

## Management of Limb Lesions of Ballistic Trauma at Sominé DOLO Hospital of Mopti

**Bréhima Traoré<sup>1\*</sup>, Djibril Traoré<sup>1</sup>, Modibo Coulibaly<sup>2</sup>, Soumaila Sagara<sup>1</sup>, Oumar Guindo<sup>3</sup>, Abdoulaye Traoré<sup>4</sup>, Dramane Cissé<sup>1</sup>, Pierre Coulibaly<sup>5</sup>, Kiffery Ibrahim Keita<sup>6</sup>, Fodé Mory Keita<sup>7</sup>, Dramane Samaké<sup>8</sup>, David T Théra<sup>1</sup>, Aly Guindo<sup>1</sup>, Aly Diallo<sup>9</sup> and Adégué P Togo<sup>10</sup>**

<sup>1</sup>Department of General Surgery, Sominé DOLO Hospital of Mopti, Mali

<sup>2</sup>Medical Biology Laboratory Service, Sominé DOLO Hospital of Mopti, Mali

<sup>3</sup>Public Health Department, Sominé DOLO Hospital of Mopti, Mali

<sup>4</sup>Anesthesia/Resuscitation Service and Operating Room, Mali

<sup>5</sup>Gyneco-Obstetrics Department, Sominé DOLO Hospital of Mopti, Mali

<sup>6</sup>Referral Health Center of Sikasso, Mali

<sup>7</sup>Army Polyclinic of Kati, Mali

<sup>8</sup>Department of Medicine, Sominé DOLO Hospital in Mopti, Mali

<sup>9</sup>Department of General Surgery Sikasso Regional Hospital, Mali

<sup>10</sup>Department of General Surgery, CHU Gabriel Touré, Mali

**\*Corresponding Author:** Bréhima Traoré, Department of General Surgery, Sominé DOLO Hospital of Mopti, Mali.

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### Abstract

**Background:** Mali is a west African country which has been going through armed conflict, insecurity and socio-political instability since 2012. This multidimensional crisis has led to an avalanche of violence with health repercussions, including ballistic trauma to limbs. Sominé DOLO hospital is a second reference hospital located in the center of Mali where the war wounded are referred. The objective of this work was to describe the characteristics and the management of limb lesions due to ballistic trauma.

**Patients and Methods:** This was a prospective study from January 1 to December 31, 2019 in the surgery department. Our study focused on 170 limb-injured patients out of the 250 patients admitted to the emergency department for ballistic trauma. The study population consisted of patients of all ages presenting a ballistic injury to the limbs. Data was captured and analyzed on Epi-info 7.2.4.0. Proportions and means were calculated for qualitative and quantitative variables, respectively.

**Results:** Out of the 250 cases of ballistic lesions, 170 cases (68%) of limb injuries were found. The average age was 41 years. The sex-ratio was 9. Isolated wounds without fracture were the most frequently lesions in the limbs, 108 cases (63.5%) followed by fractures 62 cases (36.5%). Out of the 179 cases, surgery was performed twice in 83.6%. Patients with open fractures accounted for 54 (31.8%) and had been operated on more than 3 times. We resorted to orthopedic treatment, 30 cases (48.4%) received a plaster splint, 14 (22.6%) an external fixator and in 6 cases (9.7%) limb amputation was performed. The evolution was favorable in 90.8% of cases, however some cases of complications was noted such as surgical site infection (6.3%) and 5 cases of death (2.9%).

**Conclusion:** It appears that the majority of patients affected by ballistic trauma to the limbs were civilians with a predominance of the male sex. Lesions of the lower limbs were the most frequent. Surgical trimming and delayed closure well conducted reduced the risk of complications.

**Keywords:** Armed Conflict; Limbs Lesions; Surgical Management

## Introduction

Since January 2012, Mali has been facing an unprecedented armed conflict which opposes the regular army in one hand and in the other hand, self-defense militias made up of hunters to terrorist groups and like belligerents. This multidimensional crisis drains its share of violence characterized by ballistic trauma, particularly in the limbs. Ballistic trauma is the consequence of the penetration of a projectile into the body: bullet, lead, metal fragment from the envelope or the contents of an explosive device (grenade, mine, shells, bomb and so one) [1]. Firearm trauma is a real public health problem in several countries, especially developing countries [2]. The firearm trauma have experienced an upsurge linked to the increase in gun crime; the illegal and uncontrolled possession of firearms; armed and intercommunal conflicts; the war against the terrorists. Projectile injuries are nowadays more and more frequent in civilian populations and the management of these lesions responds to specific rules that must be known because sometimes different from the usual traumatology [3]. In times of war the systematic exploration of penetrating wounds is the rule. Initial treatment at the front is limited to emergency procedures. Final care is deferred in most cases [1]. In civilian practice, the availability of complementary means of exploration makes it possible to establish real diagnostic strategies and to have a non-surgical attitude to certain lesions [1]. If hemorrhage is the first cause of early death, infection is the second from the twenty-fourth hour and the prevention of this infection is crucial [1]. The Malian crisis began in the up-north and rapidly spread to the center, Mopti. In this region, Sominé Dolo Hospital is the only 2<sup>nd</sup> reference health facility capable of caring for war wounded (both civilian and military). The aim of this work is to describe the characteristic and the surgical management of limbs injuries du to ballistic trauma during Malian war.

