Management of neglected open extremity fractures in low-resource settings: Experience of the French Army Medical Service in Chad

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ABSTRACT

Introduction: The purpose of this study was to report the experience of the French Army Medical Service in the management of neglected open extremity fractures and related-complications in Chad.

Hypothesis: Delayed treatment of open extremity fractures is possible in a low-resource setting.

Methods: An observational prospective study was performed in a French Forward Surgical Team deployed in N’Djamena for six months.

Results: Twenty-seven patients, 24 men and three women, mean age 30 years old with an open fracture that was managed more than 24 hours after it occurred were included. The mean treatment delay was 83 days. Fractures were located in the tibia in 20 cases. There were 15 non-infected and twelve infected fractures. The number of cases of debridement, flap coverage, and the overall number of procedures were higher in the group with infection, but the difference was not significant. Treatment of infected fractures was complicated by six early recurrent infections, while there were no complications in the group without infection. The mean follow-up was 4.4 months. Infection was controlled in eleven cases, however evaluation of fracture healing was limited because of the short follow-up in the group with infection. Functional outcome of the lower extremities was often complicated by knee stiffness.

Discussion: Delayed management of open fractures depends on the available resources. In low-resource settings, the goals of surgery should be modest. Treatment of non-infected injuries and osteomyelitis is possible. On the other hand, treatment of infected fractures and septic nonunions should be undertaken with caution if all the necessary aspects of treatment, in particular extended antibiotic treatment and sequential procedures are not possible.

Level of evidence: level IV.

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1. Introduction

Access to modern medicine is still limited in Sub-saharan Africa. In rural areas, this is mostly because local medical facilities are lacking and travelling conditions are difficult due to poor roads and limited means of transportation [1]. Access to healthcare is also a problem for the poor urban population, who may have difficulty paying hospital costs [2,3]. Thus, fractures are often first treated by traditional bone-setters and healers whose methods are not adapted to the management of open fractures [3–6].

Most patients only consult an orthopedic surgeon after a certain delay presenting with severe injuries or sequela that are difficult to cure with the diagnostic and therapeutic means available in local facilities [2,7]. Management of septic complications in open fractures is an especially complex problem. Multiple surgical procedures are necessary, including soft tissue repair, antibiotics and long-term follow-up, which are all problematic in this setting [8,9].

The goal of this study was to analyze the types of treatment administered to neglected open fractures of the extremities and their complications by a French Forward Surgical Team (FST) deployed in Chad, where diagnostic and therapeutic resources are limited but better than those in local facilities.

2. Patients and methods

The Epervier FST is a French medical treatment facility that has been deployed at the Kosei Airbase in N’Djamena, Chad since 1986. More than 95% of its activity involves Medical Aid to the Population (MAP). Reconstruction surgery of the extremities is difficult for several reasons: there is only one orthopedic surgeon; available
surgical material, blood products and antibiotics are limited; there are very few hospital beds; access to postoperative rehabilitation is nearly impossible; and follow-up of patients who must sometimes travel several hundred kilometers to the clinic is unpredictable.

2.1. Patient selection

An observational prospective study was performed for six months between 2010 and 2011. All Chadian patients admitted for treatment of an open fracture that had occurred more than 24 hours before were included, as well as patients who presented with late complications associated with a lack of appropriate primary treatment. Patients were excluded from the study if they had been previously operated on in another medical centre.

2.2. Data collection

The following data were collected: age, gender, mechanism of injury; delay until management in the acute (<7 days), subacute (7 days–3 months) or chronic (>3 months) period [10]; location of injuries; type of open fracture wound according to the Gustilo classification [11]; the presence of infection and/or exposed bone at presentation; the development of late complications such as nonunion, osteomyelitis or malunion; as well as the functional impairment. Nonunion was defined as fractures that had not healed more than six months after injury.

All surgical procedures were analyzed. The number of basic procedures and the mean number of operations per patient were calculated, excluding removal of hardware. Deep tissue samples were systematically obtained during the first operation. In case of infection, appropriate antibiotic treatment was given to patients free-of-charge.

2.3. Evaluation of results

Control of infection and fracture healing were evaluated at follow-up. Recurrent infection was defined as the presence of two of the following signs:

- local inflammation with or without pus;
- C-reactive protein > 10 mg/L;
- presence of bone sequestrum on radiographs [12].

In the lower limb, functional outcome was considered to be satisfactory if the patient could walk without help and with no significant joint stiffness; average, if patients could walk but movement was limited due to stiffness; poor if patients couldn’t walk or needed to use two crutches.

