protocol. The emergency team checked each patient's airways, breathing, circulation, and disability. Following the primary assessment, a primary investigation was done after the patients were stabilized. The emergency department performed emergency procedures such as chest tube insertions, surgical toilets, and abdominal wound explorations under local anesthesia. Lastly, the patients were categorized, according to their condition, to receive further treatment by the General Surgery or Orthopedic Units for any additional necessary surgeries or follow-ups.

2.5. Operative treatments

In cases of abdominal injury or internal bleeding, operative surgeries such as laparotomy are urgently performed. Orthopedic operations are typically done within three to five

days. Optimization of patients was done preoperatively (to replace the blood loss) and reviewed by an anesthetist, who then further requests relevant investigations. Following the optimization, patients will be followed by the responsible units, which will assess the patients in the outpatient clinic in intervals of two weeks, one month, three months, six months, and one year depending on their condition.

2.6. Data collection and analysis

Flowchart sheets were used to collect the baseline characteristics of the patients. Age, sex, residence, education, and occupation were checked. Information regarding the site of the bullet, condition at the time of presentation, diagnosis, complications, and outcomes was determined. Types of operation and intervention were determined based on each case. The data collected were entered and analyzed using the SPSS version 21 statistical software (IBM Corporation, Chicago, IL). Results were tabulated and presented as frequencies and percentages, accordingly. For each test, $P < 0.05$ was considered statistically significant (95% CI).

3. Results

A total of 157 patients were diagnosed with gunshot injuries and included in the study. The mean age of patients was 27.7 years, ranging from 1 to 65 years. The most common age group was 20–29 years (31.8%) followed by age groups 30–39 and 10–19 with 26.1% and 22.3%, respectively. All patients' characteristics are shown in Table 1. Most of the patients in this study were males 87.9% and 46.2% of them were married. In this study, 25% of the patients were residents of Elobeid city while the rest were from outside the city. About two-thirds of the patients were either illiterate (36.1%) or had primary school-level education (37.3%), while some worked as farmers or laborers (36.1% and 28.5%, respectively).

Table 2 demonstrates the anatomical site of gunshot wounds, diagnosis, and treatment done for the patients. The anatomical site of the wounds was found mainly in the lower limbs and upper limbs in 65 patients (41.4%) and 36 patients (22.9%), respectively. Additionally, the least common wound site is the perineum with only three (1.9%) patients being affected. The most common diagnosis among patients in this study were limb fractures and soft tissue injuries among 78 (49.7%) and 45 (28.7%) patients, respectively. There were three patients diagnosed with a head injury. Specific treatments in this study included wound debridement which was done for 91 (58.0 %) patients. Other treatments

included bone fixation, laparotomy, and chest tube insertion which were done for the rest of the patients. There is a significant correlation (*P*-value < 0.05) between the final management outcome and the site of the gunshot (Table 2).

More than 120 (75%) patients were treated and discharged in a good condition and 27 (17.2%) were referred to specialized centers for further treatment. Figure **1** presents the relation between the patient's diagnosis and the treatment outcomes or referral to other hospitals. We found that about five (3.2%) patients were discharged against medical advice and five (3.2%) additional patients died. It was also found that about 45% (72 patients) stayed more than 20 days owing to their diagnosis and treatment options; hospital stay is demonstrated in Table 3. The longest hospital stay (>20 days) was found in patients who had been diagnosed with limb fractures or soft tissue injuries with 38 and 19 cases, respectively. Furthermore, the treatments provided affected the hospital stay, wound debridement, and external or/and internal fixators were found to be the commonest surgical procedures. A significant correlation (*P*-value < 0.05) was found between hospital stay and treatment.

