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Mbujimayi, DR Congo.**



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Pin-Tract Infection in External Fixation of Long Bones in Mbuji mayi, DR Congo.

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ABSTRACT

Purpose: External fixation for long-bone fractures is widely used in resource-limited settings but carries a substantial risk of pin-tract infection. This study aimed to describe the epidemiological, clinical, and bacteriological profile of pin-tract infections in an under-equipped environment.

Methods: this longitudinal descriptive study was conducted from March 2023 to August 2025 in two healthcare facilities in Mbuji mayi (DR Congo). Patients who underwent external fixation of a long bone were included, provided they received radioclinical follow-up, bacteriological examination of the pin tract, and post-removal evaluation. Data were analyzed using IBM SPSS 28.0.

Results: Eighty-eight isolates out of 292 samples (30.1% of the pins) confirmed pin-tract infection, with at least one pin positive in 38 out of 52 patients (73.0%). Clinically, pin-tract infection presented with pain, edema, and drainage. Staphylococcus epidermidis (33%), Enterobacteriaceae (27.3%), and Staphylococcus aureus (22.7%) dominated the bacteriological profile. Therefore, external fixation is associated with a significant risk of pin-tract infection. The magnitude of this problem highlights the need for preventive strategies and targeted treatment based on local pathogen distribution.

Unique Contribution to Theory, Practice and Policy: This study provides the first local bacteriological mapping of pin-tract infections in Mbuji mayi, quantifies their high prevalence in under-resourced settings, and offers evidence-based guidance for adapting prevention and antibiotic strategies to local microbial patterns.

Keywords: External Fixation, Pin-Tract Infection, Bacteriological Profile.

INTRODUCTION

External fixation is a widely used method of osteosynthesis worldwide, both as a temporary treatment pending internal fixation and, in many resource-limited settings, as a definitive solution [1,2]. Introduced into our practice barely two decades ago, it has become established in the therapeutic arsenal for fractures of the long bones of the limbs [3].

Because of its ease of handling and reusability, the external fixator (EF) is perfectly suited to the under-equipment constraints that characterize much of sub-Saharan Africa [2,4]. However, the main complication remains pin-tract infection (PTI), suspected by some of being the cause of treatment failure [5-7].

Several factors have been associated with the development of PTI, including advanced age at the time of fixation, severity of the initial injury, rural agricultural living conditions, comorbidities such as diabetes, and smoking. Technical factors—such as motorized pin insertion, inadequate fixation, and prolonged duration of external fixation—also play a significant role [5-8].

Three pathogenic mechanisms have been proposed in the development of PTI: local inflammation around the pins, fluid accumulation at the pin–bone interface, and mechanical irritation due to suboptimal frame assembly [6,7].

Preventive strategies include the use of bioactive coatings (antibiotics, hydroxyapatite, or silver nitrate), manual pre-drilling with irrigation to reduce thermal necrosis, strict pin-site care protocols, and, when possible, avoiding the reuse of pins [9,10].

The objective of this study was to describe the epidemiological, clinical and bacteriological profile of pin-tract infections in the context of under-equipment.

METHODS

This descriptive and prospective study was conducted from March 1, 2023 to August 31, 2025, i.e. a period of two years and 6 months, in two health establishments in Mbuji-Mayi (Democratic Republic of Congo): the Surgical Department of Bonzola General Hospital and the SUMEDCO Centre (formerly POLYMBU). These facilities were selected for their geographical accessibility, their expertise in managing osteoarticular conditions, and their equipment enabling adequate care of common musculoskeletal disorders.

Sampling was exhaustive and included all patients who provided free and informed consent and met the following criteria: having undergone external fixation (EF) of a long bone during the study period; having available radioclinical follow-up; having undergone bacteriological assessment of the pin tracts; and having been evaluated after fixator removal. Patients who died during treatment or were lost to follow-up were excluded.

The variables of interest included sex, age, place of residence, socioeconomic status, location of the external fixator, presenting complaints at evaluation, clinical signs, and the evolution of pin sites after fixator removal. Socioeconomic status was assessed using an index adapted from the 2013 DRC Demographic and Health Survey [12].

