Scientific Research Publishing

Open Journal of Stomatology, 2023, 13, 342-352
https://www.scirp.org/journal/ojst
ISSN Online: 2160-8717
ISSN Print: 2160-8709

Management of Maxillofacial Gunshot Trauma in the Stomatology and Maxillofacial Surgery Departments of Ouagadougou

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How to cite this paper: Millogo, M., Idani, M., Coulibaly, A., Dargani, M.F., Sanfo, M. and Konsem, T. (2023) Management of Maxillofacial Gunshot Trauma in the Stomatology and Maxillofacial Surgery Departments of Ouagadougou. *Open Journal of Stomatology*, **13**, 342-352.
https://doi.org/10.4236/ojst.2023.1310028

Received: August 31, 2023
Accepted: October 9, 2023
Published: October 12, 2023

Abstract

Introduction: Maxillofacial ballistic trauma is a serious injury that is difficult to manage, with significant complications and after-effects. The authors report their experience in managing this type of trauma in the context of insecurity linked to terrorism. **Patients and Methods:** This was a descriptive cross-sectional study with retrospective data collection covering the period from January 1, 2018 to December 31, 2022 in the stomatology and maxillofacial surgery departments of the university hospitals of Ouagadougou. **Results:** In 5 years, 52 patients were collected, *i.e.* 10.4 cases per year. The mean age of the patients was 31.46 ± 15.41 years, and the sex ratio was 3. In 67.31% of patients, these injuries were the result of shootings during terrorist attacks. The jugal (36.54%) and chin (32.69%) regions were the most affected. The mandible (36.54%) and zygomatic bones (28.85%) were the most injured bones in these traumas. All patients underwent surgical treatment, and 25% suffered secondary complications. All patients retained at least one sequela. **Conclusion:** Maxillofacial injuries caused by ballistic trauma are true emergencies that can be life-threatening and functionally disabling. Their management is delicate and the outcome is uncertain, hence, the prevention is important.

Keywords

Gunshot Trauma, Maxillofacial, Facial Fracas, Terrorism

1. Introduction

Maxillofacial gunshot injuries are serious penetrating injuries caused by a firearm projectile. These projectiles can be of various types: bullets, pellets, buck-

shot, metal fragments from the lining or contents of an explosive device (grenade, mine, shell, bomb, etc.) [1]. This type of trauma is generally described among soldiers during armed conflicts. In peacetime, they are rare and reported during attempts at autolysis, assaults or hunting accidents [2] [3]. In Burkina Faso, for almost a decade now, we have been witnessing an upsurge in these traumas due to the context of violent extremism characterized by terrorist attacks over a large part of the country, affecting both civilian and military populations [4] [5].

These traumas constitute serious maxillofacial emergencies, due to their life-threatening and impressive nature. The extent and severity of injury depend on the type of projectile, the distance of the shot, the kinetics, the point of impact, and the resistance of surrounding tissues and organs. Maxillofacial damage is a source of complex lesions, affecting all facial and even craniocervical structures [6]. In the short term, these lesions can be life-threatening or functionally disabling for one or more organs [3] [6]. From a distance, the challenge lies in functional and aesthetic rehabilitation [7] [8]. The management of this type of trauma requires a multidisciplinary emergency approach, including well-coordinated resuscitation measures and sequenced surgical procedures [6] [8]. Surgical management is often iterative and often requires complex reconstructive procedures [8] [9]. In our context, optimal management of these injuries remains a challenge, given the limited technical platforms available. The aim of this study is to report the therapeutic and evolutionary modalities of these serious injuries in the context of insecurity and medical under-equipment.

2. Patients and Methods

This is a descriptive cross-sectional study with retrospective data collection covering the period from January 1, 2018 to December 31, 2022 in the stomatology and maxillofacial surgery departments of Ouagadougou city's university hospitals.

The study was carried out in the first half of 2023 in the CHUs of Yalagado Ouédraogo, Tengandogo and Bogodogo. All patients treated and regularly followed up for maxillofacial gunshot trauma from 2018 to 2022 were included. Data were collected using data collection forms and patient interviews.

All patients treated, regularly followed up and with complete clinical documentation were included. Data were collected from patients' clinical records, operative report registers and patient interviews. Any injury to the maxillofacial sphere caused by a projectile from a firearm or explosive device was considered a maxillofacial gunshot wound. Epidemiological (age, sex), clinical (etiologies, delay in consultation, lesions, imaging), therapeutic (delay in management, type of treatment, number of surgical interventions) and evolutionary (complications, sequelae) variables were collected. Only patients whose clinical records could be used were included in the study. In order to collect all sequelae without bias, their evaluation was done through a direct interview between the patient and a neutral practitioner. Data were analyzed using Epi Data software.