Patients were divided into two groups according to whether or not they had infection on arrival.

2.4. Statistical analysis

Demographic parameters were treated with Excel software (Microsoft, Redmond, WA, USA) to calculate means and standard deviations (SD). Qualitative variables were compared using the Fischer exact test. P < 0.05 was considered to be significant.

3. Results

Three hundred and fifty-five Chadian patients were seen at the orthopedic consultation for the first time: 27 (7.6%) patients were included in the study. There were 24 men and three women, mean age 30 ± 18 years old [range 3–75]. The mechanism of injury was a road accident in 19 cases, a work-related accident in three cases and a fall in 5 cases. The mean treatment delay was 83 ± 127 days [range, 1–545 days]. Three patients were admitted during the acute period, 20 during the subacute period and four during the chronic period. Nineteen patients had been treated by a traditional bone-setter and eight had been to a dispensary (Fig. 1).

3.1. Description of injuries

Seventeen patients presented with an open fracture from the original accident, while ten had a simple fracture with secondary opening due to failed closed reduction and/or immobilization (Fig. 2). Injuries to the tibia were predominant followed by the femur (Table 1). Two patients who could walk without help, presented with healed fractures with chronic osteomyelitis.
Weightbearing was impossible in the other patients with lower extremity injuries.

There were 15 non-infected fractures: two Gustilo 3b tibial fractures treated and 13 subacute or chronic fractures that were mostly type 1 Gustilo fractures (that had occurred during the original accident or following secondary opening) that had healed spontaneously. There were 12 infected fractures: a Gustilo 3b tibial fracture treated during the acute phase, and eleven subacute or chronic fractures including three that were associated with secondary opening (Table 2). Isolated bacteria were sensitive to antibiotics: *Staphylococcus aureus* (6 cases), *Streptococcus* (1 case), *Escherichia coli* (5 cases), *Proteus mirabilis* (2 cases) and *Pseudomonas aeruginosa* (1 case).

### 3.2. Surgical treatment

Although the difference was not significant, the number of internal fixations and bone grafts was higher in the group without infection (Table 2). External fixation was used in this group when the condition of the skin was uncertain. The number of debridements and flap coverages was higher in the group with infection, but was not significantly different. Osteomyelitis was treated by debridement without correction of any associated malunion (Fig. 3). Soft tissue coverage was obtained by pedicled fasciocutaneous or muscle flaps (Fig. 4). The mean number of procedures per patient was twice as high in the infected group: 2.9 versus 1.4.

Postoperative complications included six early recurrent infections in the group with infection requiring sequestrectomies and repeat bone resection in four cases. One amputation was performed several weeks after unsuccessful conservative treatment of septic tibial nonunion. On the other hand, there were no complications in the group of non-infected fractures.

### 3.3. Follow-up results

All patients were seen at a follow-up consultation after a mean 4.3 ± 3.8 months [range, 0.5–12 months]. Infection was controlled in eleven out of twelve cases, but one patient had recently been operated on for recurrent infection (Fig. 5). Fracture healing was obtained in 19 patients and was underway in the others because of the short follow-up. Functional outcome in the 18 patients who presented with healed fractures was considered to be satisfactory in twelve cases and average in six cases because of stiffness of the knee due to a lack of physical rehabilitation. Although the rate of bone union seemed to be higher in non-infected fractures, the mean follow-up was not comparable (Table 4).

### 4. Discussion

The conditions of management of the open fractures and the “classic” complications observed in this series are no longer found in the developed countries, but are a reminder of the huge gap between the African and European healthcare systems [2,7]. In Chad, there are very few local medical clinics and healthcare

<table>
<thead>
<tr>
<th>Procedure, Nb</th>
<th>Non-infected fractures (15 patients)</th>
<th>Infections (12 patients)</th>
<th>Value of <em>p</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Amputation</td>
<td>–</td>
<td>1</td>
<td>–</td>
</tr>
<tr>
<td>Wide excision/Debridement and lavage</td>
<td>12</td>
<td>22</td>
<td>0.13</td>
</tr>
<tr>
<td>Sequestrectomy/bone resection</td>
<td>–</td>
<td>7</td>
<td>–</td>
</tr>
<tr>
<td>Plaster cast alone</td>
<td>3</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>External fixation</td>
<td>8</td>
<td>10</td>
<td>0.55</td>
</tr>
<tr>
<td>Internal fixation</td>
<td>5</td>
<td>1</td>
<td>0.36</td>
</tr>
<tr>
<td>Vacuum assisted wound closure</td>
<td>–</td>
<td>4</td>
<td>–</td>
</tr>
<tr>
<td>Flap coverage</td>
<td>3</td>
<td>9</td>
<td>0.09</td>
</tr>
<tr>
<td>Bone graft</td>
<td>6</td>
<td>2</td>
<td>0.4</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td>56</td>
<td>0.18</td>
</tr>
</tbody>
</table>