## Patients and Methods

This was a prospective study from January 1 to December 31, 2019 in the surgery department. Our study focused on 170 limb-injured patients out of the 250 patients admitted to the emergency department for ballistic trauma. During cases of massive and saturating influx, the alert and the triggering of the white plan were carried out by the chief executive officer (CEO) of Sominé Dolo hospital. This white plan included a crisis unit made up of two zones: a first which was the center for calls and coordination with the other extra-hospital intervention teams and the second

zone brings together the hospital staff around the referent CEO of the white plan. On admission, the war wounded were classified into four different categories of actions to be made according to the white plan of the Sominé Dolo hospital. The 1<sup>st</sup> category was the expectants or black triage tag color, the 2<sup>nd</sup> category was the immediate or red triage tag color, the 3<sup>rd</sup> category was the delayed yellow triage tag color and the 4<sup>th</sup> category was the minor or green triage tag color. The study population consisted of patients of all ages presenting a ballistic injury to the limbs. Patients who refused hospital care at the profit of traditional treatment, patients with an unusable record and patients who refused to give their consent were excluded from this study. The epidemiological, clinical, paraclinical, surgical and therapeutic aspects of ballistic trauma of the limbs and its evolution were assessed. Data was captured and analyzed on Epi-info 7.2.4.0. Proportions and means were calculated for qualitative and quantitative variables, respectively.

## Results

Over the period of the study we recorded 1601 various traumas at the level of the emergency department among which 250 were related to ballistic trauma or 15.6% and 170 had traumatized limbs that accounted for 68% out of 250 ballistic trauma. Male sex was well represented, 90.4% of the cases with a sex-ratio of 9. The age group from 46 to 60 years was the most represented, 48.8% of the cases. The mean age was  $40.9 \pm 13.3$  years and extremes ranging from 2 to 98 years. Most of the patients came from the Bankass circle, 69/170 patients or 40.6%. The majority of patients were cultivators 101/170 patients (59.4%) against 45/170 (26.5%) of military. Most of the ethnic groups in the Mopti region were concerned mainly the Dogons 94/170 (55.3%). Intercommunal and joint conflicts were the most frequent etiologies with 78/170 (45.9%) and 67/170 (39,4%), respectively. The majority of patients were admitted as part of the referral/evacuation 142/170 (83.5%) and 121/170 (71.2%) of the cases were admitted to the emergency department less than 6 hours after the ballistic trauma. Isolated lesions of the soft parts were the most frequently found, 79/170 cases (46.5%), followed by bone lesions 69/179 (40.6%). Isolated wounds without fractures were the most frequently found lesions in the limbs, 108/170 (63.5%) followed by Fractures, 62/170 (36.5%). The lower limb was the most frequently seat of fractures, 44/62, 71% (Figure 1). Fractures were open in 54/62 (87.1%). The type II open fracture was the most common, 22/54, 40.7% of the cases (Table 1). Nerve damage was the most frequently found

associated lesions 4/9, 44.4% of cases (Table 2). The standard X-ray was the most performed medical imaging examination 84/123 (68.3%). Blood grouping in ABO Rhesus and systems and cells count were the most performed biological assessment with (44.8%) and (41.6%), respectively. All patients received medical treatment based on analgesic and antibiotic. Cefazolin was the most administered drug in 88% of our patients. Ringer lactate solution was administered in 81.6% of cases followed by salt serum 0.9% in 79.2%. Blood transfusion was performed in 18% of cases. General anesthesia was performed in 79.2% of cases. Surgery was performed twice in 83.6% of cases. The open fractures had been operated on more than 3 times. Orthopedic treatment with plastered splints was performed in 48.4% case, external fixator in 22.6% case and an amputation of the limb in 9.7%. Out of 28 of our patients who had to develop a complication; 46.4% had anemia followed by 25% of neurological complication. The lethality was 2.9% and were polytrauma cases. The length of hospitalization was 10-30 days in 50.4% of cases. All of the deaths occurred among farmers with the most affected age group of 46-60 years. The average length of hospitalization was 35.05 days with the extremes ranging from 1 to 99 days.