Pin-tract infection (PTI) was clinically assessed using a classification adapted from the Checketts–Otterburn system [13]. Minor infection was suspected in the presence of pain, inflammation, or purulent discharge around the pin site and confirmed by the isolation of a pathogenic organism on culture. Major infection was defined by the presence of radiographic abnormalities in addition to clinical signs.

Bacteriological samples were collected from each mounted pin according to the recommendations of the French Language Society of Infectious Pathology (SPILF) [14]. The insertion site was cleaned with 70% denatured alcohol. A syringe fitted with a catheter was used to aspirate the purulent fluid along the pin-tract. If no secretion was obtained, 1–2 mL of saline solution was injected along the pin-tract and aspirated. The syringe was then sealed and sent directly to the laboratory for culture.

Antibiotic susceptibility testing was performed using the modified Kirby-Bauer disk diffusion method on Mueller-Hinton agar and interpreted according to Clinical and Laboratory Standards Institute (CLSI) criteria. The antibiotics tested were amoxicillin (30 µg), ampicillin (10 µg), amikacin (30 µg), ceftriaxone (30 µg), cefixime (5 µg), ciprofloxacin (5 µg), clindamycin (2 µg), erythromycin (15 µg), gentamicin (10 µg), levofloxacin (15 µg), and trimethoprim-sulfamethoxazole (1.25/23.75 µg) [15]. Disks were supplied by Liofilchem (Italy) and purchased from local distributors in Mbujimayi.

Inhibition diameters were classified into three categories: "Sensitive" (S), when efficacy was expected at standard dosages; "Sensitive with increased exposure" or "Intermediate" (I) when efficacy required an increase in dose or exposure; and "Resistant" (R), when efficacy was unlikely, even with increased exposure.

All patients were treated exclusively with a unilateral external fixator. The pin tracts were managed according to the following protocol: disinfection of the orifices with denatured alcohol around any healed orifices, application of Dakin's solution around any orifices with drainage or a wound, and administration of oral antibiotics and anti-inflammatories to patients presenting signs of infection. After external fixator removal, dressings were applied using pure povidone solution.

Data were analyzed using IBM SPSS Advanced Statistics 28.0. Mean, standard deviation, and corresponding frequencies and percentages were calculated for continuous variables such as age and fixation duration. Associations between categorical variables were assessed using Fisher's exact test, with statistical significance level set at $p < 0.05$ and a 95% confidence interval.

Ethical approval was obtained from the Ethics Committee of the Official University of Mbujimayi, and the study was conducted in strict accordance with the fundamental ethical principles of the 2013 Helsinki Declaration.

RESULTS

Epidemiological, clinical, and bacteriological profile of pin-tract infection (PTI) treated with external fixation (EF) for long-bone fractures in Mbuji mayi.

1. Utilization rate of external fixation and cohort composition

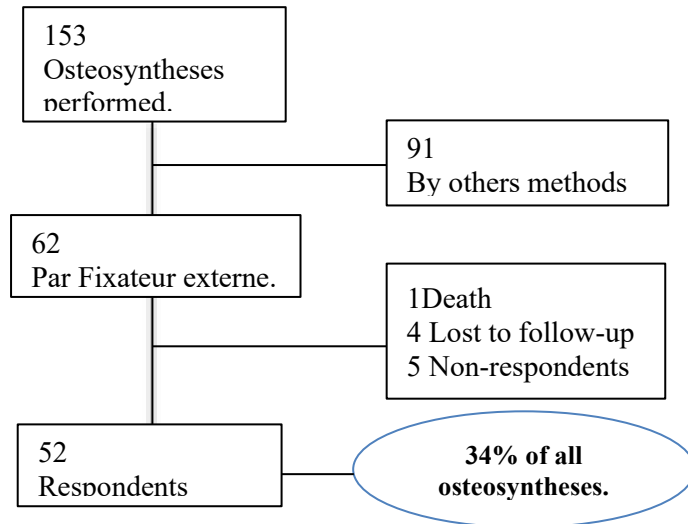


Figure 1. Flowchart illustrating patient selection for the study. The rate of use of FE was 34%, corresponding to 52 responding patients out of 153 cases of osteosynthesis in general (Source: Authors).

