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Original Research Article

Open Fractures of the Limbs: Epidemiological, Therapeutic and Forensic Aspects in the Department of Orthopaedics and Traumatology of the Ignace Deen University Hospital, Conakry (Guinea)

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Abstract: ***Introduction*:** Open fractures of the limbs are a formidable surgical emergency because of the osteo-muscular damage and the high risk of infection. External fixation is a method of choice, allowing the fracture site to be stabilised at a distance. This work analyses the anatomical, functional and medico-legal results of management with external fixators in the Department of Orthopaedics and Traumatology of the Ignace Deen National Hospital in Conakry. ***Patients and Methods*:** This was a 12-month prospective study (1 January – 31 December 2019) that included 27 cases of open fractures of the limbs treated by external fixator among 34 cases collected (out of 297 hospitalisations). Epidemiological, clinical, therapeutic and outcome data were collected. Skin opening was classified according to Cauchoix and Duparc, and results were assessed using the Johner and Wruhs criteria. ***Results*:** The mean age was 36.5 years (range: 13–60 years), with a male predominance (sex ratio = 2.8). Road traffic accidents (RTAs) accounted for 66.67% of aetiologies. The leg was the most frequent site (81.48%). The Hoffmann fixator was used in 77.78% of cases. Ten cases of infection were recorded, including 5 sequestrating osteitis. The mean length of hospital stay was 106 days. At final evaluation (12 patients in dynamic follow-up), results were excellent in 58.34%, good in 25%, fair in 8.33% and poor in 8.33%. ***Conclusion*:** External fixation remains an effective method for the management of open fractures of the limbs in African conditions, giving good anatomical and functional results despite prolonged delays before care. The medico-legal impact, particularly in the context of RTAs, calls for rigorous documentation and systematic expertise.

Keywords: Open Fractures, External Fixator, Forensic, Guinea.

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INTRODUCTION

Open fractures of the limbs are defined as breaks in bone continuity associated with soft-tissue injury that places the bone in communication with the external environment (Gustilo & Anderson, 1976). Their severity stems from the combination of mechanical instability and a high risk of infection, which may compromise limb salvage (Gustilo *et al*., 1984).

Among these fractures, open comminuted fractures of the leg are particularly severe because of the thin musculocutaneous cover of the anterior surface of the tibia, which favours direct bone exposure and complicates surgical coverage (Court-Brown *et al*., 1998).

A well-codified emergency in traumatology, these fractures remain dreaded because of the extent of the osteo-muscular damage, the frequent infectious complications and the prolonged duration of care (Ribault *et al*., 1991). External fixation has proved effective in this setting: it stabilises the fracture using pins inserted at a distance from the wound and connected by extracorporeal metal rods, thus avoiding any internal implant in contact with a potentially contaminated focus (Behrens & Searls, 1986).

Several types of external fixator are available, differing in rigidity, handling and possibilities of dynamisation or progressive distraction (Ilizarov, 1989; Jacquemier *et al*., 2007). In our setting, the Hoffmann, FESSA (Fixateur Externe des Services de Santé des

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Armées, the external fixator of the French Army Medical Services) and Ilizarov fixators were used.

From an epidemiological standpoint, open fractures of the limbs are a major public health problem in sub-Saharan Africa, closely linked to increasing road traffic, ageing infrastructure and the rise in firearm violence (WHO, 2004; Odimba, 2007). Their impact goes beyond surgery: functional sequelae, temporary or permanent disability and long hospital stays make them a growing medico-legal concern, particularly in road traffic and occupational accidents (Fournier-Charrière & Tourniaire, 2005).

In Guinea, epidemiological data on open fractures remain insufficiently documented. The aim of this work was to analyse the epidemiological and therapeutic characteristics of open fractures of the limbs treated by external fixation in the Department of Orthopaedics and Traumatology of the Ignace Deen University Hospital in Conakry, and to explore the medico-legal implications of this condition.

PATIENTS AND METHODS

This was a prospective study conducted over 12 months, from 1 January to 31 December 2019, in the Department of Orthopaedics and Traumatology of the Ignace Deen National Hospital in Conakry, the main referral centre for traumatology in Guinea. All patients seen for an open fracture of the limbs treated by external fixator, followed up and assessed functionally and medico-legally in the department during the study period were included. We excluded open fractures treated by a technique other than external fixation, closed fractures treated by external fixator, and patients lost to follow-up.

