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Towoezim Tchaa Hodabalo
Department of Orthopaedics and Traumatology, Kara University Hospital, University of Kara, Togo

Dellanh Yaovi Yanick
Department of Orthopaedics and Traumatology, Sokodé Regional Hospital, University of Lomé, Togo

Ayouba Gamal
Department of Orthopaedics and Traumatology, Lomé Regional Hospital, University of Lomé, Togo

Bakriga Batarabadja
Department of Orthopaedics and Traumatology, Notsè Hospital, University of Lomé, Togo

Kombaté Kanfitine Noufanague
Department of Orthopaedics and Traumatology, Afagnan Hospital, University of Lomé, Togo

Walla Atchia
Department of Orthopaedics and Traumatology, Campus University Hospital of lomé, University of Lomé, Togo

Abalo Anani
Department of Orthopaedics and Traumatology, Sylvanus Olympio University Hospital of Lomé, University of Lomé, Togo

Corresponding Author:
Towoezim Tchaa Hodabalo
Department of Orthopaedics and Traumatology, Kara University Hospital, University of Kara, Togo

Methods of bone fixation and skin loss coverage in open leg fractures in precarious area

Towoezim Tchaa Hodabalo, Dellanh Yaovi Yanick, Ayouba Gamal, Bakriga Batarabadja, Kombaté Kanfitine Noufanague, Walla Atchia and Abalo Anani

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Abstract
Introduction: Open leg fractures are common. The aim of this study was to describe the therapeutic and evolutionary aspects of open leg fractures in two hospitals in northern Togo.
Patients and Method: This study was retrospective and descriptive over a 4-year period, from January 2019 to December 2022. It concerned patients managed for a recent open leg fracture in whom osteosynthesis and plasty to cover the fracture site were performed.
Results: We selected 37 patients. The mean age was 34 years. There were 30 men and 7 women, with a sex ratio M/F = 4.3. They were victims of a road accident (95%, n=35) and a work-related accident involving a heavy object falling on the leg (5%, n=2). According to the Gustilo and Anderson classification, the wounds were type II (38%, n=14), and type IIIB (62%, n=23). According to the AO classification, the fracture line was simple in 54% and complex in 46%. Osteosynthesis of the tibia was performed with an external fixator in 23 patients (62%), and centromedullary nailing in 14 cases (38%). The fracture site was covered by a fasciocutaneous flap (43%; n=16) and a muscle flap (57%; n=21). At a mean follow-up of 28 months, there were 4 cases of chronic osteitis. According to the Ketenjian evaluation criteria, the result was judged excellent and very good (57%, n=21); good (30%, n=11) and poor (13%, n=5).
Conclusion: External fixator and muscle flaps are the most commonly used techniques, with satisfactory results.

Keywords: Leg, Type II and IIIB open fractures, external fixator, centromedullary nail, fasciocutaneous flap, muscle flap

Introduction
Open leg fractures are common due to the subcutaneous position of the tibia. They account for 8 to 10% of traumatic injuries to the musculoskeletal system [1]. In Togo, they represent 39.2% of all open fractures [2]. In developing countries, they are caused by road accidents, particularly involving two-wheeled vehicles, and are frequently found in young adults [3, 4]. Open leg fractures are the result of high-energy trauma, responsible for lesions that are often multi-tissular and can impair limb function [5]. They are serious, with an infection rate of 2-40% and a non union rate of 23% [6, 7]. Initial management of open fractures is crucial to subsequent prognosis. In addition to antibiotic therapy, it combines debridement and trimming, fracture stabilization and fracture site coverage [8, 9]. Bone stabilization involves the use of external fixators versus internal osteosynthesis, notably centromedullary nailing and screw plates [10], while skin loss is covered using fascio-cutaneous flaps or muscle flaps. The aim of our study was to describe the therapeutic and evolutionary aspects of open leg fractures in precarious environments.