2. Socio-demographic Characteristics

Forty-five patients (86.5%) were male, yielding a sex ratio of 6.42 in favor of men. The mean age was 36.4 ± 15 years, with the 21–40-year age group being the most represented (48.1%). The external fixator was most commonly applied to the leg (67.5%) (Table 1).

Table 1. Socio-demographic characteristics of patients and location of FE

Characteristics	Frequency (n=52)	Percentage (%)
Sex		
Female	7	13.5
Male	45	86.5
Age (years)		
≤ 20	7	13.5
21-40	25	48.1
41-60	16	30.7
> 60	4	7.7
Origin		
Outside of Mbuji mayi	27	51.9
Mbuji mayi	25	48.1
Socioeconomic level		
Low	19	36.5
Middle	28	53.8
High	5	9.6
Location if external fixator		
Leg	35	67.3
Thigh	15	28.9
Forearm	1	1.9
Arm	1	1.9

Sex ratio (M/F): 6.42. Mean Age: 36.4 ± 15 years

3. Pin-tract infection and clinical evolution

Twenty-one patients (40.4%) showed no clinically significant local signs of infection around the pins at evaluation. Minor infection (grades 1–3) was observed in 26 patients (50%), while major infection (grades 4–6) occurred in 5 patients (9.6%). The overall recovery rate was 94.2% (Table 2).

Table 2. Grading of pin tract infection and its evolution

Grade of infection	Frequenc y	Recovery rate	Complications rate
No infection	21	21 (100.0)	0 (0,0)
Minor infection			
Grade 1	3	3 (100.0)	0 (0,0)
Grade 2	13	13 (100.0)	0 (0,0)
Grade 3	10	100.0	0 (0,0)
Major infection			
Grade 4	2	1 (50.0)	1 (50,0)
Grade 5	2	1 (50.0)	1 (50,0)
Grade 6	1	0 (0.0)	1 (100,0)
Total	52	49 (94.2)	3 (5,8)

Adapted according to the Checketts-Otterburn model

4. Bacteriological profile of pin-tract infection

4.1. Prevalence of positives cultures

Thirty-eight patients (73.0%) had at least one positive culture. Of the 292 pins implanted in 52 patients, 88 pins (30.1%) tested positive for bacteria. The most frequently isolated germs were: *Staphylococcus epidermidis* (33%), *Enterobacter* (27.3%), and *Staphylococcus aureus* (25.3%) (Table 3).

Table III. Patients, number of pins removed and germs isolated by bacteriological examination

Labels	Frequency	Percentage (%)
Patients under external fixator	52	100.0
Patients with a positive culture	38	73.0
Number of pins removed	292	100.0
Number of positive samples	88	30.1
Isolated germs:		
<i>Staphylococcus Epidermidis</i>	29	33.0
<i>Enterobacter (cloacea, agglomerans)</i>	24	27.3
<i>Staphylococcus aureus</i>	20	22.7
<i>Proteus (Vulgaris, mirabilis)</i>	7	8.0
<i>Klebsiella Pneumoniae</i>	4	4.5
<i>Beta-hemolytic Streptococcus A</i>	3	3.4
<i>Pseudomonas aeruginosa</i>	1	1.1

4.2. Antibiotic susceptibility profile

All isolated organisms proved resistant to amoxicillin and cotrimoxazole. Clindamycin and erythromycin showed intermediate activity, while ceftriaxone retained good efficacy against Gram-positive cocci. Finally, levofloxacin and amikacin exhibited high activity against all isolates.

DISCUSSION

In this series, men represented the vast majority of patients (86.5%), yielding a sex ratio of 6.42. This male predominance, also reported by several authors, is commonly attributed to men's greater exposure to high-risk socio-professional activities and trauma-prone environments [3].

The mean age was 36.4 ± 15 years, consistent with findings from Odatuwa-Omagbemi in Nigeria [16] and Mtoro et al. in Kisangani, who also reported a predominance of cases among individuals aged 20–40 years [17]. This age group is typically characterized by intense mobility, occupational exposure, and widespread use of motorcycles as a primary means of transportation, all of which increase the risk of accidents.

