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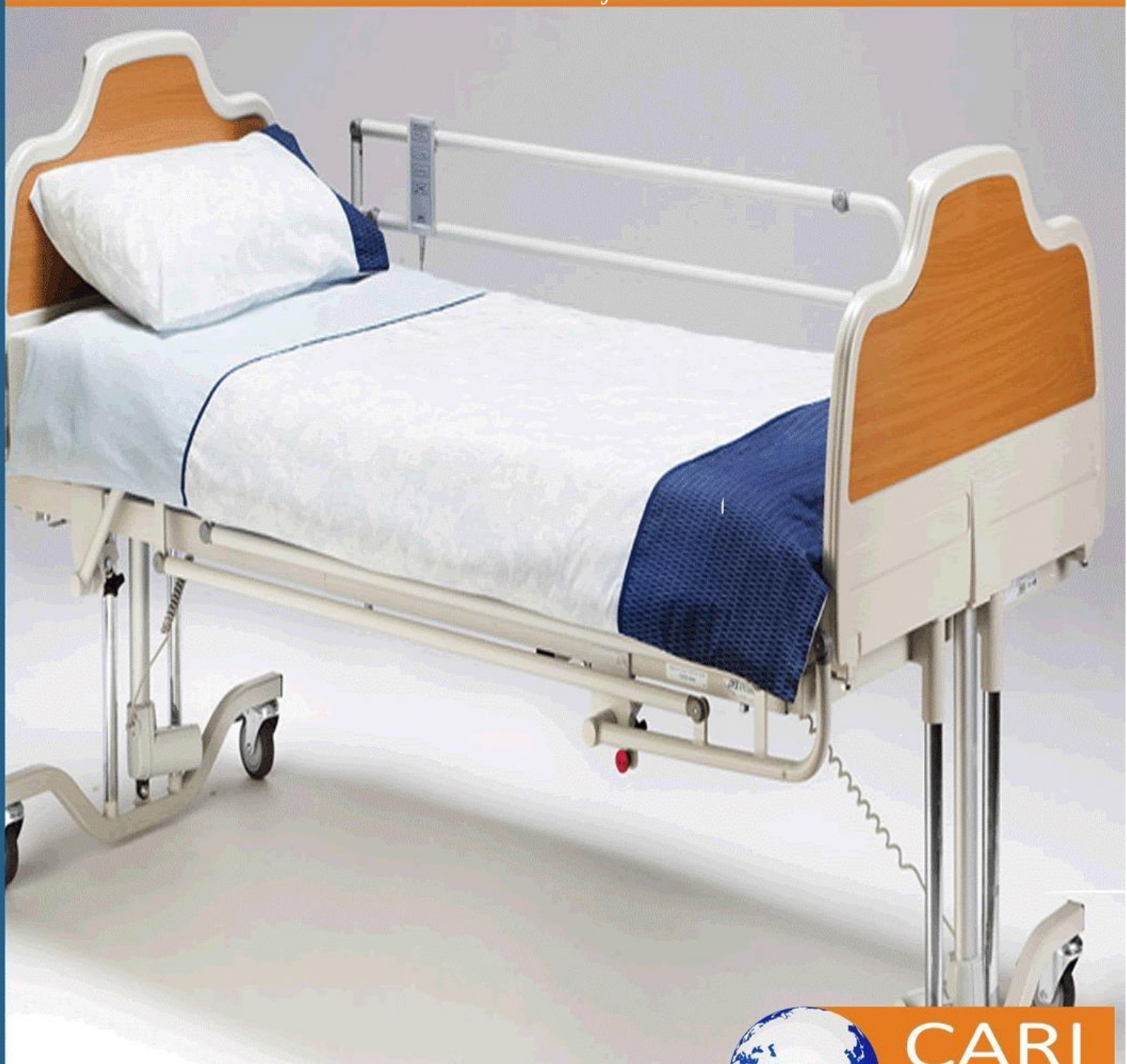

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Favouring Factors and Germs Involved in Infection of Open Leg Bone Fractures at Bonzola Hospital in Mbujimayi: Descriptive Cross-Sectional Study

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Abstract

Purpose : Leg bone fractures are the most common skeletal fractures of the pelvic limb. The aim of this study was to determine the factors favoring infection of open leg bone fractures, and the germs involved.