3. Results

In 5 years, we collected 52 cases of maxillofacial ballistic trauma, *i.e.* 10.4 cases per year. The average age of the victims was 31.46 ± 15.41 years, with extremes of 7 and 75 years. The sex ratio was 3. These injuries were caused by shootings during terrorist attacks (48.08%), armed attacks (30.77%), explosive device blasts (19.23%) (**Figure 1**), and accidents (stray bullet) (1.92%).

The average consultation time was 37.04 hours, with extremes of 3 and 240 hours.

An entry orifice was found in 43 patients (82.69%) and an exit orifice in 8 (15.38%) (**Table 1**, **Figure 2**). In 9 patients, it was impossible to distinguish these orifices. Lackmann type IVb lesions 86.54% (**Figure 3**), bone lesions 86.54% and lesions of noble organs 42.31% were the most frequent (**Table 2**). Bone lesions included fractures in 17 patients (32.69%), complex fractures in 20 patients (38.46%) and mono-focal fractures in 8 patients (15.38%). The mandible was involved in 36.54% and the zygoma in 28.85% of cases (**Table 3**).

Immediate complications included 5 cases (9.6%) of motor disorders, including 3 cases (5.77%) of oculomotor disorders and 2 cases (3.85%) of facial paralysis. Fourteen (26.92%) patients presented sensory disorders, including 8 cases (15.38%) of labiomental anesthesia and 6 cases (11.54%) of infraorbital hypoesthesia. Thirty-seven patients (71.15%) had extra-facial lesions, including 18 cases (34.62%) of cranial lesions, 10 cases (19.23%) of cervical lesions, 7 cases (13.46%) of limb lesions and 2 cases (3.85%) of thoracic lesions.

CT scans were performed in all patients, and revealed the projectile in 34 (65.38%) and metallic debris in 10 (19.23%) (**Figure 4**).

The average time to surgery was 5 days, with extremes of 3 hours and 41 days. Management was multidisciplinary in the case of associated lesions, and included debridement in all patients, osteosynthesis in 21 and orthopedic treatment in 13 (**Table 4**). Secondary complications such as suppuration in 8 patients, sepsis in 4 patients and pulmonary emboli in 1 patient were noted and successfully managed.

Figure 1. Maxillo-facial trauma caused by an improvised explosive device, multiple entry orifices with damage of the right eyeball.

Table 1. Distribution of patients according to location of entry and exit orifices.

Location	Number	Frequency (%)
Entry Orifice		
Cheek	16	30.77
Chin	13	25
Nose	4	7.69
Ear	4	7.69
Eye	2	3.85
Lip	2	3.85
Neck	2	3.85
Exit Orifice		
Chin	3	5.77
Cheek	2	3.85
Lip	1	1.92
Nose	1	1.92
Eye	1	1.92

Figure 2. Left jugal entry orifice.

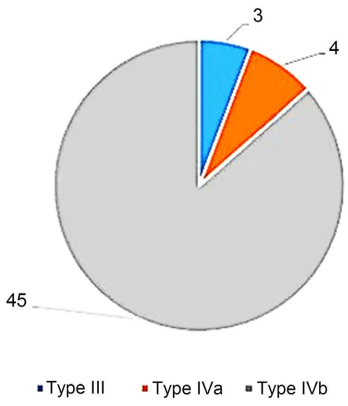

Figure 3. Distribution of lesions according to the Lackmann classification.

Table 2. Distribution of patients according to the injured structures.

Injured Structures	Number	Frequency (%)
Nerves	9	17.31
Salivary glands	7	13.46
Tongue	4	7.69
Vessels	2	3.84
Bones	45	86.54
Teeth	19	36.54
Nose	6	11.54
Eye	4	7.69

Table 3. Distribution of patients according to bone lesions.

Location	Number	Frequence (%)
Mandibular	19	36.54
Orbito-zygomatic	15	28.85
Maxillar	8	15.38
Nasal bones	2	3.85
Forehead	1	1.92

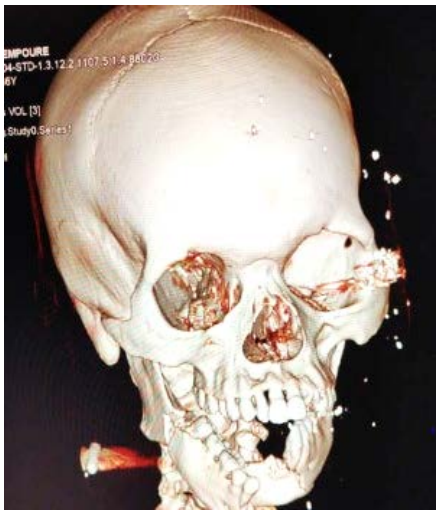

Figure 4. 3D CT image, left mandibular and zygomatic fracas with a projectile at right cervical level (yellow arrow) and left perifacial metal debris.