Patients and Method
This was a retrospective, descriptive study carried out at Kara and Sokodé Hospitals (Togo) over a four-year period, from January 2019 to December 2022. It involved patients aged over 15 years and managed for an open leg fracture in whom osteosynthesis and plasty to cover the fracture site were performed.

Exclusion criteria were leg crushes, type I and II open fractures that progressed well after suturing in the emergency department, and open leg fractures that consulted late, after the onset of infection. The parameters studied were age, sex, type of injury, means of osteosynthesis and coverage of the fracture site, and clinical and anatomical results at the last recoil.

Skin lesions were described using the Gustilo-Anderson classification [11]. Bone lesions have been classified according to AO [12]. As soon as the patient was admitted to the emergency department, the wound was medically treated. This included minimal washing with saline solution and administration of an antiseptic solution. A sterile dressing was applied, followed by temporary immobilization of the fracture site with à splint. Antibiotic therapy consisted of 2 g amoxicillin-clavulanic acid loading dose injectable, followed by 1g every 8 hours.

For highly contaminated wounds, ceftriaxone 2 g daily by injection was preferred, combined with metronidazole 500 mg three times a day. Tetanus prophylaxis was systematically administered with a dose of tetanus toxoid and human tetanus immunoglobulin. In the operating room, under anaesthesia, the patient underwent abundant washing, often with tap water followed by physiological water, followed by meticulous debridement and trimming. Bone fixation was achieved using either an external fixator or a centromedullary nail, depending on the availability of implants and the surgeon's choice. The fracture site was covered either during the same operation or at a later date, depending on the condition of the wound and the patient's socio-economic status. The fracture site was covered with a fascio-cutaneous flap, or a muscle flap, depending on the surgeon's experience and the extent of the skin loss (Fig 1).

Fig 1: Secondary necrosis of a wound initially classified as Gustilo-Anderson type II in front of a fracture site of both bones of the left leg in a 45-year-old patient. A: clinical aspect of cutaneous necrosis. B: leg X-ray, antero-posterior view; C: profile view

Anatomical and functional results were assessed using the modified Ketenjian criteria [13] after an average follow-up of 28 months.

Results

Thirty-seven (37) patient files were retained. The mean age was 34 years. There were 30 men and 7 women, with a sex ratio M/F = 4.3. They were victims of a road traffic accident (95%, n=35) and a work accident involving a heavy object falling on the leg (5%, n=2). Among the road traffic accidents, a motorcycle was involved (94%, n=33) and in two cases (6%, n=2) it was a car-pedestrian impact.

According to the Gustilo and Anderson classification, wounds were type II (38%, n=14), and type IIIB (62%, n=23). Type II wounds had secondary necrosis, resulting in exposure of the fracture site. There was simultaneous fracture of both leg bones (89%, n=33). In 3 patients (8%), the fibular line was located on the lateral malleolus. In one case (3%, n=1), the bone injury was an isolated tibia fracture. According to the AO classification, the fracture line on the tibia was simple in 54% and complex in 46% of cases (table 1). The fracture was located in the proximal third (32%; n=12), middle third (49%; n=18) and distal third (19%; n=7). The open leg fracture was associated with an open patella fracture (8%; n=3); and a fracture of the homolateral femur resulting in a floating knee (11%; n=4). Head trauma was associated (14%; n=5).

The mean time to the operating room was 34 hours, with extremes of 6 and 60 hours for type IIIB open fractures, and 16 days, with extremes of 12 and 27 days for secondary skin necrosis. Osteosynthesis of the tibia was performed using an external fixator in 23 patients (62%) (Figure 2), and centromedullary nailing was performed in 14 cases (38%). Lateral malleolus pinning was associated with fractures of the distal third.

