



Received: 12-09-2022  
Accepted: 22-10-2022

## International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

### Diaphyseal Fractures of the Forearm: Epidemiological, Clinical and Therapeutic Aspects in Mahajanga Madagascar

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#### Abstract

Given the frequency of fractures of the two bones of the forearm, it is particularly important to study their clinical and therapeutic aspects. Our objective in this work is to describe the epidemiological and therapeutic aspects of these fractures. This work is a retrospective study concerning a series of 55 cases of fractures of the two bones of the forearm, seen in the Service of surgical emergencies of the University Hospital Professor ZAFISAONA Gabriel Mahajanga, from January 2019 to December 2020. The frequency of forearm bone fractures in the service was 1.63% in relation to admissions and 25.58% in relation to fractures. Age ranged from 2 to 63 years, with a mean of 32.5 years. The male gender represented 65% of the cases, and 52.50% were pupils or students. Road accidents were

the most frequent cause, found in 42.50% of patients, occurring in urban areas (82.50%). The mechanism of direct impact was predominant in 75% of cases. The fracture was located on the left forearm in 50% of patients and 75% were closed, without associated lesions. The fracture involved both bones in 55% of cases, with the middle third of the fracture (67.50%). The majority of patients were admitted within the first two hours after the trauma (65%) and 87.50% of them were managed within 24 hours. Orthopedic treatment was widely used (70%), while surgical treatment by osteosynthesis was adopted in 30%. But to have better data bases on the choice of treatment, it seems interesting to us to carry out a study on the comparison of results between orthopedic treatment and surgical treatment.

**Keywords:** Forearm, Fracture, Accident, Anatomopathological Aspect, Management, Mahajanga

#### Introduction

Diaphyseal fractures of the two bones of the forearm do not pose a diagnostic problem, but above all a therapeutic problem related to the anatomical characteristics of the forearm, which supports prognosis and supination <sup>[1]</sup>. Thus, the functional prognosis of the limb may be at stake, in particular the axial rotations which is essential for the optimal use of the upper limb allowing the control of the hand's ability to grasp <sup>[2]</sup>. The objective of the present study was to describe the epidemiological, clinical and therapeutic characteristics of diaphyseal fractures of the two bones of the forearm seen in the Surgical Emergency Department of the University Hospital Centre Professor Zafisaona Gabriel (CHU PZAGA) Mahajanga.

#### Methods

This is a retrospective and descriptive study of 2 consecutive years, from January 2019 to December 2020, carried out in the department of surgical emergencies and trauma surgery of CHU PZAGA Mahajanga. All patients with forearm bone fracture were included, without distinction of age or gender, with complete and exploitable files. The parameters studied were the sociodemographic profile, the etiological circumstances, the clinical and radiological parameters as well as the emergency and orthopedic management. The data were collected using a pre-established form. Anonymity and confidentiality were respected during the study.

Text and graphics were entered and performed using Microsoft Office Word and Excel 2019. For data processing and statistical analysis, we used SPSS® version 25.0 software. Results were represented as absolute values and percentages.

## Results

In total, out of the 3374 patients admitted to the Surgical Emergency Department of the PZAGA Mahajanga University Hospital for trauma to the upper limb, 215 patients, i.e. 6.37%, were victims of fractures, 55 of which had a diaphyseal fracture of the two bones of the forearm, i.e. a frequency of 1.63% in relation to trauma and 25.58% in relation to the other fractures. After exclusion, 40 cases were analyzed. The male gender were the main victims, representing 65% of our study population ( $n = 26$ ), compared with 35% for the female gender ( $n = 14$ ). The sex ratio (M/F) was 1.85. The age groups of 0-14 years and 15-24 years were the most concerned during the study period with respective rates of 35% ( $n = 14$ ) and 25% ( $n = 10$ ) (Table 1). The mean age of the patients was 32.5 years with a minimum age of 2 years and a maximum age of 63 years. Students (52.5%,  $n = 21$ ) and farmers (10%,  $n = 4$ ) were the main victims. The left side was mostly affected with a rate of 50% ( $n = 20$ ) and the fracture involved both sides in one patient (2.5%).

