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Place of Delayed Primary Closure in Ballistic Wounds and by Explosive Devices at the Somine Dolo Hospital in Mopti

Karembé, B[1*], Traoré, D[1], Tounkara, I[1], Konaté, M[1], Diarra, I[1], Dicko, Y[1], Traoré, B[1], Traoré, A[1], Diarra, A[1], Ganmenon, M[1], Sanogo, S[1], Traoré, S[1], Touré, A[1], Fall, I[1], Samaké, M[1], Diarra, D[1], Kanté, L[1], Dembélé, B. T[1], Togo, A[1]

[1]Assistant Master at FMOS, Department of Surgery, CHU Gabriel Touré BP:267, Bamako, Mali

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***Corresponding author:** Karembé, B
Assistant Master at FMOS, Department of Surgery, CHU Gabriel Touré BP:267, Bamako, Mali

Abstract **Original Research Article**

***Objectives*:** To study delayed primary closure in ballistic and explosive device injuries by describing the clinical, therapeutic and evolutionary aspects. ***Methodology*:** This was a prospective study running from August 1, 2022 to May 31, 2023 including all patients of all ages presenting a ballistic or explosive device injury. ***Results*:** In 10 months, we collected 190 cases of ballistic and explosive device trauma, or 35.9%. The average age was 31.89 ± 14.026 years with a sex ratio of 12. Intercommunity conflicts were the most frequent causes (61.1%). Limb injuries represented 78.9 %, of which isolated wounds without fracture were the most frequent (59.5%). Standard radiography was 'the most used medical imaging (94%). DPC (Deferred Primary Closure) was performed in 71.2% followed by DPC + external fixator in 19%. We recorded 2 cases of death. ***Conclusion*:** Well-conducted delayed primary closure helps reduce the risk of complications, give the patient every chance of survival and shorten the hospital stay.

Keywords: Ballistic trauma, conflicts, delayed primary closure.

INTRODUCTION

Ballistic wounds are the consequence of the penetration into the body of a projectile: bullet, lead, metal fragment coming from the casing or contents of an explosive device (grenade, mine, shell, bomb, etc.) [1].

Delayed primary closure is closure of the wound by simple approximation of the deep structures and the skin, without tension, carried out four to seven days after surgical debridement; therefore during the fibroblastic phase of healing.

Ballistic trauma constitutes a real public health problem in several countries, especially developing ones [2]. In recent years, they have experienced a resurgence linked to:

- The increase in gun crime;
- Armed and intercommunity conflicts.

Projectile injuries nowadays affect civilian populations more and more frequently [3]. Today in the United States for example; "model" of urban civil violence; there are 230 million firearms in circulation; 24,000 killed and 300,000 wounded per year, the equivalent of the losses of American forces during the Vietnam conflict [1]. It is adolescents and young adults from the most disadvantaged social strata who pay the heaviest price [2].

Knowledge of the type of weapon, the type of ammunition, the impact distance; wearing a bulletproof vest makes it possible to estimate the potential injury [1]. However, it must be remembered that the severity of the injury will depend above all on the organ affected more than on the type of projectile injuring. Lesions of the limbs are predominant (65% of cases; 95% for people wearing helmets and flak vests) [1]. Lesions of the head, neck and trunk are observed in 10 to 20% of cases. These lesions have a considerable mortality; 80% for head lesions, 70% for thoracic lesions.

The cause of death is either central nervous system damage or hemorrhage. Spinal cord injuries cause great morbidity.

In times of war, systematic exploration of penetrating wounds is the rule; initial treatment at the front is limited to emergency procedures. Definitive care takes place in the rear structures [1].

If hemorrhage is the first cause of early death, infection is the second from the twenty-fourth hour;

prevention of this infection is crucial [1]. Delayed primary closure allows:

- To have a much lower incidence of wound complications;
- To have a shorter hospital stay
- To reduce the cost of care.

Given the absence of epidemiological or clinical data relating to this method of treatment of ballistic or explosive traumatic wounds linked to armed conflicts, we initiated this work whose aim was to determine the place occupied by this treatment.