The mean duration of external fixation for leg fractures was 22 weeks and 5 days. This aligns with the findings of Albushtra et al. in Yemen [18], although it exceeds the African average of 14–17 weeks (98–120 days) reported in other studies [17,19]. Differences may be explained by fracture characteristics, severity of lesions, surgical technique, and contextual factors such as administrative delays and financial constraints, which can prolong treatment. The mean duration of fixation for femoral fractures (32 weeks) is comparable to that reported by Panda in Kinshasa, although in that study the duration was calculated from the time of bone grafting and concerned chronic osteitis treated with the Papineau technique [4].

Clinically, 40.4% of patients showed no signs of pin-tract infection, while 50% presented with minor infections (Grades 1–3) and 9.6% with major infections (Grades 4–6). The overall cure rate was 94.2%, with a complication rate of 5.8%. These results fall between those reported by Potgieter et al. (88% cure; 12% complications) and Dahl et al. (98% cure; 2% complications) [20,21]. The slightly higher complication rate in our series may be related to the relatively long follow-up period after fixator removal—ranging from one month to more than one year—which likely improved detection of late complications.

Pin-tract infection was confirmed in 38 patients (73.0%), corresponding to 30.1% of all pin-site samples. This frequency is within the 18–50% range reported by Coulon et al. [22]. African studies, however, have reported slightly higher rates: 36.7% in Nigeria (Olasinde et al.) and 41% in South Africa (Potgieter et al.) [5,20]. Variations across studies may reflect differences in methodology, fracture patterns, prevention protocols, antiseptic regimens, equipment quality, and surgical technique. The relatively lower incidence observed in our setting underscores the need for further local research comparing new versus reused pins and manual versus motorized insertion techniques, which may help explain these discrepancies.

The bacteriological findings of this study are consistent with established trends. *Staphylococcus epidermidis* and Enterobacteriaceae were the most frequently isolated organisms, followed by *Staphylococcus aureus*. Similar distributions have been reported by Nadeem et al. in a series of 200 infected pins: *S. epidermidis* (30%), *Enterobacter* spp. (25%), and *S. aureus* (20%) [23]. Potgieter et al. also reported a predominance of *S. aureus* and Enterobacteriaceae, with comparable resistance patterns, particularly reduced susceptibility to β -lactams [20]. These parallels highlight the importance of tailoring antibiotic prophylaxis and treatment to local microbiological profiles. A targeted approach based on susceptibility data is essential to prevent the emergence of multidrug-resistant strains.

This study is the first to provide bacteriological data on pin-tract infections in Mbuji mayi. It offers a detailed mapping of pathogens and their antibiotic susceptibility profiles in a context of limited resources, providing essential evidence for adapting prevention and treatment protocols. However, the impact of pin-tract infection on fracture healing — particularly non-union — remains to be clarified and warrants further investigation.

CONCLUSION

External fixation is associated with a substantial risk of pin-tract infection, most commonly caused by Enterobacteriaceae and staphylococcal species. These pathogens generally retain susceptibility to fluoroquinolones, aminoglycosides, and third-generation cephalosporins. The prevalence of this complication highlights the need for management strategies that integrate both preventive measures and targeted treatment based on the identification of isolated organisms.

The main limitation of our study is its small sample size. Pin-tract infection is the most frequent complication of external fixation, with reported rates ranging from mild inflammation to deep infection and osteomyelitis. This study provides the first bacteriological mapping of pin-tract infections in Mbuji mayi. The findings offer evidence-based guidance for adapting prevention protocols and antibiotic strategies to local microbial patterns.

Conflict of Interest Declaration: The authors declare that they have no conflict of interest.

Contributions of the authors

EMB: Conception, study design, and manuscript drafting. TKK: Data analysis, interpretation, and manuscript drafting. CKM, JNT, SMM: Study conception, data interpretation, and overall supervision. SUA: Study conception, data validation, and overall supervision. All authors: Critical revision and final approval of the manuscript.

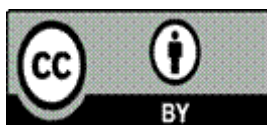
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