**Table 1:** Distribution of patients by age

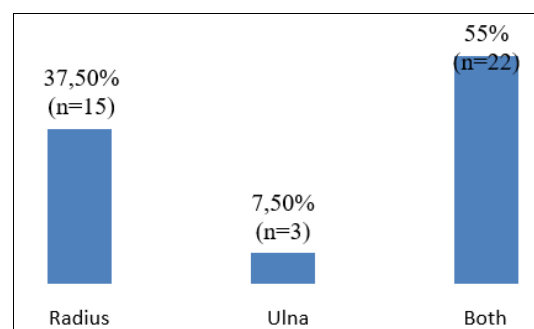
	Number (n)	Proportion (%)
0 to 14 years	14	35
15 to 24 years	10	25
25 to 34 years	7	17,5
35 to 44 years	4	10
45 to 54 years	4	10
55 and over	1	2,5
Total	40	100,0

The etiologies were mainly road traffic accidents (MVA) with a rate of 42.5% ( $n = 17$ ) and domestic accidents 25% ( $n = 10$ ) (Table 2). The majority of fractures occurred as a result of impact by direct mechanism, accounting for 75% of cases ( $n = 30$ ), while 25% ( $n = 10$ ) occurred by indirect mechanism.

**Table 2:** Distribution of patients by etiology of trauma

	Number (n)	Proportion (%)
Public road accident	17	42,5
Domestic accident	10	25
Sports accident	6	15
Work-related accident	6	15
Civil liability accident	1	2,5
Total	40	100,0

The fracture was closed in 75% of cases ( $n = 30$ ) and was isolated in the majority of cases (70%,  $n = 28$ ). Post-traumatic pain was the main complaint (97.5%,  $n = 39$ ) with a mean visual analog scale (VAS) of  $8 \pm 2.5$ . Functional impotence was observed in 90% ( $n = 36$ ). Apart from skin lesions (25%,  $n = 10$ ), vascular and/or nerve lesions were found in 12.5% of patients ( $n = 5$ ). X-rays of the forearm were ordered in 62.5% ( $n = 25$ ) of patients admitted to the emergency room. The fractured bone segment is summarized in Fig 1.

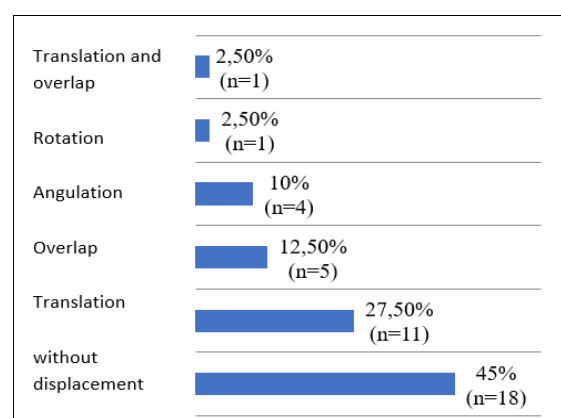


**Fig 1:** Distribution of patients by fractured bone segment

The middle 1/3 was the most observed fracture site (67.5%,  $n = 27$ ), and the upper 1/3 was the least affected (5%,  $n = 2$ ). The characteristics of the fracture features are summarized in Table 3 and Fig 2.

**Table 3:** Distribution of patients by fracture trait

	Number (n)	Proportion (%)
Transverse	22	55
Transverse and oblique	1	2,5
Oblique	12	30
Settling	2	5
Green wood	2	5
Spiral	1	2,5
Total	40	100



**Fig 2:** Distribution of patients by type of fracture displacement

The average time to admission of patients to the emergency department was 2.2 hours after the trauma with extremes of 10 minutes and 36 hours.

Management began within 4 hours of admission in 87.5% of cases ( $n = 35$ ) and was mainly orthopedic. Medical treatment consisted of paracetamol-based analgesics, with or without morphine titration according to the victim's VAS score. In case of open fracture, amoxicillin-clavulanic acid antibiotic was administered. Orthopedic treatment was performed in the operating room under propofol sedation while surgical treatment was mainly under intravenous general anesthesia (GA) (propofol, fentanyl).