MATERIALS AND METHODS

This was a prospective study running from August 1, 2022 to May 31, 2023 in the emergency department of Sominé Dolo Hospital in Mopti. Patients of all ages presenting with a ballistic or explosive device injury were included in our study. Excluded from this study were patients who refused hospital care in favor of traditional treatment and other types of injury. The parameters studied were the epidemiological aspects, the clinical, paraclinical, therapeutic and evolutionary aspects. Data entry and analysis were carried out using IBM SPSS version 25 software.

Word processing and tables were carried out with Microsoft Word 2016 and Excel 2016 software respectively. The statistical comparison test used was Chi2 with a significance threshold of $p<0.05$.

The study was conducted with the agreement of the hospital administration. All surgical and emergency department staff have been informed. The interviews were conducted with the informed consent of patients meeting the inclusion criteria.

RESULTS

In 10 months, we collected 190 cases of ballistic and explosive device trauma out of 528 cases of trauma, or 35.9%. The average age was 31.89 ± 14.026 years and extremes of 4 and 75 years. The sex ratio was 12 (176 men and 14 women). Farmers were the majority (94 patients or 49.5%) followed by Soldiers in 26 cases (13.7%).

Intercommunity conflicts constitute the most frequent etiologies 116 cases or 61.1% followed by inter-armed conflicts in 33.2% of cases. Table I summarizes the other circumstances of occurrence.

Firearms are the cause of the majority of injuries to the injured in 72.6% of cases. Referrals constituted the most frequent mode of admission, i.e. 120 referred cases (63.2%). The majority of our patients were admitted within 6 hours of the trauma, i.e. 120 cases (63.2%).

Injuries to the limbs were the most represented 150 cases or 78.9% of cases of which isolated wounds without fracture were the most frequent at the limb level 91 cases or 59.5%. The pelvic limb was the most common site of fractures in 39 cases or 62.9% and type II open fracture (Gustillo and Anderson) was the majority in 49 cases or 79%. Soft tissue lesions represented 108 cases (56.8%) (Figure 1) followed by bone lesions 65 cases (34.2%).

Hemothorax and intestinal perforation were the thoracic and abdominal lesions observed in 71.4% of cases and 72.7% of cases, respectively.

Standard radiography was the most used medical imaging test in 172 cases or 94%. All our patients benefited from medical treatment based on analgesics, antibiotics and tetanus serovaccination. Transfusion was carried out in 53 cases or 27.8% of which 11.1% were transfused with two units of packed blood cells.

The surgical procedure was performed twice in 163 patients or 85.8%. DPC (Delayed Primary Closure) was performed in 131 patients or 71.2% followed by DPC + external fixator in 35 cases or 19% (Figure 2). Skin grafting has summer the third most intervention performed in 8 cases or 42.5% (Figure 3) followed by vascular repairs and debridements in four cases (Figure 4 & 5). The other actions performed are summarized in Table II.

Surgical site infection was the most frequent complication in 7.9% of cases (Figure 6) and we recorded 2 cases of death or 1.1%. Clavien's Grade I Dindo was the most represented in 60.9% of cases (Table III). Table III shows the other complications according to Clavien Dindo. Injuries caused by firearms caused more complications (Figure 3). The length of hospitalization was 5 has 10 days at 104 patients or 54.7 % but cases of bone lesions of the limbs lasted longer in hospitalization: 61 to 90 days or 21 cases.

Table I: Distribution of injured people according to the circumstance of occurrence

Circumstance	Frequency	Percentage (%)
Conflict intercommunity	**116**	**61. 1**
Inter-armed conflict	63	33.2
Brawl	6	3.2
shooting incident	5	2.6
Total	190	100

Table II: Second Intervention

Gestures	Frequency	Percentage
DPC (delayed primary closure)	**131**	**71. 2**
DPC+ External Fixator	35	19
Partial CPD	7	3.8
Partial DPC + External Fixator	6	3.3
Redebration	3	1.6
Amputation	2	1.1
Total	184	100