Variables Studied

Sociodemographic data included age, sex and occupation. Anatomo-clinical variables were aetiology, anatomical site, degree of skin opening according to the Cauchoix and Duparc classification, and fracture line type. Time to hospital care, type of fixator used, length of hospital stay and complications were also analysed.

Surgical Method

All patients had standard anteroposterior and lateral radiographs of the affected bone segment, including the joints above and below. Surgical management comprised careful wound debridement followed by emergency or delayed-emergency application of an external fixator. The following fixators were used: the Hoffmann fixator (frame or triangulated assembly), the FESSA (single-plane assembly) and the Ilizarov fixator (semicircular assembly).

Treatment was conducted in two stages: (1) external fixation until wound healing and formation of a callus cloud; (2) secondary replacement of the external fixator by a plaster cast, except for humeral fractures, which were kept in the fixator until complete union. Sequential control radiographs (postoperative D3, D21 and D30) were used to monitor reduction and callus formation.

Assessment of Results

Results were assessed using the functional criteria of Johner and Wruhs (Johner & Wruhs, 1983), which classify outcomes into four categories: excellent, good, fair and poor. Length of hospital stay was taken into account in the overall assessment of care.

Medico-Legal Aspects

A medico-legal analysis was carried out for each patient whose injury resulted from a road traffic accident (RTA), an occupational accident or a firearm injury. The data collected included time to bone union, duration of total temporary incapacity (TTI), residual functional sequelae, presence of partial permanent disability (PPD) and postoperative infectious complications. These data were recorded with a view to possible medico-legal expertise according to Guinean references and international standards (Vieira & Pinto da Costa, 2008; Rousseau *et al*., 2010 Data were collected on pre-established survey forms and entered into Microsoft Excel 2010. Results are presented as tables and figures and expressed as numbers and percentages.

RESULTS

Of 6,711 consultations recorded in the department, 324 patients consulted for an open fracture of the limbs, a frequency of 4.83%. Among the 3,009 hospitalisations, 297 cases of open fractures were recorded, i.e. 9.87%. Thirty-four cases of open fractures were included in the study, of which 27 were treated by external fixation (79.41%).

The mean age of the patients was 36.5 years, with extremes of 13 and 60 years. The 25–36 age group was the most represented (37.04%), followed by the 37–48 group (25.93%). A clear male predominance was observed: 20 men (74.07%) and 7 women (25.93%), a sex ratio of 2.8. Workers were the most affected occupational group (29.63%), followed by traders and farmers (18.52% each) (Table I).

RTAs were the main aetiology with 18 cases (66.67%), followed by firearm injuries with 7 cases (25.93%) and sports accidents with 2 cases (7.41%) (Table I).

Table I: Sociodemographic and aetiological characteristics of the patients (N = 27)

Characteristic	n	%
Age group (years)		
13–24	6	22.22
25–36	10	37.04
37–48	7	25.93
49–60	4	14.81
Sex		
Male	20	74.07
Female	7	25.93
Occupation		
Workers	8	29.63
Traders	5	18.52
Farmers	5	18.52
Pupils / students	4	14.81
Civil servants	3	11.11
Drivers	2	7.41
Aetiology		
Road traffic accidents (RTAs)	18	66.67
Firearm injuries	7	25.93
Sports accidents	2	7.41

Mean age: 36.5 years — Range: 13–60 years — Male/female sex ratio: 2.8.

The leg was the most frequently affected bone segment (22 cases, 81.48%), followed by the femur (4 cases, 14.82%) and the humerus (1 case, 3.70%). According to the Cauchoix and Duparc classification, there were 9 type II (47.37%) and 10 type III (52.63%) fractures among the 19 recent fractures included (Table II). Eight patients had been received as second-line referrals after failure of traditional treatment (infected open fractures).

Radiologically, fracture lines were preferentially located in the middle third (62.96%). The comminuted line was dominant (74.07%) (Table II).

Ten patients (37.04%) were managed within the first 6 hours after the trauma. Twelve patients (44.44%) were admitted only after 24 hours, mainly because of prior recourse to traditional medicine (8 cases) and delays in transfer from the interior of the country (10 referred cases) (Table II).

The Hoffmann fixator was the most used (21 cases, 77.78%), followed by the FESSA (5 cases, 18.52%) and the Ilizarov fixator (1 case, 3.70%) (Table II and Figures 1 and 2). The mean length of hospital stay was 106 days (range: 60–151 days).