Methods: This descriptive cross-sectional study was carried out at Bonzola Hospital in Mbujimayi, D.R. Congo, from January 1, 2018 to June 30, 2021, and included patients with open leg bone fractures. The association between a factor and the occurrence of infection was assessed using the correlation test (considered significant if $p \leq 0.05$).

Results: Fracture site infection was found in 60.3% of open fractures, dominated by Staphylococcus aureus. Factors significantly associated with the occurrence of this infection were time from trauma to first aid, treatment received prior to hospital admission, type of treatment received prior to hospital admission (in a health center), prolonged time from trauma to hospital arrival, context of admission to Bonzola Hospital (emergency), Gustilo fracture type (II and III) and first bone treatment.

Unique Contribution to Theory, Practice and Policy: Open leg bone fractures are common. Infection occurs particularly in Gustilo and Anderson types 2 and 3. There are controllable factors associated with the occurrence of infection.

Key words: *Open Fracture, Leg Bone, Infection, Favouring Factors, Germs.*

Introduction

Leg bone fractures are the most common skeletal fractures of the pelvic limb. They are often open and may involve one or both leg bones. Because of its subcutaneous location and poor vascularization, the tibia is the most exposed bone [1]. Worldwide, the incidence of open tibial shaft fractures averages 17 per 100,000 people per year. These fractures mainly affect young adults under the age of 40, with a male:female sex ratio of 2:1 [2]. The most frequent complications are compartment syndrome (10%), infection (2-40%), pseudarthrosis (23%), thromboembolic disease (60% in the absence of thromboembolic prevention) and anterior knee pain (>50%). The rate of infection in open tibial fractures varies from 2% to 40% depending on the series [1-4].

The main complication of open fractures is infection, which jeopardizes limb preservation in the short term and consolidation in the medium term (septic pseudarthrosis). Infection is one of the factors that delay healing and prolong hospital stay, with a high risk of thromboembolic disease [5, 6]. The lack of factual data on open leg bone fractures in our setting, despite their high frequency, motivated the initiation of this study, which aimed to provide answers to the question of how common is the occurrence of infection, what factors expose open leg fractures to infection, and what germs are involved?

The overall aim of this study was to determine the factors and germs responsible for infection of open leg bone fractures, in order to help reduce their rate.

Methods

Type of study

This is a descriptive cross-sectional study carried out at Bonzola Hospital in Mbujimayi, D.R. Congo, from January 1, 2018 to June 30, 2021, on patients with open leg bone fractures.

Study setting

This study was conducted in the surgical department of the Hôpital Général de Référence (HGR) Bonzola, located in the commune of Kanshi, town of Mbujimayi, Kasai-Oriental province, Democratic Republic of Congo.

The HGR Bonzola has a capacity of 223 beds, including 74 beds for the surgical department, which employs two surgeons, 4 general practitioners and 17 nurses.

The choice of this hospital structure was motivated by the fact that it constitutes a framework for the care and referral of patients with various traumatic and orthopedic pathologies in the province of Kasaï Oriental.

The HGR Bonzola bacteriology laboratory was used for bacteriological analysis of secretions collected from fracture sites.

Participants and sample

The study included patients who had consulted HGR Bonzola either in an emergency setting, by referral from other medical facilities, or by ordinary outpatient consultation for pelvic limb skeletal bone fractures during the study period. Seventy-three patients with open leg bone fractures with complete medical records were included in the present study. The sample was therefore exhaustive.

Study variables

The parameters of interest were demographic: (age and sex); pre-hospital (circumstances of trauma, time in hours between trauma and first aid, place of first aid, treatments received before admission to Bonzola); clinical (time of admission to HGR Bonzola, type of fracture according to Gustilo classification); bacteriological (germ isolated) and therapeutic (qualification of staff who administered first aid, room used for first aid, use of sterile cloths, soft-tissue first aid, first bone treatment and final bone treatment).

Data source

The following documents were used for data collection: a pre-established and pre-coded data collection sheet; patients' medical records; culture and antibiotic susceptibility laboratory result vouchers; consultation, hospitalization and laboratory registers, as well as operative reports.

