Scientific Research Publishing

Open Journal of Orthopedics, 2024, 14, 381-390
https://www.scirp.org/journal/ojo
ISSN Online: 2164-3016
ISSN Print: 2164-3008

Surgical Site Infections in Trauma and Orthopaedics at Bouaké Teaching Hospital (Côte d'Ivoire)

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How to cite this paper: Yao, L.B., Krah, K.L., Kouassi, A.A.N., M'bra, K.I., Kouassi, K.J.-E. and Kodo, M. (2024) Paper Title. *Open Journal of Orthopedics*, **14**, 381-390.
https://doi.org/10.4236/ojo.2024.149033

Received: June 23, 2024
Accepted: September 10, 2024
Published: September 13, 2024

Abstract

Background: Surgical site infections are serious healthcare problems. The aim was to describe the epidemiological, diagnostic, therapeutic, and prognostic aspects of surgical site infections in Trauma and Orthopaedics at Bouaké Teaching Hospital. **Method**: This retrospective, descriptive, and analytical study was conducted from January 2019 to December 31, 2021. The data studied included prevalence, initial lesions, type of surgical intervention, type of SSI, bacteria involved, treatment, and outcomes. **Results**: Forty-four (11%) of the 399 patients included in the study developed a surgical site infection. The mean age was 27 years, with 36 male and 8 female. Initial lesions were predominantly open fractures (n = 31; 70%), with a mean delay of 48 hours for surgical management. Emergency interventions accounted for 70% (n = 31) of cases. The NNISS infection risk score was 1 in 80% (n = 35) of cases. Superficial infections (n = 34; 77%) appeared early, on a mean 6 days postoperatively. Bacteriological analysis primarily identified *Pseudomonas aeruginosa* (n = 10; 23%), sensitive to Imipenem and Chloramphenicol but resistant to Amoxicillin-clavulanic acid, Ceftriaxone, Gentamicin, and Ciprofloxacin. Multidrug-resistant bacteria were found in 89% (n = 8) of cases, with all bacteria resistant to Ceftriaxone. Surgical revision was performed in 10 patients (23%), primarily involving debridement with hardware retention (n = 7; 70%). Chloramphenicol was the most commonly used antibiotic post-antibiogram (61%). Outcomes were favourable in 98% of cases. Identified risk factors included the type of lesion according to NRC classification, the delay in managing open fractures, and the NNISS score. **Conclusion**: The prevalence of surgical site infection was 11%, favoured by the delayed operation of open fractures.

Keywords

Surgical Site Infection, Open Fractures, *Pseudomonas aeruginosa*, Ceftriaxone

1. Introduction

Surgical site infections (SSI) are among the most common nosocomial infections, alongside urinary tract infections, pneumonia, and sepsis [1]-[3].

The incidence of SSI varies between 1.4% and 41.9% for all surgeries combined [4] [5]. In trauma and orthopaedic surgery, SSIs can significantly impact both the surgeon and the patient, potentially negating the benefits of surgical reoperation [3]. These infections often lead to re-intervention, prolonged hospital stays, increased costs, and higher morbidity and mortality rates [3] [6]-[10]. Many countries have national surveillance and control programs for nosocomial infections [11]-[13]. In developing countries, such as Côte d'Ivoire, and particularly in Bouaké, trauma and orthopaedic surgery is often performed under less than ideal conditions, frequently in under-equipped operating rooms without a collective social security system for urgent and adequate patient care. Under these circumstances, what is the prevalence of SSI in Trauma and Orthopaedics at Bouaké Teaching Hospital? The aim was to describe the epidemiological, diagnostic, therapeutic, and prognostic aspects of SSIs and to identify associated risk factors.

2. Methods

A retrospective, descriptive, and analytical study was conducted from January 2019 to December 31, 2021. The study included all patients who underwent surgery classified as hyper-clean, clean, clean-contaminated, and contaminated according to the National Research Council (NRC) [14], followed for one month postoperatively if no implant was used, and for 12 months if an implant was used [15]. Variables studied included epidemiological, diagnostic, therapeutic, and prognostic factors. The variables were collected on a survey form from the medical file and the results of the bacteriological sampling. The diagnosis of SSI was based on the presence of local inflammatory signs, pus, and the identification of microorganisms within one month of surgery, extended to 12 months if osteosynthesis material or prosthesis was present [15]. Healing was characterised by the total regression of signs, scarring, and bone consolidation [15]. Statistical analysis determined the relationship between sex, age, NRC classification, treatment delay, ASA score [16], NNISS score [17], and the occurrence of SSI using Fisher's exact test and Chi-square test with a significance threshold of $p \leq 0.005$.

3. Results

During the study period, 399 patients were included, with SSIs developing in 44 patients, a prevalence of 11%. The mean age was 27 years (15 - 58), with 36 males (82%) and 8 female (18%). The patients had no comorbidities (diabetes, sickle cell disease, and HIV). Initial lesions and surgical procedures are summarised in **Table 1**.