Table III: Classification of complications according to Clavien Dindo

Classification of surgical complications according to Clavien Dindo	
Grade I	Any adverse post-operative event not requiring medical, surgical endoscopic or radiological treatment
Grade II	Complication requiring medical treatment not authorized in grade 1. **Peripheral venous thrombosis, total parenteral nutrition, transfusion**
Grade III	Complication requiring surgical, endoscopic or radiological treatment
Grade IIIa	Without general anesthesia Radiologically guided puncture
Grade IIIb	Under general anesthesia Surgical revision for bleeding or other cause
Grade IV	Life-threatening complication requiring intensive care
Grade V	Death

Figure 1: Right shoulder wound (HSDM surgery department)

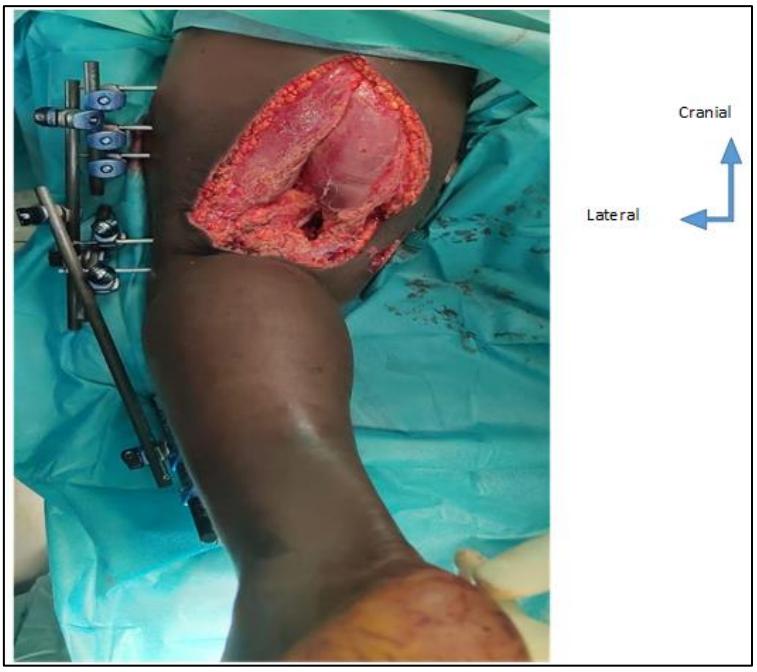

Figure 2: DPC + external fixator (image from HSDM surgery department)

Figure 3: Autograft skin (image from the HSDM surgery department)