Emergency surgical treatment was mainly reserved for open

fractures (25%,  $n = 10$ ) and consisted of wound trimming with closure of the skin opening (100%). Emergency osteosynthesis was performed in 5% of patients ( $n = 2$ ) who had vascular and/or nerve damage. Table 4.

**Table 4:** Distribution of patients according to the type of treatment used

	Number (n)	Proportion (%)
Orthopedic reduction	28	70
Osteosynthesis	12	30
- Screwed plate	9	22,5
- External fixator	2	5
- Centromedullary pinning	1	2,5
Total	40	100,0

## Discussion

### Frequency

Trauma to the forearm is particularly prone to fractures of the shaft of the radius and ulna. These fractures are very frequent, particularly in children where they constitute almost half (45%) of long bone fractures and a quarter of all fractures<sup>[3]</sup>. At the CHU PZAGA Mahajanga, we identified 25.58% of forearm bone fractures for any person presenting with a fracture on admission. In Tulear, Tata et al in 2018, during their study on the management of limb fractures had found that, 16.3% of patients were victims of diaphyseal fractures of the 2 bones of the forearm<sup>[4]</sup>. However, our result is similar to that of Doumbia in Mali, 85 cases of forearm fracture were recorded over a period of 1 year, giving a frequency of 32.44% of all fractures<sup>[5]</sup>. In contrast, in developed countries, forearm fractures are relatively rare. In Scotland, an epidemiological study conducted in 2014 involving 5953 fractures had reported that forearm fracture accounted for 1.20% of all fractures<sup>[6]</sup>. A study on the epidemiology of fractures in 15,000 adults, Singer et al stated that diaphyseal fractures of the forearm affected 0-4 per 10,000 people per year<sup>[7]</sup>. This high frequency of forearm fractures in Mahajanga may be related to the relatively small sample size of our study population compared to series in developed countries.

### Gender

In the present study, we found a male predominance in 65% of cases, with a sex ratio of 1.85. This finding is comparable to that of Ramatafandry in 2020, the author also reported a male predominance of 66.67%, giving a sex ratio of 2<sup>[8]</sup>. In Mali, N'Diaye in 2009<sup>[9]</sup>, Doumbia in 2013<sup>[5]</sup> and Konaté in 2021<sup>[10]</sup> also found that men were the main victims of forearm bone fractures, representing respectively 65.3% (sex ratio of 1.88), 89.41% (sex ratio 8.44) and 78.10% (sex ratio 3.6). This observation is also valid in European countries such as Scotland<sup>[6]</sup> and France<sup>[11]</sup>. The results in Madagascar are therefore in agreement with those of the literature, whether African or other.

### Age

The majority of our patients were under 25 years of age, i.e. 60%, of whom 35% were under 15 years of age and 25% were between 15 and 24 years of age. We note that the population most concerned was a young population, comparable to those of the different series in the African literature. In Doumbia's 2013 study in Mali, the 0-10 year age group was the most affected with a rate of 28.23%, followed by the 11-20 year age group with 24.70%<sup>[5]</sup>. In

children, a fracture is common especially before the age of 9 years according to Vopat ML et al,<sup>[12]</sup>. A cohort study conducted in 2014, had shown that 59% of children with a fracture were victims of a fracture of the forearm bones<sup>[13]</sup>. The young age group is inhabited by playful hyperactivity according to Abiome R et al while the anatomical peculiarities of young subjects make them a vulnerable being<sup>[14]</sup>.

### Etiological circumstances

Fractures of the two forearm bones occur in several circumstances and their frequency differs from one series to another. Nevertheless, the most frequent cause is a fall, especially in children<sup>[2, 15]</sup>. In our series, the main etiologies of forearm bone fractures found were MVA with 42.50% of cases, followed by domestic accidents in 25%. In developed countries, according to McQueen, apart from falls (35%), direct impact occupied 30% of the aetiological circumstances, and road traffic accidents occupied only the last place (23%), with a very unequal distribution between pedestrians knocked down (19%), and vehicle passengers (4%)<sup>[15]</sup>. The circumstances vary from country to country and according to the population studied. In adults, a French study conducted by Marcheix P-S et al in 2016 had detected that the lesion mechanism was secondary to high-energy trauma in 89% of cases. The authors found that among MVAs, accidents caused by two-wheelers constituted the 27% of accidents against 28% for 4-wheelers. While sports accidents were observed in 16% of their study population<sup>[11]</sup>. The predominance of MVAs observed in our series could be explained by the fact that tricycles and two-wheeled machines were involved.