Data analysis:

The data collected on the individual charts were encoded and analyzed using IBM SPSS Advanced Statistics 20.0.0 software. Results were presented in tabular form and expressed in terms of numbers (n), proportions (%) and means (M). The existence of an association between a factor and the occurrence of infection was assessed using the correlation test. Associations were considered significant when the p-value was ≤ 0.05.

Ethical considerations

This study received approval from the Research Ethics Committee of the Official University of Mbujimayi (CERUOM) and was approved by the Human Resources Department of the Bakwanga Mining Company (MIBA). Informed consent was obtained from participants prior to data collection. Confidentiality and anonymity of participants were guaranteed in the use of data.

Results

Frequency of open fractures at Bonzola RGH

Of a total of 286 patients with pelvic bone fractures, 104 had leg bone fractures (36.4%), 73 of which were open fractures (70.2%) and 31 closed fractures (29.8%). Of the 73 patients with open fractures, 44 had developed an infection, i.e. a hospital frequency of 60.3%.

Among patients treated for open leg bone fractures, males were in the majority (76.1%), with a male: female sex ratio of 2.7. The 41-50 age group was predominant (28.3%). The average age of

patients was 38±3 years. Road traffic accidents were the main cause of trauma, accounting for 72.3% of all cases.

Clinical and therapeutic aspects, and occurrence of infection.

Type 3 open fractures according to the Gustilo and Anderson classification had a very high infection rate (82.4% n= 14/17), followed by type 2 open fractures with 68.6% (n= 24/35).

All patients had undergone soft-tissue treatment. Patients treated orthopedically with reduction plus plaster during initial and definitive bone treatment had a high proportion of infections, with 62.5% (n= 10/16 cases) and 62.8% (n= 27/43 cases) respectively (Table 1).

Table 1 : Distribution of open fractures according to occurrence of infection based on severity of opening (Gustilo), quality of 1st and 2nd (definitive) bone treatment

Variables	Occurrence of infection (n=73)		
	Yes n(%)	No n (%)	Total n(%)
Severity of skin opening			
Type 1	6 (28,6)	15 (71,4)	21(100)
Type 2	24 (68,6)	11 (31,4)	35(100)
Type 3	14 (82,4)	3 (17,6)	17(100)
Immobilization after initial bone treatment			
Metal gutter	33 (62,3)	20 (37,7)	53(100)
Fenestrated cruro-pedestal plaster	10 (62,5)	6 (37,5)	16(100)
Continuous translation	1 (25,0)	3 (75,0)	4 (100)
Immobilisation after bone treatment			
External fixer	6 (54,5)	5 (45,5)	11 (100)
Reduction + Plaster	27 (62,8)	16 (37,2)	43 (100)
Bone excision + Papineau graft + external fixator	11 (57,9)	8 (42,1)	19 (100)

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Germs isolated at sites of infected open leg bone fractures

Bacteriology was carried out in only 44/73, or 60.3% of patients with infection. Staphylococcus aureus was the most frequently encountered germ, accounting for 38.6% (n=17/44), especially in superficial infections (76.5% n=13/17). The germ isolated in the laboratory had no significant statistical association with the notion of superficial or deep infection (Chi-square= 12.7; Chi-square= 18.31; ddl= 10; p>0.05) (Table 2).

Table 2 : Distribution of cases according to germs involved

	Type of infection (n= 44)		Total
Germs isolated	Superficial	Deep	
Staphylococcus aureus	13	4	17
Staphylococcus albus	1	0	1
Proteus vulgaris	5	0	5
Providencia stuartii	4	1	5
Proteus mirabilis	5	4	9
Streptococcus pyogenes or group A beta hémolytic	3	4	7

Factors influencing the occurrence of infection

We analyzed demographic, pre-hospital (anamnestic), clinical and therapeutic factors for their possible influence on the occurrence of infection. Demographic factors (sex, age) were found to have no influence on the occurrence of infection. Sex (p= 0.882), age (p= 0.359).