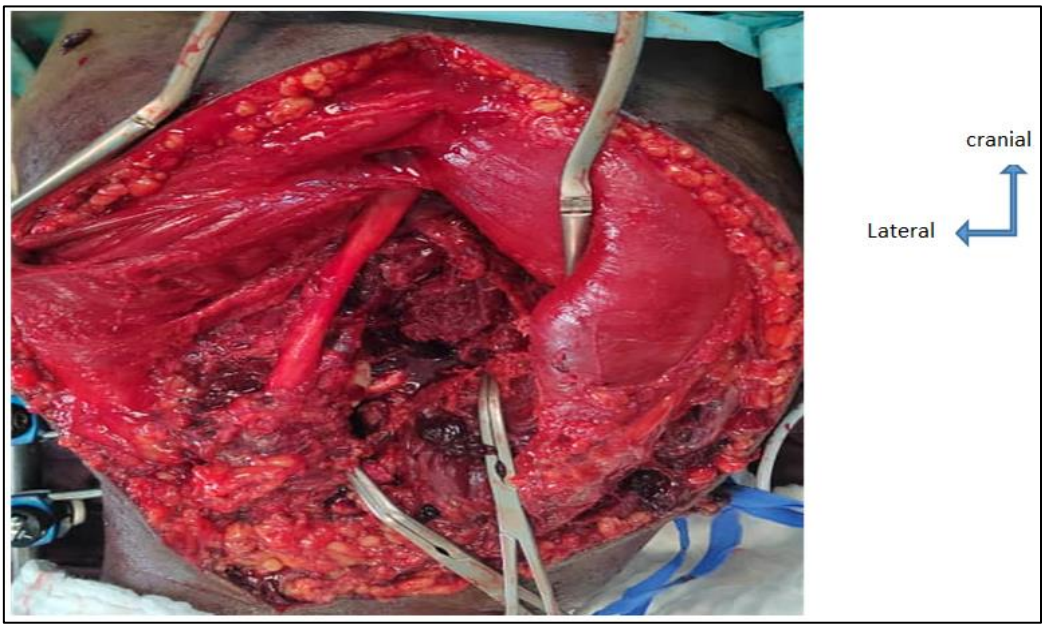

Figure 4: Total section of the femoral artery (image of the HSDM Surgery Department)

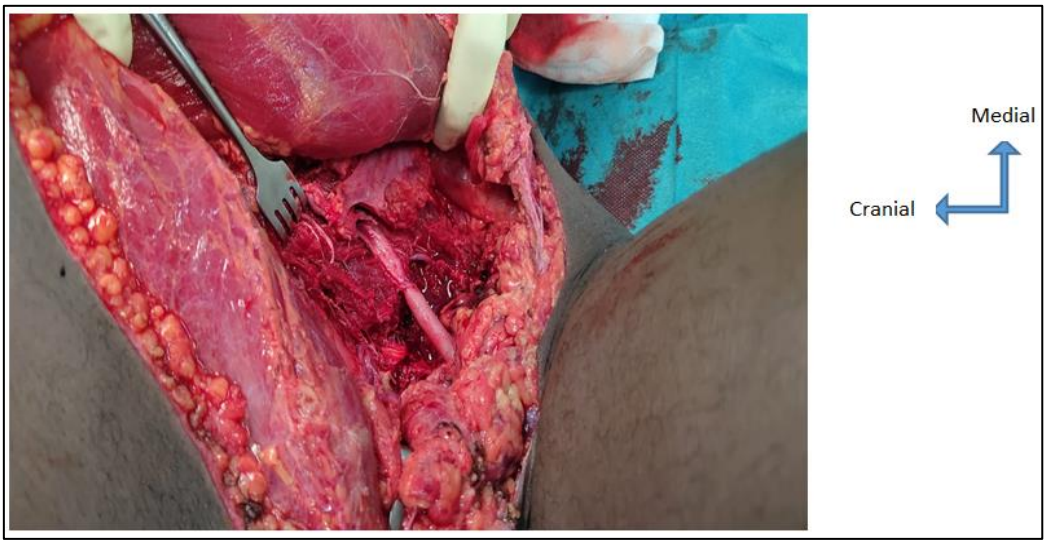

Figure 5: Vascular repair (image from the HSDM Surgery Department)

Figure 6: Gas gangrene caused by Clostridium perfringens (image from the HSDM Department of Surgery)

DISCUSSION

1. Epidemiological aspects

The average age of our patients was 31.9 years with extremes of 4 and 75 years. These results are similar to those found by Djibo.A [4] and I. Keita [2] and L. Ly [5] respectively 30.94 years; 30 years ; and 31.65 years with p>0.005. This is explained by the fact that it is the young people who are the holders of rifles and above all the most apt to join the brotherhood of hunters (first fighters to organize self-defense in the villages).

The male gender was in the majority in our study at 92.6% with a sex ratio of 12. Same trend reported by Rachatane O [6]; Sagara S [7] and Djibo A [4] who respectively found a male predominance of 93.2%, 90.4% and 89.5% with p>0.05. This male predominance could be explained by the fact that it is men who are at the forefront of defense in the event of armed conflicts to defend women and children.

In our study, it was the civilian population who paid the heaviest price, unlike those involved in the fighting, the military. Farmers, students and housewives were the most affected with 49.5%, 6.8% and 4.7% respectively. The military represented 13.7% of our patients. Our result differs from that of Hoffman C [8] and of L. Ly [5] who found more victims in the military population with 95.5% and 100% respectively. This could be explained by the fact that in our study, attacks were much more directed against the civilian population in the context of intercommunity conflicts and attacks by armed groups.