Table 1: Type of the fracture line

	AO classification	Number	Percentage
Oblique	A2	12	32
Transverse	A3	8	22
With 3rd fragment	B2	11	30
Partial comminution	B3	6	16
Total		37	100

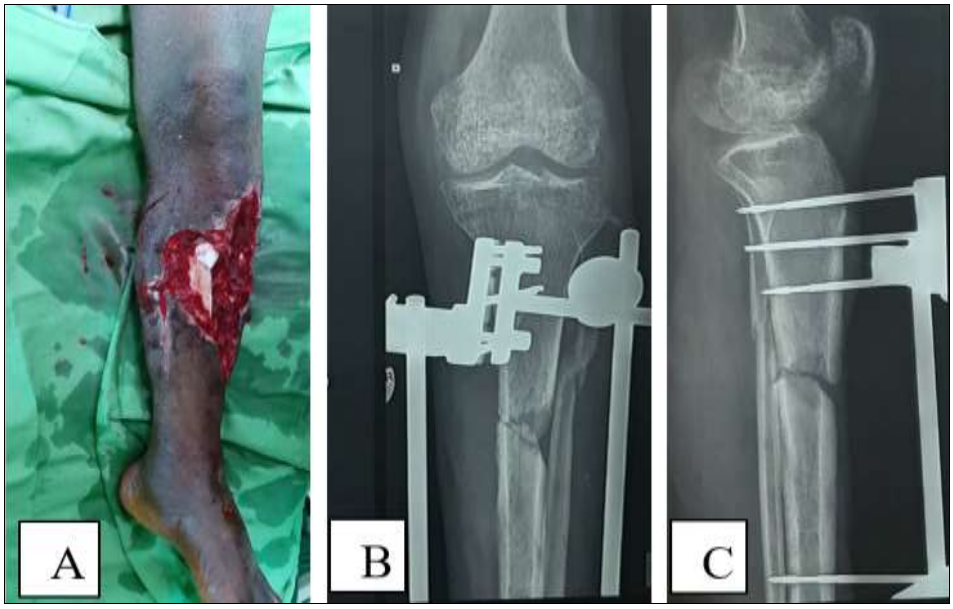

Fig 2: Management. A: wound appearance after debridement and trimming. B and C: bone stabilization with external fixator. We note the loss of bone substance after trimming

The fracture site was covered by a fasciocutaneous flap (43%; n=16) and a muscle flap (57%; n=21) (Table 2).

Table 2: Flap types

	Fracture site	Number
Muscle flap		
Soleus with distal hinge	Middle third, distal third	12
Soleus with proximal hinge	Middle third, proximal third	5
Gastrocnemius	Proximal third	4
Fasciocutaneous flaps		
Sural with distal hinge	Middle third, distal third	12
Cross leg	Proximal third	3
Gliging flap	Distal third	1
Total		37

The muscle flap was performed at the same time in eight (08) patients, and delayed in 13 others. The proximal hinge soleus flap and the proximal hinge medial gastrocnemius flap were used for proximal fractures. The distal hinge soleus flap was used to cover middle third and distal fractures. Muscle flaps were supplemented by a thin skin graft (figure 3). The fasciocutaneous flap was sural with a distal pedicle in 12 cases. A cross leg flap was used in 3 patients. Weaning was obtained on day 21. In one case, a gliding flap was used.

Fig 3: Coverage of skin loss. A: budding wound after muscle flap. B: healing after thin skin grafting.

Necrosis of the fasciocutaneous flap occurred in one patient. Four (04) muscle flap failures required revision. Primary bone consolidation was achieved (35%, n=13) within an average of four months, mostly following centromedullary nailing (Table 3). At a mean follow-up of 28 months, bone consolidation was achieved (89%, n=33) with an average lead time of 7.2 months (figure 4). There were 4 cases of chronic osteitis on consolidated bone, 4 non union, 2 of which were septic. The infection rate was 16% (n=6). Ankle stiffness was noted in 8 patients. According to the Ketenjian evaluation criteria, results were judged to be excellent and very good (57%, n=21); good (30%, n=11) and poor (13%, n=5).