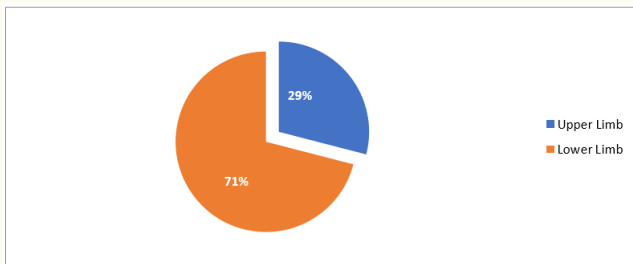


Figure 1: Distribution of patients by fracture location.

Figure 2: Iconography of ballistic trauma to limbs (Source: Sominé DOLO Hospital of Mopti, Mali).

| Grades  | N  | Percentage% |
|---|----|-------------|
| I (wound < 1 cm)  | 14 | 25,9        |
| II (wound 1-10)   | 22 | 40,7        |
| IIIA (extensive tissue damage > 10cm, not requiring flap)                       | 11 | 20,4        |
| IIIB (lesions > 10 cm, involvement of the exposed bone periosteum, flap needed) | 5  | 9,3         |
| IIIC (arterial involvement requiring vascular reconstruction)                   | 2  | 3,7         |
| Total   | 54 | 100         |

Table 1: Distribution of patients by type of open fracture according to Gustilo et Anderson.

| Associated lesions | N | Pourcentage % |
|--------------------|---|---------------|
| Vascular lesions   | 2 | 22,2          |
| Nerve damage       | 4 | 44,4          |
| Polyfracture       | 3 | 33,3          |
| Total              | 9 | 100           |

Table 2: Distribution of associated limb injuries.

### Discussion

The average age of our patients was 40.9 years with extremes of 2 and 98 years. This result is superior to that of Alain., *et al.* [17], Keita I. [2], Chaibou MS., *et al.* [15] and Djibo A. [16] who found 28 years; 29.4 years; 29.5 years and 30.9 years respectively. This

difference is statistically significant ( $\chi^2 = 3.7394$ ) and  $p < 0.05$ . The majority age group in our study was 46-60 years with 48.8%. This result is different from that reported by Djibo A. [16] in Niger which had found a majority age group of 16-30 years with 48.5%. Keïta I in Mali found an age group of 21-40 years with 55.8%. The difference in our results compared to those of the literature could be explained by the particular context of the war in central Mali, which occurs against a backdrop of intercommunal conflict, but also by the fact that it is young adults who are the holders of rifles and especially the most suitable to enter the brotherhood of hunters (the first combatants to organize self-defense in the villages).

The male sex was in the majority in our study up to 90.4% and a sex ratio of 9. Same trend reported by Djibo A. [16] and Kéïta I. [2] who found a male predominance of 89.53% and 88.4% respectively. On the other hand, this result is a little lower than that of Alain., *et al.* [18] with 98%. This male predominance is explained by the fact that it is men who are at the forefront of defense in the event of armed conflict to defend women and children. The majority of the injured came from the circles of Bankass (27.6%), Bandiagara (22.8%) and Mopti (22.4%). The populations of the three circles have been the most affected and affected by the inter-communal conflict in the Mopti region.

In our study it is the civilian population that has paid the heaviest price unlike the actors of the fighting that are the military and hunters. The military represented 18.4% of our patients, our result differs from that of Hoffman C [18], with 95.5% on the other hand comparable to those of Djibo A. [16] and Kéïta I. [2], which reported 28.27% and 20.9% 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 intercommunal conflicts and attacks by armed groups. The majority of patients were admitted in less than 6 hours or 71.2% of cases comparable to that of Keïta I. [2] which found 79% of cases with  $p > 0.05$ . Due to the proximity of conflict zones to health facilities, the readiness of the population to contact civil protection or the police and the availability of means of transport, the wounded were evacuated for treatment within a reasonable time. Many patients were referred in 83.2% of cases because Sominé DOLO Hospital is the only 2<sup>nd</sup> reference medical-surgical structure in the Mopti region. The less seriously injured were cared for locally without being referred. A strong humanitarian presence in the region facilitates the care of the wounded.