Table 4. Distribution of patients according to the specific treatment received.

Surgical Procedure	Number	Frequency (%)
Trimming	52	100
Projectile extraction	29	55.77
Osteosynthesis	21	40.38
Metal debris extraction	15	28.85
Maxillo-mandibular blockage	13	25
Titanium splinting	9	17.31
Rhinopoiesis	3	5.77

All patients kept at least one sequel of their trauma. These sequelae included 19 cases of edentulism, 21 cases of unsightly scars, 8 cases of labiomental anaesthesia, 5 cases of psychic disorders, 4 cases of facial asymmetry, 3 cases of anophthalmia, 3 cases of infraorbital anaesthesia and 2 cases of facial paralysis. Ten cases of edentulism had benefited from removable prostheses, and the cases of psychic disorders had received psychiatric follow-up.

4. Discussion

In the context of poor medical equipment, the management of maxillofacial trauma caused by firearms remains inadequate, leading to serious functional and aesthetic after-effects.

Maxillofacial gunshot injuries are relatively frequent in our country in recent years, due to the context of violent extremism linked to terrorism [5] [10]. Armed attacks are a daily occurrence and do not spare the maxillofacial sphere. The reported annual frequency of 10.4 cases does not reflect the reality of these traumas in our country. Indeed, many victims are treated in other healthcare centers, such as military hospitals and regional hospitals.

In both wartime and peacetime, these injuries are mainly seen in young males [2] [6] [8]. In wartime, belligerents are almost exclusively young men. In peacetime, young men are the ones who handle firearms the most, and are therefore the most exposed [6] [9]. In the Burkinabe context, the youthful structure of the population and the commitment of young adult males in the fight against terrorism would justify their frequent involvement. In addition, this part of the population is the preferred target of terrorist attacks, which spare women, children and the elderly [4] [5].

In peacetime, maxillofacial gunshot injuries are caused by a variety of situations, generally dominated by suicide or homicide attempts, assaults and various accidents [11] [12] [13]. In France, Maurin *et al.* reported 50% suicide attempts, 44% assaults, and 6% accidental or undetermined causes [14]. These traumas generally derive from depression, organised crime, drug abuse, police blunders, mishandling of firearms, etc. [9] [13]. In our context, these traumas were caused mainly by terrorist incidents and assaults in 67.31% and 30.77% of cases respectively. The context of insecurity linked to violent extremism that prevails in our country would justify this finding. Indeed, our country has been plagued by terrorist attacks since 2015 over a large part of its territory. These attacks are of various kinds including shootings and the use of improvised explosive devices [5] [10]. As for urban violence (assaults), they are thought to stem from the proliferation of firearms especially since the advent of terrorism, the consumption of psychotropic drugs and organized crime favored by social inequalities. The case of accidental trauma caused by a stray bullet occurred during a coup d'état. The victim, an elderly woman, was hit in her home by the projectile, which penetrated the roof.

Delays for victims' consultations were long in our context, with an average

delay of 37.04 hours, with extremes of 3 hours and 240 hours. The context of insecurity and the lack of specialized services explain these delays in consultation. Indeed, the organization of terrorist attacks victims evacuation is difficult, given the inaccessibility and dangers for rescue workers, armed bandits controlling a large part of the territory. In this context, victims wait several days before being rescued. In developed countries and those safe from terrorism, victims are rescued earlier, justifying early consultations [8] [9] [15].

Clinical examination of victims most often reveals the entry orifice, except in cases of major damage such as explosive blasts, which occurred in 9 patients in the present study. The exit orifice, on the other hand, is not systematic, as the projectile may remain in the body, as was the case for 34 patients in this series. The existence and size of the exit orifice depend on the type of ammunition, the firing distance, and the anatomical structures encountered along the projectile's trajectory [6] [16]. Dense structures such as bones and loose tissues act as projectile brakes [16] [17].