Table II: Anatomical, radiological and therapeutic characteristics

Characteristic	n	%
Anatomical site (N = 27)		
Humerus	1	3.70
Femur	4	14.82
Leg (tibia / fibula)	22	81.48
Skin opening, Cauchoix and Duparc (n = 19 recent fractures)		
Type II	9	47.37
Type III	10	52.63
Fracture line (N = 27)		
Comminuted	20	74.07
Transverse	3	11.11
Oblique	3	11.11
Spiral	1	3.71
Time to hospital care (N = 27)		
< 6 hours	10	37.04
6–12 hours	1	3.70
12–24 hours	4	14.82
> 24 hours	12	44.44
Type of external fixator (N = 27)		
Hoffmann	21	77.78
FESSA	5	18.52
Ilizarov	1	3.70

FESSA = Fixateur Externe des Services de Santé des Armées. Eight infected fractures referred as second-line cases are not included in the Cauchoix and Duparc classification.

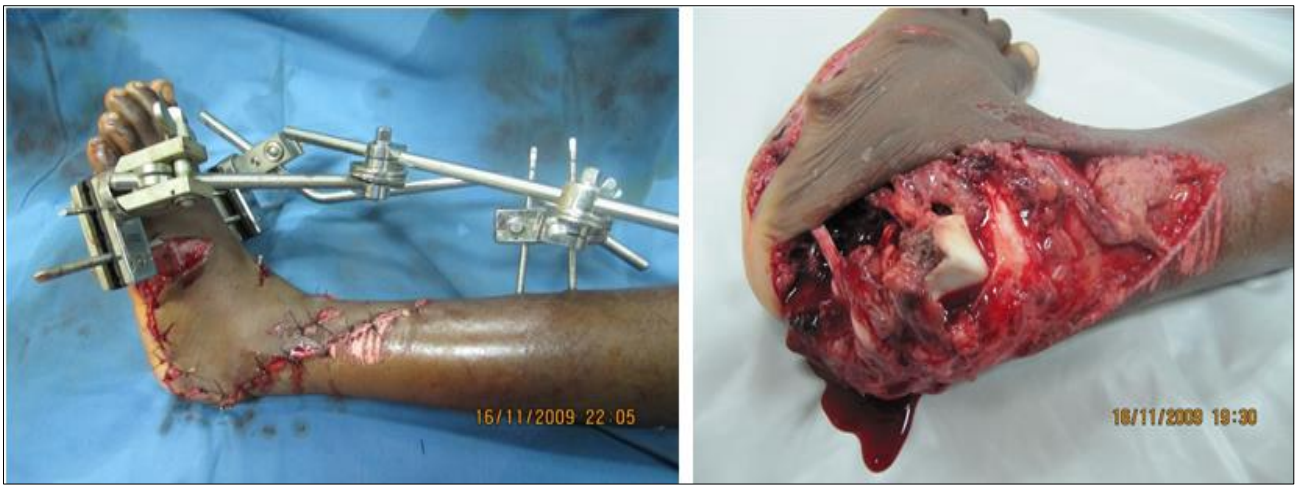


Figure 1: Open type III fracture (Cauchoix and Duparc) of the ankle after debridement, stabilised by a triangulated Hoffmann fixator



Figure 2: Open type III fracture (Cauchoix and Duparc) of the left leg after debridement, stabilised by a FESSA fixator

A favourable course was observed in 17 patients (62.96%). Ten cases of infection were recorded: 3 superficial soft-tissue infections (11.11%), 2 pin-track suppurations (7.41%) and 5 sequestrating osteitis (18.52%). Four patients had pain on walking, and one case of knee stiffness (flexion limited to 76°) was noted (Table III).

At evaluation, after a mean follow-up of 8.5 months (range: 6–32 months), 12 patients were reviewed and assessed according to the Johner and Wruhs criteria. Results were excellent in 7 cases (58.34%), good in 3 cases (25%), fair in 1 case (8.33%) and poor in 1 case (8.33%) (Table III).

Medico-Legal Findings

Of the 27 patients treated by external fixator, 25 presented a context that could justify medico-legal expertise: 18 RTAs (including 7 involving identified third parties) and 7 firearm injuries. The mean estimated duration of total temporary incapacity (TTI) was 106 days. Residual functional sequelae were objectified in 6 cases (chronic pain on walking, joint stiffness) and could be used as a basis for assessing partial permanent disability (PPD). No standardised initial medico-legal certificate had been issued for these patients at the time of admission, underlining a notable documentation deficit (Table III).