Surgical intervention was elective in 13 patients (30%) and performed in emergency in 31 patients (70%). Patients with closed lesions had a mean preoperative hospitalisation delay of 11 days (8 - 18 days). Open fractures were operated on within a mean of 48 hours (24 - 168 hours). The initial type of intervention is detailed in Table 2.

Table 1. Distribution of surgical procedure according to NRC classification.

Class	Surgical procedure	n	%
1) Ultra clean	Prosthetic surgery	0	0
2) Clean	Osteotomy, closed fracture osteosynthesis. Laminectomy, arthroscopy. Cold removal of osteosynthesis material.	13	30
3) Clean contaminated	Type I open fracture before the 6th hour	0	0
4) Contaminated	Type II open fracture after the 6th hour or type III open fracture.	31	70
Total		44	100

Table 2. Distribution of type of intervention.

Interventions	**n**	**%**
Debridement + external fixator	16	36
Debridement + screwed plate	11	25
Centro-medullary nailing	10	23
Debridement + pinning	3	7
Screwed plate	3	7
Debridement + Judet screw plate	1	2
Total	44	100

Interventions lasted a mean of 1 hour 32 minutes (1 hour 10 minutes - 2 hours 18 minutes).

Antibiotic therapy consisted of Ceftriaxone 2 g/day combined with Metronidazole 1.5 g/day. The ASA score and NNISS risk are summarised in Table 3.

Table 3. Distribution of ASA classification and NNISS score.

	n		**(%)**
ASA Score	n = 44		
ASA I		41	93
ASA II		3	7
NNISS Score	n = 44		
0 (1.5%)		5	11
1 (2.6%)		35	80
2 (6.8%)		4	9

SSIs were early (n = 42; 95%) or late (n = 2; 5%), occurring on a mean within 6 days (4 - 210 days), with a mean delay of 14 days. SSIs were superficial (n = 34; 77%) or deep (n = 10; 23%). Diagnosis of SSIs was made during hospitalisation (n = 38; 86%) and post-hospitalisation (n = 6; 14%). Identified bacteria are summarised in Table 4. All bacteria were sensitive to Imipenem, Chloramphenicol, and resistant to Amoxicillin-clavulanic acid, Ceftriaxone, Gentamicin, and Ciprofloxacin.

Table 4. Distribution of identified bacteria.

Family	Genera and species	n	(%)
Gram-negative bacilli	- Pseudomonas aeruginosa	10	22
	- Klebsiella pneumoniae	7	16
	- Escherichia coli	5	11
	- Klebsiella species	4	9
	- Enterococcus species	3	7
	- Enterobacter species	3	7
	- Proteus vulgaris	2	4
	- Alcalescens dispar	2	4
Gram-positive cocci	- Staphylococcus aureus	9	20
Total		45	100

Eight multidrug-resistant bacteria (89%) were noted, including *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Escherichia coli*, *Klebsiella species*, *Enterobacter species*, *Enterococcus species*, *Alcalescens dispar*, and *Staphylococcus aureus*. One case of polymicrobial infection (*Pseudomonas aeruginosa and Klebsiella pneumoniae*) was noted. Antibiotics used post antibiogram are summarised in Table 5.

Table 5. Distribution of antibiotics used.

Antibiotics	n	%
Chloramphenicol	27	61
Ciprofloxacin	7	16
Gentamicin	5	11
Amoxicillin-clavulanic acid	3	7
Gentamicin + Ciprofloxacin	2	5
Total	44	100

Administration routes were oral (n = 39; 85%) and intramuscular (n = 7; 15%), with a mean treatment duration of 40 days (5 - 94 days). Daily local care with sodium hypochlorite was administered to all patients. Surgical revision was performed in 10 patients (23%) with one intervention (n = 5; 50%) and two interventions

Table 6. Distribution of surgical revisions.

Interventions	n	%
Debridement with retention of hardware	7	70
Implant removal + debridement + external fixator	3	30
Total	10	100

Table 7. Influence of certain factors on SSI occurrence.

Factors	Infection		*p*-value
	Yes	No	
Age Groups	44	355	0.25343
[15 - 25[	14	70	
[25 - 35[	12	100	
[35 - 45[	10	69	
[45 - 55[	3	47	
[55 - 65[	5	69	
Gender	44	355	0.39383
Male	36	270	
Female	8	85	
NRC	44	355	0.00061
1	13	203	
3	31	150	
ASA	44	355	0.45298
ASA I	41	339	
ASA II	3	16	
Treatment delay for closed fractures	13	203	2.21618
[10 - 20[	4	28	
[1 - 10[	9	175	
Treatment delay for open fractures	13	152	0.00437
≤48 h	11	96	
>48 h	20	56	
NNISS Score	44	355	0.00308
1	35	236	
0	5	110	
2	4	9	

(n = 5; 50%). The mean revision delay was 21 days (18 - 212 days). Revision types are summarised in Table 6.