2. Clinical Aspects

In our series, lesions were more frequent on the limbs with 78.9% of cases. Our results are similar to those reported by Kéita I. [2] who found more limb damage 81.2% with p >0.05. Limb damage is multifactorial, combining classic shootings, shooting accidents and incidents, and mine explosions.

Soft tissue lesions were the most represented with 108 cases or 56.8%. This result differs from that of Djibo A. [4]**,** who found 69% of cases and that of the ICRC [9] which found soft tissue lesions in 73% of cases but consistent with that found by S Sagara [7] 46.4% of cases (p>0.05). This could be explained by the fact that bullets always pass through the superficial parts and cause their destruction (ballistic effect) before reaching the deeper parts.

We recorded 65 cases of fracture. Our result does not differ statistically from that of Djibo A. [4] with 94.6% (p >0.05). This is explained by injury ballistics, the projectile penetrates the human body and releases energy into the tissues causing the injury.

Chest injuries were recorded in 5.8% of cases, our result does not differ statistically from those of the ICRC [9], and Djibo A [4] who found 7% and 6.1% respectively (p > 0.05).

In our study abdominal lesions were found in 5.8%. Our result does not differ statistically from those of Djibo A. [4] and the ICRC [9] in 2015 which found 6.5% and 7% of cases respectively (p > 0.05).

3. Paraclinical aspects:

Standard radiography was the most requested with 94% of cases, this result is consistent with that reported by I Keita [2] with 95.4% and with data from the literature which requires radiography in front of all gunshot wounds, even if there is an outlet.

In our study, only 0.5% of patients had an ultrasound. This result is similar to that of Djibo A [4] who found 1.1% with p>0.05. This is explained by the fact that most of the clinical pictures encountered were quite suggestive of visceral damage justifying immediate laparotomy.

4. Therapeutic aspects:

In our study all patients received analgesics. Among the products used 100% received paracetamol

(injectable or tablet). Our result is similar to that of Djibo [4] and Sagara S [7] but superior to that of Chaibou MS *et al*., [10] in Niger who found a paracetamol use rate of 93.3% with p<0.05.

All our patients had received antibiotic therapy. This could be explained by the very high risk of infection in war surgery and the systematization of antibiotic therapy in the event of injury in war surgery. In fact, the wounds present strong bacterial contamination, the bullets and other fragments are not sterile at the time of firing and the contaminated projectile introduces bacteria through the entry point [11]**.** 27.8% of our patients had received a blood transfusion, our result is higher than those found by Hoffman **C.** [8] in 2012 in Afghanistan which found a rate of 18% and that of Djibo A [4] with 8.4%. This difference would be linked to the serious nature of the injuries in our series.

Patients admitted for firearm and explosive device wounds received debridement and delayed primary closure. Which is a cardinal principle in the care of war wounded with wounds. We never close a wound of war; Debridement is done and the wound is left open except for the head, neck and genitals. Then we will carry out the delayed closure 5 to 7 days after debridement if and only the wound is clean.

Evolution: It was simple in 87.9% of cases. This could be explained by respecting the treatment time, careful debridement as first intention and delayed primary closure as second intention 5 to 7 days later. This result is comparable to that of I Keita [2] who found a simple evolution in 79% of cases with p > 0.05.

Complications: Infection of the surgical site was the most frequent complication with 7.9% of cases, this is explained by the opening of the skin, the delay in treatment and certain traditional methods carried out before arrival at the hospital. the hospital and the risk of infection.

Length of hospitalization: The majority of patients had a length of hospitalization of between 5 and 10 days, i.e. 54.7% of cases. This short duration of hospitalization is most often explained by respecting the treatment time and by carrying out secondary closure (delayed primary closure).

CONCLUSION

Well-conducted delayed primary closure reduces the risk of complications, provides a good result, gives the patient every chance of survival and shortens their hospital stay. Morbidity and mortality linked to ballistic injuries depend on the nature of the injuries, the experience of the surgical team and the context in which the injured are treated.

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