Table III: Course, functional results and medico-legal findings

Variable	n	%
Postoperative course (N = 27)		
Favourable course without complication	17	62.96
Superficial soft-tissue infection	3	11.11
Pin-track suppuration	2	7.41
Sequestrating osteitis	5	18.52

Functional results, Johner and Wruhs criteria (n = 12)		
Excellent	7	58.34
Good	3	25.00
Fair	1	8.33
Poor	1	8.33
Medico-legal findings (N = 27)		
Context justifying expertise (18 RTAs, 7 firearm injuries)	25	92.59
Residual functional sequelae (possible PPD)	6	22.22
Standardised initial medico-legal certificate issued	0	0.00

RTA = road traffic accident; PPD = partial permanent disability. Mean follow-up of the 12 patients assessed: 8.5 months (range: 6–32 months).

DISCUSSION

In our series, open fractures of the limbs accounted for 9.87% of hospitalisations. This figure is comparable to that of Moyikoua *et al*., (1992) who, at the Brazzaville University Hospital, reported a frequency of 10.2% for open fractures of the leg. In France, Ribault *et al*., (1991) reported lower figures (6.3%), probably linked to better road safety. The higher frequency observed in sub-Saharan Africa is explained by the rapid growth of motorised traffic without adequate road safety infrastructure (WHO, 2004).

The mean age of our patients (36.5 years) is consistent with African literature. Souna *et al*., (2004) in Niger reported a mean age of 33 years (range: 6–60 years). This predominance of young working-age adults is also described by Dossim *et al*., (2005) in their Ivorian series. It reflects the major economic and social impact of these injuries on the working population.

The male predominance observed in our series (sex ratio = 2.8) is a constant in African literature. Souna *et al.,* (2004) explain it by men's greater exposure to risky activities. Dossim *et al*., (2005), in a series of 108 cases of open fractures of the leg, found 80 men (74%). In European series, this ratio tends to balance out because of women's equal participation in professional life and motorised transport.

RTAs accounted for 66.67% of aetiologies in our study, a result comparable to that of Savornin *et al*., (1989) (54.16%) and Chantelot *et al*., (1999) (13 of 23 humeral fractures due to RTAs). The frequency of firearm injuries (25.93%) is particularly high in our setting and reflects the regional security situation. It is close to the 23% rate reported by Savornin *et al*., (1989). This high proportion of ballistic trauma is of particular medico-legal importance, since every firearm injury must be the subject of a mandatory declaration and rigorous documentation in the medical file (Fournier-Charrière & Tourniaire, 2005; Vieira & Pinto da Costa, 2008).

The predominance of leg fractures (81.48%) is a constant in all African and European series. Vancuyck *et al*., (1988) reported 39 cases of tibial involvement among 40 open fractures of the lower limb. This vulnerability is explained by the anatomical topography of the tibia, whose anterior surface lacks muscle cover, exposing the bone to the slightest direct trauma.

In our series, types II and III predominated (33.33% and 37.04% of the 27 patients, respectively), reflecting the severity of the trauma received. This result is superimposable on that of Vancuyck *et al*., (1988), who found 18 cases of type II and 13 of type III. The Cauchoix and Duparc classification, although old, remains in use in most African centres to guide therapeutic decisions and constitutes a reference medico-legal element.

The predominance of comminuted fracture lines (74.07%), located in the middle third, agrees with the data of Raissouni *et al*., (2000), who found 6 comminuted lines in 12 cases. Comminution, linked to high-energy RTAs and ballistic trauma, is a factor of poor functional prognosis and a determining element in the assessment of the medico-legal severity of the injury.

Time to care exceeded 24 hours in 44.44% of our patients, a clearly unfavourable figure compared with European data (Ribault *et al*., (1991): 60% managed within 6 hours). This delay, linked to the absence of medicalised transport, prior recourse to traditional medicine and geographical remoteness, is a major aggravating factor for the risk of infection (Cierny *et al*., 1985).

From a medico-legal standpoint, this delay is an essential element to document in the medical file. In the event of litigation, the forensic physician must distinguish what stems from the initial injury from what results from secondary aggravation due to delayed care. The liability of the healthcare facility may be engaged if the delay is due to internal organisational shortcomings.

Our two-stage therapeutic strategy (external fixation followed by secondary plaster cast) is comparable to that described by Vancuyck *et al.*, (1988) and Moyikoua *et al*., (1992). The predominant use of the Hoffmann fixator (77.78%) is due to its availability and ease of application in our resource-limited context. The FESSA offers solid assemblies thanks to its rigidity, whereas the Ilizarov fixator, more complex to use, gives

the most stable assembly but requires greater technical skill.