The mean hospitalisation duration was 28 days (4 - 60 days). The mean healing delay was 56 days (28 - 105 days). The mean fracture consolidation delay was 120 days (103 - 374 days). Two cases (5%) of osteitis were noted in patients with SSI, requiring surgical revision. At a mean follow-up of 29 months (13 - 47 months),

43 patients were reviewed. Healing was noted in all patients, with no deaths. **Table 7** summarises the influence of certain factors on SSI occurrence ($p \leq 0.005$).

4. Discussion

The aim of this study was to describe the epidemiological, diagnostic, therapeutic, and evolutionary aspects of surgical site infections in Trauma-Orthopaedics at the teaching Hospital at Bouaké.

In this present study, the prevalence was 11% (n = 44). The rates vary by region [3] [5] [18]-[27]. There is a difference between the low SSI rates in occident [21] [24] and the high rates in developing countries [5] [18]-[20]. This difference could be due to the challenging working conditions in poorly equipped operating theatres in sub-Saharan Africa and the type of study. The patients were young (27 years old) and male (82%), indicating a young, active, and mobile population, victims of road traffic accidents [18]-[20]. The infection was not related to age and gender [23]. Immunosuppression due to HIV and diabetes, commonly found as classical infectious risk factors [3] [21] [28], was not noted in our patients. The initial lesions were predominantly type IV of the NRC classification in 70% (n = 31) of the cases, involving open fractures [20]. In this study, the occurrence of SSI was linked to initially contaminated open lesions. The mean delay in the management of open fractures was 48 hours due to limited hospital resources and patients without medical coverage. The SSI was related to the delay in the management of open fractures. There was no statistical link between the delay in the management of closed fractures and infection. The most frequently found infection score was 2.6% (80%). This present study is similar to other series [18]-[20]. The SSI was related to the infection risk score [23], mainly due to open fractures treated late. The SSI was mostly superficial (n = 34; 77%) and early (n = 42; 95%) [18]-[20] [23] [25] [26]. Deep infection was more common in other studies [19] [28]. Superficial infection was most frequently diagnosed during hospitalisation, with a mean onset time of 6 days [18]. Some authors noted more SSIs outside hospitalisation [20] [29]. This present study noted *Pseudomonas aeruginosa* (n = 10; 23%), *Staphylococcus aureus* (n = 9; 20%), and *Klebsiella pneumoniae* (n = 7; 16%) as the main bacteria. Some authors found a predominance of *Staphylococcus aureus* [3] [19] [20] [23] [24] [29]-[31]. In the past, *Staphylococcus* and *Streptococcus* were the main bacteria causing SSIs. Currently, their place has been taken by gram-negative bacilli such as coliforms, *Proteus, Pseudomonas, Klebsiella,* and *Escherichia coli*, which have even developed antibiotic resistance [20] [32]. Gram-negative bacilli were the most numerous as in other studies [20] [22] [25] [26] [33] [34]. Gram-negative bacilli develop more in patients exposed to short or long-term care settings (nosocomial infection) [26] [33]. A high rate of multi-resistant bacteria was noted, as in other studies [22] [26] [34]. *Pseudomonas aeruginosa* was sensitive to Imipenem, Chloramphenicol, and resistant to Amoxicillin-clavulanic acid, Ceftriaxone, Gentamicin, and Ciprofloxacin [22]. This bacterium is an opportunistic species naturally resistant to several antibiotics, accumulating many

mechanisms, and this natural resistance is compounded by acquired resistance [22] [33]. All bacteria were resistant to Ceftriaxone [22], which is a molecule systematically used post-operatively in all patients in the service. The treatment of SSIs consisted of local care in all patients, and in case of failure, surgical revision was performed in 10 patients (23%) in this study. Surgical revision was noted by other authors [19] [20] [35]. Debridement with retention of osteosynthesis material was the most performed (n = 7; 70%) because the SSI was early and superficial. Removal of osteosynthesis material was more commonly used in other studies [19] [35], likely related to the type of infection. Chloramphenicol was the most used molecule in treatment in 61% of cases, guided by the antibiogram. Chloramphenicol easily crosses the outer and inner membranes of gram-negative bacteria [33] [34]. The outcome was favourable in 43 out of 44 patients, or 98%, as they were treated early. It was also favourable in other series [19] [21] [22].

The limitations of this study were related to the failure to consider environmental factors involved in the occurrence of surgical site infections due to the retrospective nature of the study.

5. Conclusion

This study noted a prevalence of 11% for SSIs. The initial lesions were predominantly open fractures. The study recorded a predominance of early-onset superficial SSIs. Bacteriological analysis primarily identified *Pseudomonas aeruginosa,* which was sensitive to Imipenem and Chloramphenicol but resistant to Amoxicillin-clavulanic acid, Ceftriaxone, Gentamicin, and Ciprofloxacin. A high rate of multi-resistant bacteria and resistance to Ceftriaxone among all bacteria was also noted. Treatment consisted of local care and surgical revisions, with Chloramphenicol as the antibiotic. The outcome was favourable in 98% of cases. This suggests the establishment of an SSI surveillance programme (multidisciplinary team).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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