Fig 4: Control X-ray of the leg at 6 months post-op, showing bone consolidation. A: A/P view; B: profile view

Table 3: Fracture progression according to osteosynthesis material

	Initial number	1st-line consolidation	Walking cast boot	Fibula osteotomy + nail	2nd intention consolidation	Non union
Hoffmann I	10	0	10	3	8	2
Orthofix	8	5	3	0	3	0
External fixator for the armed forces health service	5	0	5	2	4	1
Nail	14	8	0	0	5	1
Total	37	13	18	3	20	4

Discussion

The aim of our study was to describe the management of Gustilo-Anderson type II and IIIB open fractures in our context. Limitations are related to the small size of our series, which did not allow for a comparative study of the methods used. In addition, the retrospective nature of the study meant that we were unable to collect all the data on the treatment of cases of early infection. As the cost of treatment is borne by patients and their families, treatment protocols are not always adhered to, due to financial difficulties.

Open leg fractures are prevalent in young male subjects, as reported in the literature [2, 3, 4, 10]. Road traffic accidents are the primary cause of open leg fractures in most series [14, 15, 16]. In sub-Saharan Africa, motorcycles are involved in the majority of cases, due to the proliferation of these two-wheeled machines and their use as motorcycle cabs [2, 10]. The leg is the most frequent site of open fractures in adults, due to the subcutaneous location of the medial face of the tibia [17].

These lesions raise the problem of the type of osteosynthesis and coverage of the loss of cutaneous substance. This problem is more acute in our context, which is marked by financial difficulties and limited technical resources.

As far as bone fixation is concerned, the literature has long recommended external fixation, as it offers better infection control [5, 15, 18]. A number of other reasons were also put forward, including the rapidity of the surgical procedure, the management of associated lesions and the possibility of covering the fracture site with a flap. Since the 1990s, however, infections of the external fixator pins, the need for repeat surgery before bone consolidation is achieved, and encumbrance of this osteosynthesis material for the patient, have led to a preference for internal endomedullary osteosynthesis [3, 10]. The centromedullary nail offers immediate stability, better handling for coverage of the fracture site, no encumbrance for the patient, and more often than not, bone consolidation in the first instance [3, 10, 19]. Other authors recommend the Ender nail [1, 4].

In our series, the external fixator was the most widely used (62%). This was due to its availability and lower cost compared with a centromedullary nail. Madougou in Benin, Barry in Guinea and Bombay in Cameroon used the external fixator in 42.85%, 44.7% and 94% respectively [4, 14, 20]. Mathieu *et al*. recommended the external fixator in poor sanitary conditions [21]. The centromedullary nail was used in 38% of cases in our study, and achieved first-line consolidation.

For coverage of skin loss, our preference was for a nearby muscle flap (57%), supplemented by a thin skin graft. The literature recommends the fasciocutaneous flap in emergencies, and reserves muscle flaps for cases of open fractures seen late (15 days to 3 weeks), and osteitis [5]. However, according to Danino *et al*. there is no significant difference between muscle and fascio-cutaneous flaps in terms of bone healing and infection [22].

The operative strategy in our series is not unambiguous. It depends on the surgeon's experience, the extent of the wound, the degree of soiling, but above all on the patient's financial means and the working environment. These criteria have sometimes led us to adopt the "all-in-one time" strategy [23]. This strategy led to the failure of muscle flaps in 4 cases.

According to the Ketenjian criteria, our results were excellent, very good and good in 87% of cases. These results are similar to those of Bakriga and Traoré, with 85% and 82.9% respectively [10, 24]. Complications were dominated by infection (16%) and non union (11%).

Conclusion

Open leg fractures are frequent and serious injuries. They are on the increase due to the resurgence of road traffic accidents. Their social impact is significant, as they particularly affect a young, active male population. Their management is a real problem in our daily practice. After careful debridement and trimming, the external fixator is most often used for bone fixation, and the muscle flap to cover skin loss. Our results are satisfactory and comparable to studies carried out under the same conditions.

Conflict of Interest

Not available.

Financial Support

Not available.

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