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Predisposing Factors for Fracture-Fixation Device Infections: A Retrospective Study of 50 Cases

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Abstract **Original Research Article**

Introduction. Fracture-fixation device infection is a serious complication of fracture surgery, leading to functional sequelae and repeated surgery. This study aimed to describe affected patients and the predisposing factors related to the host, the fracture and the surgical procedure. ***Methods.*** Retrospective descriptive study of 50 patients older than 15 years treated for infection after internal fixation at the Ibn Tofail Orthopaedic and Trauma Department, Mohammed VI University Hospital, Marrakech, from September 2021 to September 2024. ***Results.*** Mean age was 36.2 years (range 15–80); 82% were male (sex ratio 4.56). Road traffic accidents caused 68% of injuries. Main comorbidities were smoking (38%), alcohol use (26%), diabetes (20%) and immunosuppression (14%). Fractures were open in 28% of cases and involved the lower limb in 76%, mostly the leg (36%). Mean injury-to-surgery delay was 5 days (4 hours–28 days). Plates were the most frequently involved implants (50%), followed by nails (28%). Operative time exceeded 120 minutes in 80% of cases and 34% of patients received a transfusion. Infection was late-onset in 70%. Purulent sinus tract (80%), pain (74%) and fever (50%) were the main clinical signs. ***Conclusion.*** These infections mainly affect young men after high-energy trauma. Smoking, diabetes, open fractures, surgical delay and prolonged operative time are targets for prevention, which requires a multimodal pre-, intra- and postoperative approach.

Keywords: Infection; Internal fixation; Fracture; Risk factors; Antibiotic prophylaxis.

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INTRODUCTION

Fracture-fixation device infections (FFDI) are a serious and common complication of the surgical treatment of fractures [1]. They compromise bone healing and expose patients to functional and cosmetic sequelae, often at the cost of repeated surgery.

Diagnosis relies on a combination of clinical, laboratory, radiological, histological and microbiological findings, present in varying combinations [1,2]. The risk of infection depends on factors related to the patient, the fracture, the surgical procedure and the environment.

In resource-limited countries, where high-energy trauma and delays in care are frequent, these factors are poorly documented [3–5]. The aim of this study was to describe the profile of patients treated for FFDI in our department, to analyse the predisposing factors and to compare them with the literature in order to propose appropriate preventive measures.

MATERIALS AND METHODS

Study design and population.

This was a retrospective descriptive study conducted at the Ibn Tofail Orthopaedic and Trauma Department, Mohammed VI University Hospital, Marrakech, over a three-year period (September 2021–September 2024). Fifty patients were included.

Inclusion criteria.

Patients older than 15 years admitted for infection of an internal fixation device, established on microbiological documentation or on clinical and radiological grounds.

Exclusion criteria. Age under 15 years, incomplete or unusable medical records, infection of spinal instrumentation.

Data collected.

Data were extracted from medical records using a standardised data collection form: epidemiological data (age, sex, mechanism of injury), medical history, fracture

characteristics (type, site, location), operative factors (injury-to-surgery delay, type of implant, antibiotic prophylaxis, transfusion, operative time) and clinical signs. Infection was classified as early or late (secondary) according to the time to onset after surgery *[definition and threshold to be specified]*.

Departmental antibiotic prophylaxis protocol. Amoxicillin–clavulanic acid 2 g intravenously at anaesthetic induction, repeated if surgery exceeded 3 hours.

Statistical analysis.

Data were entered and analysed using Microsoft Excel. Quantitative variables are expressed as mean and range, and qualitative variables as counts and percentages.

Ethical considerations. Patient anonymity and data confidentiality were respected.

RESULTS

Frequency.

Fifty cases of FFDI were recorded over three years: 13 cases in 2021–2022 (3.7%), 17 cases in 2022–2023 (4.7%) and 20 cases in 2023–2024 (3.2%). *20 cases at 3.2% implies about 625 fixation procedures, versus about 350 in each of the first two years.*

Epidemiological data.

Mean age was 36.2 years (15–80 years). The 15–35 age group accounted for 48% of cases, 35–55 years for 38%, 55–65 years for 4% and over 65 years for 10%. There were 41 men (82%) and 9 women (18%), giving a sex ratio of 4.56. The injury resulted from a road traffic accident in 68% of cases, a domestic accident in 22%, an assault in 6% and a work-related accident in 4%.

Patient-related factors. Smoking was the most frequent comorbidity (Table 1).

Table 1: Patient medical history (n = 50)

Condition	n	%
Smoking	19	38
Alcohol use	13	26
Diabetes	10	20
Immunosuppression	7	14
Anaemia	6	12
Hypertension	5	10
Heart disease	3	6
Renal failure	1	2
Cancer	1	2

Fracture characteristics.