Lesions were more common in the limbs with 68% of cases. Our results are similar to those reported by Hoffman C. [18], Djibo A. [16] and Kéïta I. [2] who find more limb damage with 67%; 63% and 81.2% respectively with  $p > 0.05$ . The reach of the limbs is multifactorial associating conventional shooting, accidents and shooting incidents and mine explosions. Soft lesions were the most represented 46.4%. Our result differs from that of Djibo A. [16], which found 69% of cases and that of the ICRC [19] which found soft limb injuries in 73% of cases. This could be explained by the fact that the bullets always pass through the superficial parts and cause a destruction of these (ballistic effect) before reaching the deep parts. We recorded 62 cases of fracture including 53 cases of open fracture of the limbs or 87.1%. Our result does not differ statically from that of Djibo A. [16] with 94.6% and Owens., *et al.* [20] who found 82% with  $p > 0.05$ . This is explained by lesional ballistics, the projectile enters the human body and releases energy into the tissues causing injury. The presence of a mandatory wound gives the fracture open.

We had 6 cases of amputation or 9.7% of patients, there is a statistically significant difference with that of Djibo A. [16] who found 13 patients or 22.4% with  $p < 0.05$ . The lower limb was the most affected. This is explained by the velocity of the weapons used, which means that the lesions of open fractures are associated with significant losses of substances.

Standard radiography was the most widely used medical imaging with 84 cases or 48.41%.

In our study all patients received painkillers. Among the analgesics used 100% received paracetamol (injectable or tablet). Our result is similar to that of Djibo A. [16] but superior to that of Chaïbou MS., *et al.* [15] in Niger, at the National Hospital of Niamey in 2016 which had found a paracetamol use rate of 93.3% with  $p < 0.05$ .

All our patients had received cephalosporin-based antibiotic prophylaxis, which could be explained by the very high risk of infection in war surgery and the systematization of antibiotic therapy in case of injury in war surgery. Indeed the wounds have a strong bacterial contamination, the bullets and other fragments are not sterile at the time of firing and the contaminated projectile introduces bacteria through the point of entry. [13].

In our series 18% of our patients received a blood transfusion, our result does not differ statically from that found by Hoffman C. [19] in 2012 in Afghanistan, which found a rate of 18% higher than that of Djibo A. [16] with 8.4%. This difference is statistically significant ( $p < 0.05$ ). Our result could be explained by the absence of a blood bank in the region.

In our series, all patients admitted for firearm wounds experienced debridement and delayed primary closure. This is a cardinal principle in the care of war wounded. A war wound is never closed, the debridement and dressing is done with compresses, and then the closure will be postponed 5 days after trimming if and only if the wound is clean and the dressing dry [13,21].

Among the 28 complications, we recorded 3 infectious complications (10.7%). Our result is similar to that of Murray, *et al.* [21] in Afghanistan and Iraq in 2009 who found an infectious wound complication in 5.5% of cases. This confirms the hypothesis of the high risk of infection in the event of a wound of war. The presence of necrosis, clots, foreign bodies and serums are factors favoring infections in the same way as the contamination of wounds by skin germs [13].

In our series, the intra-hospital lethality rate linked to ballistic trauma to the limbs was 2.94% in a context of polytrauma. Our result is comparable to those found by Hoffman C. [19] in Afghanistan in 2012 and Djibo A. [16] who found a lethality of 3.3% and 5.1% respectively, but differs from that of Chaibou MS and coll. [15] in Niger in 2017 which found 9.9%. This difference is statistically significant ( $p < 0.05$ ). This could be explained by the use of weapons of war and improvised explosive devices. Polytrauma was the main cause of death in 2.8% of cases. Polytrauma is defined by lesions, at least one of which can be life-threatening.

The duration of hospitalization was in the majority of cases between 10-30 days, i.e. 50.4%. The average duration is 35.1 days with extremes ranging from 1 to 99 days. These are the lesions of the limbs which lasted more than 2 months in the majority of cases. This could be explained by the complexity of the surgical management of ballistic wounds complicated by infection. The wound must always be clean before returning secondarily to the fractures. Most patients were operated on several times.

## Conclusion

At the end of our study carried out at the regional hospital of Mopti, it appears that the majority of patients concerned by ballistic trauma of the limbs were civilians with a predominance of the male sex. The Circle of Bankass was the most affected. Lesions of the lower limbs were the most common. They were mainly caused by bullets. Restraint by the external fixator was indicated in front of fourteen (14) open fractures.

The indication of amputation of the limb was posed in 6 cases. Analgesics, antibiotics and tetanus sero-vaccinotherapy were administered to most patients. Well-conducted surgical trimming and delayed closure reduced the risk of complications. The morbidity and mortality associated with ballistic lesions depends on the nature of the lesions, the experience of the surgical team and the context in which the injured are cared for.

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