Seven of the other factors were found to have an influence on the occurrence of infection. These were four pre-hospital factors (long delay between trauma and first aid, treatment received prior to hospital admission, type of treatment received prior to hospital admission, long delay between trauma and hospital arrival), two clinical factors (context of hospital admission Bonzola, type of fracture according to Gustilo) and one therapeutic factor (type of reduction/immobilization at first bone treatment (cruro-pedictic cast) (Table 3).

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Table 3 : Influence of pre-hospital, clinical and therapeutic factors on the occurrence of infection

Variables	Pearson Corrélation = r	Meaning = p
Pre-hosptal factors		
Prolonged delay between trauma and 1st aid (>6h)	0,313	**0, 015**
Treatement received elsewhere (health centers)	0,277	**0,032**
Type of treatment received elsewhere (medical treatment and simple wound dressing)	-0,264	**0,042**
Prolonged delay between trauma and arrival at Bonzola hospital (>6h)	0, 453	**0,0001**
Trauma circumstance (Road traffic accident)	0,239	0,10
Associated Chronic pathologies (hypertension)	0,083	>0,10
Clinical factors		
Context of admission to Bonzola Hospital (emergency)	-0,274	**0,034**
Gustilo fracture (II and III)	0,277	**0,032**
Associated traumatic lesions	0,039	0,766
Qualification of person providing 1 st aid	0,127	0,334
Therapeutic factors		
Type of reduction/immobilization at first bone treatment (cruropedic cast)	-0,327	**0,011**
Use of sterile or non(sterile cloths for treatment	0,220	0,091
Soft tissue firts aid	-0,211	0,106
Definitive bone treatment	0,110	0,403

Discussion

Frequency of open fractures

Of a total of 286 patients admitted for pelvic limb bone fractures, 104 had leg bone fractures (36.4%), including 73 cases of open fractures (70.2%) and 31 cases of closed fractures (29.8%). This frequency is higher than the results of the series by Alidou T et al: 17% [6].

44 of the 73 patients with open fractures had developed an infection, representing a hospital frequency of 60.3%. The authors report that infection is the main complication of open fractures. Its proportion varies from hospital to hospital. In Sub-Saharan Africa, as in Nigeria and Chad, the rates are 51% and 44% respectively [7]. Madougou et al [8] found 30% soft-tissue infection and 28.3% skin necrosis; the same findings were made by Fonkoue and Nyamulani [9, 10]. The authors cited by Thériault B [11] maintain that a higher rate of infection is associated with open fractures, given the greater involvement of soft tissue and the often associated contamination [12, 13], particularly in cases of open Gustilo III fractures.

Demographic and pre-hospital aspects

The age of our patients ranged from one year to over 60 years, with an average of 38+/- 3 years comparable to that of Handy et al: 38 ± 5 years [14]. Roussignol et al. reported a mean age of 38 years [15]. Laigle M and Lack W found similar results, with mean ages of 36 and 28 respectively [16, 17].

21 women (28.8%) and 52 men (71.2%) were included in our study, with a sex ratio of ten men to four women. These data concur with those reported in the literature, which stipulate that men are more affected than women [18, 19]. Male predominance was also found by Dakouré and Guillain [20, 21], and has remained constant in all other similar studies [22, 23].

57/73 cases (78.1%) of open leg fractures were caused by road traffic accidents. In Japanese series, motorcycle MVAs were incriminated in 53.54% [24].

Clinical and therapeutic aspects and onset of infection

Our investigations confirmed that open fractures of the Gustilo III type had a very high infection rate (82.4% or 14/17 cases), followed by the Gustilo II type with 68.6% or 24/35 cases.

The association between the high infection rate and the severity of open fractures is confirmed by the work of Bergh et al [25]. Encinas established a relationship between the opening of the fracture site and the occurrence of infection [26], while Bayrak gave the infection rate according to the type of skin opening: 2% in type I, 10% in type II and up to 50% in type III [27].

Bayrak's observations are similar to ours; only the percentage remains very high in our study by virtue of the fact that we calculated them on the total of each Gustilo type, whereas Bayrak calculated them on all open fractures.

All authors agree, however, that the infection rate is largely correlated with the stage of the open fracture according to Gustilo's classification [28, 29].

Patients treated with reduction plus plaster had a high proportion of infection in both initial and definitive bone treatment, with 62.5% (n= 10/16 cases) and 62.8% (n= 27/43 cases) respectively.