Fractures were closed in 36 cases (72%) and open in 14 cases (28%); 48 fractures (96%) were complex. Involvement was diaphyseal in 58% of cases, epiphyseal in 40% and metaphyseal in 2%. The lower limb was involved in 38 cases (76%), predominantly the leg (Table 2).

Table 2: Location of infected fractures (n = 50)

Location	n
Shoulder	1
Arm	2
Elbow	5
Forearm	2
Wrist	1
Hand	1
Pelvis	1
Hip	2
Femur	7
Knee	4
Leg	18
Ankle	6

Surgery-related factors.

Mean time from injury to internal fixation was 5 days (4 hours–28 days). The implant was a plate and screws in 25 cases (50%), an intramedullary nail in 14 cases (28%), Kirschner wires in 7 cases (14%), a prosthesis in 3 cases (6%) and an isolated screw in 1 case (2%). An external fixator was combined with a plate in 4 patients (8%). All patients received the departmental antibiotic prophylaxis. Intra- or postoperative transfusion was required in 17 patients (34%). Operative time exceeded 120 minutes in 40 patients (80%).

Time to onset. Infection was early in 15 patients (30%) and late or secondary in 35 patients (70%).

Clinical data. A purulent sinus tract was the most frequent sign (Table 3).

Table 3: Clinical signs on admission (n = 50)

Sign	n	%
Sinus tract with purulent discharge	40	80
Local warmth	38	76
Pain	37	74
Swelling	35	70
Redness	33	66
Functional impairment	31	62
Fever	25	50
Implant exposure	11	22

DISCUSSION

Our series describes a young, predominantly male population with complex lower-limb fractures, a high prevalence of smoking, prolonged operative times and a mostly late presentation with a sinus tract.

Epidemiological profile

The mean age of 36.2 years is in line with African series: 40 years for Ayouba *et al.,*[3], 39.5 years for Touré *et al.,*[4] and 33 years for Idé *et al.,*[5]. This age group, the most active, is the most exposed to high-energy trauma. Male predominance (82%) is found in all series, with rates ranging from 66.9% to 76.5% [3–6].

Patient-related factors

Smoking.

The proportion of smokers (38%) lies between those of Wichou *et al.,*(18.2%) [7] and Liang *et al.,*(29.7%) [8] on the one hand, and those of Arrech *et al.,*(52%) [9] and Ayouba *et al.,*(73.3%) [3] on the other. The role of tobacco is well established: Singh et al., in nearly 33,000 surgical patients, reported a 1.41-fold increase in infection risk among smokers [10], and Crowe et al., in 3,836 total hip arthroplasties, a 3.1-fold increase [11].

Alcohol use.

Our rate of 26% is intermediate between those of Poultsides *et al.,*(4.3%) [12], Wichou *et al.,*(15.7%) [7] and Ayouba *et al.,*(73.3%) [3]. Alcohol abuse is reported to increase the risk of implant infection by 1.57 to 2.95 times [12,13].

Diabetes.

The proportion of diabetic patients (20%) is identical to that of Pruzansky *et al.,*[14] and lower than those of Wichou *et al.,*(27.2%) [7], Liang *et al.,*(31.1%) [8] and El Khomsi *et al.,*(31.1%) [15]. Lai *et al.,*reported a 3.91-fold higher incidence of infection in diabetic patients [16], and Jämsén *et al.,*a doubling of risk in the year following surgery [17].

Anaemia.

Our rate of 12% is lower than those of Greenky *et al.,*(19.6%) [18], Pruzansky *et al.,*(29%) [14] and Arrech *et al.,*(36.8%) [9]. This difference is explained by our definition, limited to patients already diagnosed and receiving iron supplementation, whereas these authors used preoperative haemoglobin levels.

Hypertension and heart disease.

Our rates (10% and 6%) are close to those of Arrech *et al.,*(21% and 5.2%) [9] and lower than those of Wu *et al.,*(20% and 11%) [13] and Liang *et al.,*(25.7% and 16.2%) [8]. The combination of hypertension and diabetes is reported to increase the risk of infection 10.3-fold [19].

Immunosuppression.

This affected 14% of our patients, compared with 15.7% for Arrech *et al.,*[9] and 7.1% for Baier *et al.,*[20]. In patients living with HIV, CD4 T-lymphocyte count and serum albumin appear to be more decisive than the infection itself [21]. Long-term corticosteroid therapy significantly increases the risk [22].

Fracture-related factors

The rate of open fractures (28%) and the predominance of the leg (36%) are consistent with the series of Arrech *et al.,*(26%; leg 24%) [9] and El Khomsi *et al.,*(55.6%; leg 45.7%) [15]. Open fractures, through the contamination and soft-tissue damage they involve, are a major risk factor for FFDI [23]. Being non-modifiable, they require early intravenous antibiotic therapy adapted to the Gustilo grade [24]. The precarious soft-tissue coverage of the leg explains its over-representation.