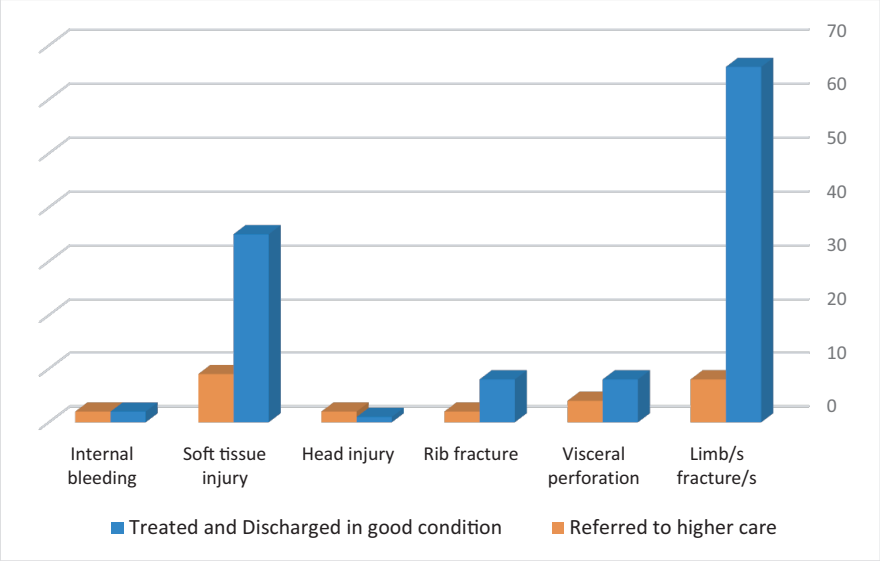

Figure 1: Patients who were treated or referred based on their diagnoses.

4. Discussion

Gunshot injuries represent a major health problem worldwide, with direct burdens on health services and the economy [9, 10]. Sudan is considered one of the sub-Saharan countries affected by internal conflict; as a result, gunshot-related injuries and mortalities are more common [11].

Table 1: Patient characteristics (*N* = 157).

Variables		Frequency	Percentage (%)
Age groups (yr)	0–9	8	5.1
	10–19	35	22.3
	20–29	50	31.8
	30–39	41	26.1
	40–49	14	8.9
	>50	9	5.7
Gender	Male	138	87.9
	Female	19	12.1
Marital status	Single	54	34.2
	Married	73	46.2
	Divorced	6	3.8
	Widow	3	1.9
Residence	Urban	40	25.3
	Rural	118	74.7
Level of education	Illiterate	57	36.1
	Primary school	59	37.3
	Intermediate school	24	15.2
	Secondary school	11	7.0
	Under school age	7	4.4
Occupation	Labor	45	28.5
	Farmer	57	36.1
	Student	14	8.9
	Housewife	17	10.8
	Employer	4	2.5
	Non-employer	21	13.3

Conflicts tend to arise due to different tribes and ethnic groups competing for basic resources in one place. Poverty increased due to intolerance in the community and armed robberies are all considered to be important factors leading to increased gunshot violence in different parts of the country [6]. To the best of our knowledge, there are no studies that determine the extent of firearm injuries in Sudan. In this study, we reviewed the data (clinical presentation, treatments, and management outcome) of 157 patients who presented to the hospital with gunshot wounds due to various causes between January 2014 and January 2019 to assess the pattern, causes, management, and outcome. The total number of patients reviewed in this study is the same or slightly higher than some available national and international [12, 13] data, but still less than the reported number from the USA and South Africa [7, 14, 15].

Table 2: Management outcome in relation to the site of pullet, diagnosis, and treatment.

Variables		Management outcome				Total	P-value
		Treated	Referred	DAMA*	Died		
Site of pullet	Upper limb	33	0	3	0	36	0.002**
	Lower limb	55	9	1	0	65	
	Thorax	10	4	1	0	15	
	Abdomen	12	7	0	5	24	
	Back and spine	4	2	0	0	6	
	Head and neck	4	4	0	0	8	
	Perineum	2	1	0	0	3	
Diagnosis	Limb fracture	66	8	4	0	78	0.991
	Visceral perforation	8	4	0	4	16	
	Rib fracture	8	2	0	1	11	
	Head injury	1	2	0	0	3	
	Soft tissue injury	35	9	1	0	45	
	Internal bleeding	2	2	0	0	4	
Treatment	Wound debridement	70	14	5	2	91	0.823
	Internal fixation	6	1	0	0	7	
	Eternal fixation	16	0	0	0	16	
	Laparotomy	9	6	0	3	18	
	Chest tube insertion	7	4	0	0	11	
	Internal & external fixation	12	2	0	0	14	

*DAMA, discharged against medical advice**Correlation is significant at the 0.05 level.

Gunshot injuries affect all age groups at different stages of life but are more prevalent in younger age groups [15]. The most common age group affected by gunshot injury in this study is the younger age which is in line with that reported previously by other studies [6, 15]. However, 18% of the study's participants are comprised of the pediatric age group.

Interestingly, our numbers, with regard to gunshot injuries in pediatric patients, are similar to a report from South Africa [14]. Like other previous studies [6, 9, 13, 15–17], our data revealed that males were disproportionately affected, and this could be explained by their outdoor presence most of the time because of societal gender roles.