### Mechanisms

Direct or indirect trauma can cause a fracture. Direct impact is the causal mechanism most frequently found in adults (during MVAs, work accidents), which can cause open fractures; whereas the indirect mechanism is found mainly in children, following a fall on the palm of the hand, with the elbow in extension<sup>[16]</sup>. The present study showed that the direct impact mechanism predominated with a rate of 75% of cases, probably in relation to the causes of the trauma, which were public road accidents. In practice, however, it is difficult to determine the direct or indirect mechanism, particularly in the case of a MVA<sup>[2]</sup>.

### Characteristics of fractures

Forearm fractures were closed in the majority of cases (75%). This result is similar to that of Doumbia in 2011 (87%)<sup>[5]</sup>. The open fracture we counted was 25% of our study population. According to the literature, the skin opening is related either to direct trauma, or by the protrusion of the fractured bone secondary to high-energy trauma, but sometimes to a gunshot, or to an airbag accident causing bilateral fractures<sup>[2, 17]</sup>. The involvement of both forearm bones was predominant in our study (55%). Other African authors had the same observation. For Konaté<sup>[10]</sup>, simultaneous fractures of the two bones of the forearm represented 68.80%. We found that the location of the fractures was mainly in the middle third (67.50%) and the fracture line was transverse in the majority of cases. According to the literature, the fracture line can occur in any third of the shaft of the two forearm bones, but often in the middle third with rupture of the interosseous membrane<sup>[3]</sup>.

The appearance of the fracture line may be simple (transverse, oblique, spiral), or complex with a 3rd fragment or bifocal, or even comminuted depending on the extent of the trauma and the etiological circumstances [3]. Displaced fracture is frequent in relation to the action of muscle forces, the displacements are determined by the location of the lines in relation to the muscle insertions [2, 3]. Our patients had mostly a fracture with translation (27.50%), and overlap (12.50%).

### Management

The majority of our patients were admitted within the first two hours after the trauma (65%). In all cases, analgesics were administered on admission to the emergency room with paracetamol, which may or may not be associated with other molecules depending on the intensity of the pain. Emergency osteosynthesis was reserved for open fractures with skin breakdown or vascular and nerve complications, and consisted of placement of an external fixator. Skin opening, with exposure of bone and deep tissue to the environment, leads to an increased risk of infection, bleeding complications of the wound, and pseudarthrosis [18]. In addition, the presence of a skin opening makes treatment difficult and clouds the prognosis [19].

In the absence of these complications, osteosynthesis was performed remotely in our patients. GA was the type of anesthesia performed in all patients due to the unavailability of consumables and tracking devices necessary for locoregional anesthesia (LRA). However, LRA is a widely used technique in traumatology and orthopedics because it provides sufficient anesthesia with a possibility of extending the postoperative analgesic effect [20].

It has been demonstrated for several decades that orthopedic treatment of forearm fractures is more prone to callus, which causes limitation of pronosupination amplitude, pain in the inferior radioulnar joint, and aesthetic problems [21]. In addition, Cumming D et al found that in case of orthopedic management of a fracture, the risk of secondary displacement increases [22]. Some authors state that in children, surgical treatment remains the exception [23]. In adults, on the other hand, osteosynthesis should be indicated from the outset for unstable diaphyseal fractures of both forearm bones, because the temptation to reduce overlapping diaphyseal fractures is very difficult. Hence, surgical treatment is currently used in the majority of cases of forearm fractures in order to minimize the risk of malalignment as well as to decrease the loss in prognosis [24]. Thus, we can say that the use of surgical treatment observed in our study is largely inferior to that recommended in the literature, which could be related to the difficulties of access to osteosynthesis materials in our study site. This was also mentioned by Doumbia in his study [5].

### Conclusion

In order to reduce functional complications of the limb following a forearm bone fracture, our daily practice must opt for this surgical management as long as possible not only for open fractures but also for closed fractures if the indication is necessary.

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