One series reported that 46.1% of patients treated with reduction-window plaster had developed infection [30].

Isolated germs

Bacteriologically, our work found that Staphylococcus aureus was the most common germ encountered, with 17/44 cases (38.6%). This result is identical to that reported in the literature, which states that staphylococcus aureus is the usual infectious agent [31, 32].

Factors influencing the occurrence of infection

We analyzed demographic, pre-hospital, clinical and therapeutic factors to seek their possible influence on the occurrence of infection. Four pre-hospital factors were found to have an influence on the occurrence of infection. Four pre-hospital factors were found to have an influence on the occurrence of infection: the long delay between the trauma and first aid favoured the onset of infection, as did all treatments received either at home or at the traditional practitioner's, which delayed first aid. On the other hand, treatment in a health center or first hospital helped to reduce the rate of infection. Prolonged delay between trauma and hospital arrival or first aid was a negative factor.

Kikobya also found that the time between fracture and arrival at the point of care, as well as the time between trauma and first aid, were risk factors in the occurrence of infection in open leg fractures [32].

Laigle observed, for associated chronic pathologies, that a history of diabetes mellitus would expose four times more to infectious complications [16]. Toxic habits (tobacco and alcohol) and the degree of openness of the skin are also risk factors for infection of open fractures.

These were the context of admission to the Bonzola hospital and the type of fracture according to Gustilo. Receiving and treating open fractures as emergencies limited the occurrence of infection.

Several authors have emphasized Gustilo fracture type as an important determinant in the occurrence of infection [33].Our results also confirm those of Webber et al, who found that the most important factor in the occurrence of infection was Gustilo open fracture type [1, 34].

With regard to therapeutic factors, our study showed that a good first bone treatment has a beneficial influence on the occurrence of infection. None of the authors consulted studied this parameter. Our hospital does not have all the necessary equipment to ensure conventional treatment of open fractures on arrival. The first bone treatment performed in this hospital with limited resources is therefore a waiting treatment before definitive surgical management, which may take place a few hours or days later.

Study limitations

The limitations of our study are its retrospective nature and the non-randomized nature of the sample.

Conclusion

Open leg bone fractures are common and often become infected in our setting, particularly Gustilo type 2 and 3 fractures.Staphylococcus aureus is the germ most frequently encountered. The factors associated with the occurrence of infection in these open fractures are, on the one hand, controllable factors such as prolonged delay between trauma and first aid, prolonged delay between trauma and arrival at the destination hospital and, on the other hand, an uncontrollable factor constituted by the type of fracture opening according to Gustilo (II and III). The only uncontrollable factor associated with the occurrence of infection is the severity of the skin opening.

What's known about it

Leg bone fractures are the most common skeletal fractures of the pelvic limb

Open leg bone fractures become seriously infected.

What this study contributes

Staphylococcus aureus is the germ most frequently encountered in infected open leg bone fractures in Mbujimayi

Factors associated with the occurrence of infection in these open fractures are, on the one hand, on the one hand, controllable factors such as the long delay between trauma and first aid, the long delay between trauma and arrival at the destination hospital and, on the other hand, an uncontrollable factor constituted by the type of fracture opening according to Gustilo (II and III).

Conflicts of interest

The authors declare no conflicts of interest

Contributions of the authors

(1) MUAMBA MUKENDI C.: Substantial contribution to the design and configuration, data acquisition, analysis and interpretation of the data.

(2) MBUYAMBA TSHIKOMBA H.: Contribution to the analysis, interpretation of the data, follow-up of the work and drafting of the manuscript.

(3) NGANDU TSHILUNDA J.: Contribution to analysis, interpretation of data and follow-up of work.

(4) UWONDA AKINJA S.: Substantial contribution to design and configuration, data acquisition, analysis, interpretation of data and direction of entire work.

(5) KAMWEMA SHAMUANA R.: Corresponding Authors ,substantial contribution to the design and configuration, data acquisition, analysis and interpretation of the data

(6) WAKUNGA WARACH G.: Substancial contribution to the design and configuration, data acquisition, analysis data interpretation and direction of the entire job.

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