The commonest anatomical site not affected in the body by nonfatal firearm injuries are the extremities of the upper or lower limbs, including soft tissue as well as bone tissue [7]. In this study, the lower limb followed by the upper limb is the most commonly injured (65%). Conversely, the perineum was found to be the least affected site (2%). These findings are like those reported in previous literature [6, 8, 14]. However, results

Table 3: Hospital stay related to diagnosis and treatment.

		Hospital stay						
		0–5 days (N = 28)	**6—10 days (N = 29)**	**11–15 days (N = 16)**	**16–20 days (N = 12)**	**>20 days (N = 72)**	**Total**	**P-value**
Diagnosis	Limb fracture	11	13	8	8	38	78	0.465
	Visceral perforation	3	3	2	3	5	16	
	Rib fracture	0	1	2	0	8	11	
	Head injury	3	0	0	0	0	3	
	Soft tissue injury	10	12	4	0	19	45	
	Internal bleeding	1	0	0	1	2	4	
Treatment	Wound debridement	19	21	9	7	35	91	0.00**
	Internal fixation	1	1	3	0	2	7	
	External fixation	0	2	2	0	12	16	
	Laparotomy	4	2	1	4	7	18	
	Chest tube insertion	2	1	1	0	7	11	
	Internal & external fixation	2	2	0	1	9	14	

**Correlation is significant at the 0.05 level.

from a study done in Sudan, during the period of civil demonstrations, showed only one patient with a gunshot wound in the lower extremity hip bone [18]. The extent of injury and tissue damage following gunshots depends on several factors such as wound ballistics, tissue structure, and the respective anatomical relationships [19]. Our data showed limbs fracture with local soft tissue injuries as the most common presenting diagnosis, followed by visceral perforations, rib fractures, and head injuries. These findings are similar to those of studies conducted previously [8, 14, 15].

Furthermore, a study done by Livingstone *et al.* in a major trauma center in the USA showed that 75% of patients admitted with gunshot wounds underwent at least one surgical intervention procedure [20]. Almost all our patients underwent one or more surgical intervention(s) ranging from minor wound debridement to exploratory laparotomy. Other surgical procedures included bone internal, external fixation or both, and chest tube insertion. However, some other reports showed only 53% of the patients required a surgical intervention [7]. The economic aspect of prolonged hospital stays and their burden on the healthcare system was addressed. About half of the patients in our study stayed in the hospital for more than 20 days. This is a significantly long

hospitalization period in comparison to other studies [17, 21]. However, this long stay can be explained by the presence of open limb fractures which usually need external fixation and frequent wound debridement and dressing. The overall outcome of the patient in our data was good, where 75% of patients were treated and discharged in a good condition. About 17% of patients were referred to specialized centers for further management that is not available at our medical center.

Suicidal attempts are the commonest cause in developed countries [22]. However, armed robbery attacks were found to be the commonest cause of gunshot injuries based on published data from Nigeria and some other African countries. [22] In this study, our findings are not in agreement with the previous studies showing personal enmity to be the more common cause of gunshot injuries. This could be explained by the presence of many interpersonal conflicts in these regions mostly due to different social reasons.

According to reports from developed countries, firearm injuries have the highest case fatality rate in every age group, with a mortality rate ranging between 5.5% and 15.3% [13, 23]. Furthermore, studies done in Libya, Tanzania, and South Africa showed a gunshot mortality rate of 4.5% to 8.3% [18, 22, 24]. In our data, the mortality rate was 3.2%, which is comparable to the lower limit of these data. This could be explained by the fact that we include only the deaths that occur following the patient's admission to the hospital and exclude any deaths occurring at the arrival or shortly after that which could tell us into survival bias. The deaths in our study population occurred within the first and second weeks of injury. According to national and international studies, all five deceased patients had gunshots to the abdomen, which are known to carry high morbidity and mortality rate [6, 25, 26]. Laparotomy was done for those patients with findings of internal organ injuries. One patient underwent chest tube insertion in addition to laparotomy for an associated chest injury.

5. Conclusion

The patients in this study were mostly young males, with personal enmity being the common cause of injury. Upper and lower limb fractures were the most common presentations. Wound debridement, bone fixation, and laparotomy were the most common treatments with significant success rates, despite prolonged hospital stays. A protocol for a severity scoring system is important to be established to properly assess the patients at the time of presentation. A prospective study is needed to effectively

evaluate the mortality rate and prehospital services or ambulance system is paramount to decreasing death occurring during patient transportation.

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Ethical Considerations

Ethical approval was obtained from the Elobeid Teaching Hospital to review patient records and use the data mentioned in the Methods section of the article.

Competing Interests

The authors of this study have no financial relationships or conflicts of interest relevant to this article to disclose.

Availability of Data and Materials

Available upon request.

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