The extent of tissue damage in these injuries depends on the type of weapon or ammunition used, the distance of the shot, the trajectory of the projectile, its velocity and the nature of the tissue encountered [16] [17]. Depending on their velocity, projectiles are classified as low-velocity (less than 609.6 m/s) or high-velocity (greater than 609.6 m/s) [17]. High-velocity projectiles cause the most tissue damage through diffusion of their kinetic energy, as in the case of weapons of war [3] [6]. Depending on the tissue exposed, ballistic damage is most severe in friable solid organs such as liver and brain, where temporary cavitation damage occurs at distance from the real trajectory of the projectile. Dense tissues such as bone and loose tissues such as subcutaneous fat are more resistant to ballistic trauma [16] [17] [18]. In our context, the high frequency of extensive tissue damage, significant immediate complications and extra-facial lesions stems from the use of war weapons and anti-personnel mines. These war weapons are very powerful and avulsive, and the context of shooting in bursts with the intention to kill would explain the multiple bodily injuries [15] [18]. Moreover, the anatomical unicity of the face, head and neck may explain their concomitant damage, further burdening the prognosis of victims. Computed tomography (CT) is essential to evaluate lesions and identify any projectiles or ballistic fragments. This imaging should only be carried out on a stable patient who has been conditioned to avoid aggravating the initial lesions [8] [9] [19]. In our series, all patients underwent a CT scan, which helped to complete the lesion assessment, locate projectiles and guide management.

Therapeutically, maxillofacial gunshot trauma is a medical-surgical emergency requiring precise, coordinated resuscitation measures [9] [15] [19]. In developed countries, they are seen and managed within the first few hours, thanks to well-organized transport and pre-hospital care of victims, and the availability of specialized services [8] [9] [15]. In our context, the delay in treatment is long (5 days) due to the inaccessibility of the scene of the tragedy because of insecurity, but also because of the embryonic state of transport and pre-hospital care. These

constraints are exacerbated by the limited technical platforms available in the hospitals, which contribute to further delays in treatment.

Immediate emergency management includes lifesaving measures (VAS liberation, hemorrhage control, conditioning) and reanimation (hemodynamic stabilization, intubation or tracheostomy, antibiotherapy, analgesics) [8] [9] [19]. Management of this type of trauma is usually multidisciplinary and concomitant, due to the multiple associated lesions, especially cervico-facial [6] [7] [20]. In our context, the management of the victims was most often not concomitant and in order of urgency due to the difficulties in assembling a multidisciplinary team.

Optimal surgical management of tissue damage caused by facial ballistic trauma is usually achieved in several steps. The first surgical phase, or "survival time", is devoted to trimming, *i.e.* decontamination, disinfection, hemostasis and extraction of debris. During this phase, the use of osteosynthesis material and sutures is not recommended, due to the risk of infection, as projectiles are not sterile [8] [9] [15]. Late trimming in our context would therefore explain the high rate of post-surgical infectious complications registered (23.08%). In the absence of postoperative suppuration, the second stage of surgery aims to restore disturbed function and facial aesthetics [8] [9] [15]. It consists of fracture osteosynthesis and reconstruction of loss of substance using various flaps [8] [9] [19]. In some cases, this reconstruction is performed in several surgical steps [9] [19]. In our series, this second surgical stage consisted of osteosynthesis in 41.38%, mandibular titanium splints in 17.31% and rhinopoiesis in 5.77%. Recourse to temporary reconstruction using titanium splints was justified by patients' difficulties of stewardship, but also by the limited technical platforms available, which do not allow micro-anastomosed flaps to be made. In addition, 13 patients underwent orthopedic treatment due to fracture comminution and/or stewardship difficulties.

In terms of evolution, maxillofacial gunshot injuries cause various sequelae of varying importance [3] [6] [19]. These sequelae depend not only on the initial lesions, but also on the quality of treatment. In advanced technology countries, the availability of various rehabilitation procedures minimizes these sequelae [9] [15] [21]. In our context of poor technical facilities, the management of certain sequelae remains a challenge, hence the high frequency of various sequelae in the present series. Thus, all patients retained one or more sequelae of their trauma, including severe ones such as neurological functional disorders in 13 cases, inseparable edentulousness in 9 cases, psychological disorders in 5 cases, and visual organ loss in 3 cases.

5. Conclusions

Maxillofacial gunshot injuries are the source of various, more or less complex lesions, whose precise inventory determines the treatment modalities. They are true emergencies, and can be life-threatening and functionally disabling. They affect

all age groups, but young males are the most vulnerable. The main circumstances in which they occur are linked to terrorist attacks and insecurity in our context.

Their initial treatment remains difficult due to the geographical inaccessibility of health centers and the precariousness of technical facilities. Preventing them requires combating violent extremism, while improving technical facilities would guarantee their optimal management.

The limitations of this study were due to its retrospective nature, making some data unavailable, but also to the absence of projectiles, which went through the body, and whose characteristics could not be described and correlated to the lesions.

Funding

This article has not received any specific funding

Authors' Contributions

All authors contributed to the writing and correction of this article.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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