The mean length of stay of 106 days is significantly longer than in European series (mean 45–60 days). This prolonged stay is explained by the frequency of infectious complications and the need for repeated local care. Medico-legally, this duration is the basis for calculating the TTI, which is decisive for the compensation of victims of RTAs and occupational accidents.

The rate of infectious complications (37%) in our series is higher than that reported by Souna *et al*., (2004) (6% superficial infections) and by Princesse Aboude (2003) (10 cases of pin-track infection). This difference is linked to the high rate of delayed care (> 24 h: 44.44%) and to the initial conditions of wound contamination. Sequestrating osteitis (5 cases) is the most serious complication, requiring prolonged sequestrectomy and curettage, aggravating the TTI and possibly justifying recognition of a definitive PPD.

Our functional results were excellent in 58.34%, comparable to those of Raissouni *et al*., (2000), who reported 58.4% excellent results in 12 cases. These satisfactory results, obtained despite the constraints of our environment, attest to the effectiveness of external fixation when the technical principles are respected. Poor results (8.33%) are linked to chronic infection and joint stiffness.

Initial Medical Certificate

The initial medical certificate (IMC) is the fundamental medico-legal document for trauma victims. It must describe precisely the nature of the lesions (open fracture, Cauchoix and Duparc grade), the foreseeable complications, the foreseeable duration of the TTI and the expected sequelae. In our series, the systematic absence of a standardised IMC at admission represents a major documentation gap, detrimental to the interests of patients who are victims of RTAs or occupational accidents (Fournier-Charrière & Tourniaire, 2005).

Total Temporary Incapacity (TTI)

The mean TTI in our series (106 days on average) is significantly longer than French and international reference values (60–90 days for an uncomplicated leg fracture). Infectious complications, notably sequestrating osteitis, may prolong the TTI by a further 6 to 18 months. This datum is decisive for the assessment of damages in the context of insurance and civil liability (Rousseau *et al*., 2010).

Partial Permanent Disability (PPD)

The residual functional sequelae observed in our series (chronic pain, joint stiffness, limping) can be assessed in terms of PPD according to the medico-legal scales in force. In Guinea, experts generally rely on the Guinean Insurance Code and the CIMA Code, but also on the indicative disability scale for occupational accidents (French reference) or on the Concours Médical. For a leg fracture with sequestrating osteitis and residual stiffness, the PPD may vary between 15% and 40% depending on severity (Fournier-Charrière & Tourniaire, 2005; Rousseau *et al*., 2010).

Firearm Injuries

The 7 cases of firearm injuries (25.93%) generate specific medico-legal obligations: mandatory declaration to the judicial authorities, preservation of ballistic evidence (extracted projectile fragments) and drafting of a detailed report. The orthopaedic surgeon must ensure documentation of the presumed trajectory of the projectile, the nature of the bone lesions induced and the septic complications linked to the nature of the necrotic tissues (Vieira & Pinto da Costa, 2008).

Medical Liability and Quality of Care

The occurrence of infectious complications in our series raises the question of medical liability. A distinction must be made between complications inherent in the severity of the initial trauma and those that may result from a failure of care (delayed debridement, inadequate technique, inadequate follow-up). Rigorous documentation of the medical file — with traceability of surgical decisions, prescriptions and control examinations — is the best protection against any subsequent challenge.

CONCLUSION

External fixation is a method of choice in the management of open fractures of the limbs in the African setting, giving good anatomical and functional results despite environmental constraints (prolonged delays before care, limited resources). The Hoffmann fixator remains the most used because of its availability and ease of handling.

Infectious complications, mainly represented by sequestrating osteitis, remain the main factor of poor prognosis and of prolongation of the TTI. Their prevention rests on the rigour of the initial debridement and early management.

From a medico-legal standpoint, open fractures of the limbs — occurring mainly in the context of RTAs, occupational accidents or firearm injuries — raise significant expertise issues. The systematic issuing of a complete initial medical certificate, rigorous documentation of TTI durations and assessment of sequelae in terms of PPD must be an integral part of management. The development of a Guinean medico-legal reference adapted to the traumatological conditions frequent in this setting is an urgent necessity.

These results argue for improved pre-hospital care, continuing training of orthopaedic surgeons in medico-legal documentation, and strengthening of the

diagnostic capacities (image intensifier, CT scan) of our department.

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