Surgery-related factors

Surgical delay. Our mean delay of 5 days is longer than that of Touré *et al.,*(2 days) [4] but shorter than those of Ayouba *et al.,*(14 days) [3] and Idé *et al.,*(19 days) [5]. At the Sylvanus Olympio University Hospital in Lomé, the surgical site infection rate fell from 21.3% in 2010 to 9.9% in 2020 [3,25], in parallel with a reduction in preoperative delay from 21 to 14 days.

Type of implant.

Plates and screws (50%) and nails (28%) predominated, as in the series of Arrech *et al.,*(40% and

35%) [9], Chiki *et al.,*(43.5% and 37%) [26] and Bouchari *et al.,*(27.3% and 18.2%) [27]. A study of septic complications of internal fixation reported 90.5% of infections on plates *[reference to be specified]*. The open approach and periosteal stripping required for plating may explain this. However, these proportions also reflect how frequently each implant is used.

Antibiotic prophylaxis.

All our patients received amoxicillin–clavulanic acid, as in the series of Arrech *et al.,*[9] and Touré *et al.,*[4], whereas the protocols of Idé *et al.,*were more varied (amoxicillin–clavulanic acid 46.4%, ceftriaxone 29.7%, cefuroxime 22.5%) [5]. The 2024 SFAR–SPILF guidelines reserve amoxicillin–clavulanic acid for Gustilo grade II and III open fractures; cefazolin is recommended for grade I fractures and for closed fractures treated by open fixation, and no antibiotic prophylaxis is required for closed fixation [28]. Our protocol should therefore be revised in line with these guidelines, particularly the redosing interval given operative times frequently exceeding 2 hours.

Operative time.

Operative time exceeded 120 minutes in 80% of our patients, comparable to Ayouba *et al.,*(121 ± 27.9 min) [3] and between Touré *et al.,*(113 min) [4] and Mba *et al.,*(148 min) [29]. Prolonged surgery increases wound exposure, tissue dissection, blood loss and duration of anaesthesia. Bouchari *et al.,*observed an infection rate rising from 11.6% for procedures lasting under 30 minutes to 68% for those over 60 minutes [27]. The need for transfusion in 34% of our patients also reflects the magnitude of the procedures.

Time to onset and clinical presentation

Infection was late-onset in 70% of cases, as in Ayouba *et al.,*(75%) [3], whereas Mba *et al.,*reported 58.4% early forms [29]. This delay may reflect socio-economic difficulties delaying consultation and access to investigations.

This late presentation explains the frequency of sinus tracts (80%), higher than in El Khomsi *et al.,*and Wichou *et al.,*(54%) [7,15] and Pourre *et al.,*(32%) [30]. A sinus tract is a confirmatory criterion of fracture-related infection according to the international consensus [2]. Fever (50%) was more frequent than in El Khomsi *et al.,*(27.9%, including chills) [15], Pourre *et al.,*(40%) [30] and Chiki *et al.,*(42.5%) [26]. Pain (74%) is in line with the rates of Pourre *et al.,*(78%) [30], Pensotti *et al.,*(72%) [31] and Ayouba *et al.,*(61.7%) [3]. Functional impairment (62%) was more frequent than in the series of El Khomsi *et al.,*(24.6%) [15] and Chiki *et al.,*(24.4%) [26].

Implications for prevention

These findings support a multimodal approach to prevention:

1. **Preoperative:** smoking cessation, the benefit of which increases with the duration of abstinence; alcohol cessation; glycaemic control; correction of anaemia and nutritional support; management of comorbidities; reduction of the injury-to-surgery delay.
2. **Intraoperative:** strict asepsis, skin preparation with an alcohol-based antiseptic, glove change before handling implants, antibiotic prophylaxis in accordance with guidelines [28], reduction of operative time, tissue trauma and bleeding.
3. **Postoperative:** aseptic wound care, monitoring of wound healing, regular follow-up and patient education to seek care as soon as redness, discharge or swelling appears.

CONCLUSION

Fracture-fixation device infection remains a serious complication with a heavy impact on functional outcome. In our series, it mainly affected young men after high-energy trauma, with a background of smoking, alcohol use and diabetes, following lengthy internal fixation — most often with a plate — of a leg fracture.

Predisposing factors are multiple and interrelated: host factors, fracture severity, and timing and duration of surgery. Prevention relies on preoperative optimisation of the patient, rigorous asepsis and surgical technique, antibiotic prophylaxis in line with guidelines, and postoperative surveillance allowing early diagnosis and treatment.

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