personnel are sorely lacking. Only the main hospitals in the capital have an orthopedic surgeon. Moreover, the size of the country, the low density of the population as well as the poor quality of the roads, make access to medical facilities extremely difficult [1]. This explains the treatment delays in this series, which are much greater than those reported in other African series, as well as the frequency of secondary open fractures due to immobilization failure [8,9,13–15].

Logically, the types of surgical treatment used for open fractures and their complications in Sub-Saharan Africa are not frequently reported in the literature. Available publications show that the most frequent difficulties for local orthopedic surgeons are: bone infection due to delayed management; insufficient fixation hardware; insufficient training in soft tissue reconstruction techniques; difficulty obtaining appropriate and long-term antibiotic treatment; and nearly impossible medium and long-term follow-up [7–9,13–17]. This original study was possible thanks to the specific situation of the Epervier FST, which has been providing free treatment to the Chadian population for more than 20 years under conditions that are similar to those in the Western countries despite the above mentioned difficulties.

Delayed treatment of non-infected fractures does not seem to be a problem as long as internal fixation is performed under strictly sterile conditions. This is confirmed by the absence of infectious complications and the high rate of healed fractures in this group. However an asymptomatic infection is always possible when there has been an open wound at some point during healing, and

Table 4
Results at final follow-up.

<table>
<thead>
<tr>
<th></th>
<th>Non-infected fractures (15 patients)</th>
<th>Infected fractures (12 patients)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follow-up (months), mean ± SD</td>
<td>5.6 ± 3.7</td>
<td>2.8 ± 3.6</td>
</tr>
<tr>
<td>Union</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obtained</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>Ongoing</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Not evaluated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functional outcome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfactory</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Average</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Poor</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Not evaluated</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

Fig. 3. Chronic osteomyelitis of the distal femur with malunion and stiff knee (a). The patient can walk without pain with the help of a crutch: it was decided not to correct the malunion, which was considered to be a too high risk in this setting. Postoperative X-ray showing ablation of sequestrum and exposed bone (b).

Fig. 4. Open fracture of the distal quarter of the infected leg in a 10-year-old child managed after 10 days of treatment in a local hospital (a). Wide excision and external fixation (b). Fasciocutaneous flap (c).
deferring internal fixation is risky [12]. In case of doubt, external fixation seems to be the best option. In certain cases this can be converted to early internal fixation when deep tissue specimens have excluded bone infection. Stabilization with a plaster cast is a regular option in African countries because of the limited availability of hardware for internal fixation [2,5,7–9]. Although this approach limits the risk of infectious complications, correction of alignment defects and maintaining stable reduction is not optimal [8,9]. In this setting, we feel that the decision to correct malunion should only be undertaken with caution in patients who can walk. Femoral malunion seems to be a good indication. [16].

The high number of surgical procedures per patient and the rate of recurrent infections emphasize the difficulty of treating delayed infections. Repeated sequestrectomies show that the results of debridement is unpredictable in chronic lesions. Although pedicled flaps can be performed without sophisticated material, effective bone reconstruction is complicated in resource-poor settings. First, because curing infection requires appropriate and prolonged antibiotic treatment. The availability of antibiotics is irregular in local pharmacies and they are often too expensive for the general population. Moreover, bone reconstruction techniques require specific surgical material that is not available, and close monitoring for several months which is extremely difficult in patients from rural areas [18].

The lack of postoperative physical therapy is another issue that determines functional outcome. Self-performed physical therapy exercises were poorly followed. Knee stiffness was nearly systematic after fractures of the diaphyseal femur or tibia. Moreover, because there are so few physical therapists, weight-bearing was difficult to control and often delayed because the patient was apprehensive. The lack of access to functional rehabilitation is especially severe in Chad where there are very few physical therapy centres and patients must pay for these.

This study includes all the limitations associated with surgical care in a resource-poor setting: imprecise age of patients and treatment delay; difficulty evaluating the type of initial open fracture; little background on treatment conditions and the distances travelled by patients; approximate evaluation of functional outcome because of the language barrier and cultural differences. Finally, the treatment options chosen only reflect the author’s experience in this specific setting.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References


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