Original article

The Microbial Profile and Resistance Pattern in Infected Orthopedic Implants Cases of a Tertiary Care Teaching Hospital

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Abstract

Background. The infected orthopedic implant and their antibiotics susceptibility pattern vary regionally and has changed over the time. The detailed knowledge of the frequency of the causative microorganisms and their antibiotics susceptibility are necessary for better therapeutic outcome. The of this study was to identify the antibiotic resistance and sensitivity pattern in various orthopedic infectious cases.
This study was a cross sectional prospective study that took place over a period of 6 months from August 2022 to March 2023 at a tertiary care hospital. The recommended methods of bacteria culture were performed. The data was analyzed by descriptive statics.
Results. A total of 34 patients (25 males and 09 females) with positive cultures of postoperative orthopedic infected implant were included. The most common causative organism of infection was Staphylococcus aureus, 16 patients (47.05%); Methicillin resistant Staphylococcus Aureus, 02 patients (5.88%); Klebsiella species, 03 patients (8.82%); and Enterococcus species,01 patient(2.94%); Escherichia coli, 07 patients(20.58) and Pseudomonas aeruginosa in 05 patients (14.70%). Data also revealed that gram-positive bacteria were isolated in 19 patients (55.888%), while gram-negative microorganisms were found in 15 patients (44.11%). Among gram positive bacteria the antibiotics with the greatest sensitivity were Fucidic acid, Linezolid, Doxycycline, Cefepime, and Meropenem, while for gram-negative bacteria the antibiotics with greater sensitivity were Amikacin, Ertapenem, Imipenem, Linezolid and Doxycycline.

Keywords: Infected Orthopedic Implant, Antibiotics Susceptibility, Antibiotic Resistance, Bacteria culture.

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1. Introduction

Surgical site infection (SSI) was defined as bacterial contamination of the surgical site within 30 days of a surgical intervention or within 1 year after surgery if an implant was used in a patient (1). Postoperative surgical site infections in orthopedics, are considered catastrophic complications that are associated with significant increase in medical expenses, prolonged hospital stay, and can lead to the loss of the operated limb or even death [2,3]. Orthopedic implants are used in these orthopedics surgeries, which leads to increased risk of infections that can be extremely hard to eradicate due to biofilm formation (3). The medical field was revolutionized by the discovery of antibiotics, including improving orthopedic surgical implant outcomes and have transformed human well-being and health for the better. The fatality rates for *Staphylococcus aureus* (*S.aureus*) bacteremia, before the use of antibiotics were very high and most wound infections were treated by amputation; for instance, in World War I 70% of amputations were result of wound infections (4). The bacterial resistance of pathogens to commonly used antibiotics and the multidrug-resistant bacterial emergence are a worldwide challenge that has increased at an alarming rate, which has to both limited and expensive choices of antibiotic [5].

Despite numerous steps and interventions to tackle antibiotic resistance, global trends show no signs of slowing down [6].In the United State alone, at least 2 million infections are caused by antibiotic resistant bacteria and 23,000 deaths per year and resulting in an economic burden of 55–70 billion dollars per year (7). The aim of this study was to assess the prevalence of orthopedic surgical site infections, to isolate the causative micro biota and perform culture & sensitivity to improve the antibiotic regimen for management of such cases.

2.Materials & Methods

Data was collected from patient medical record and history sheet. The patient history and records were thoroughly reviewed for patients who were admitted in the Department of Orthopedic Surgery, Benazir Bhutto Hospital, Rawalpindi which is a 668 bedded tertiary care government teaching hospital of Rawalpindi medical University. Cases included in the study were those with the presence of surgical site infection, after orthopedic surgery and the used of an implant. All the data was collected for a period of six months from August 2022 to March 2023. These cases were revived mainly to identify the causative micro-organism responsible for orthopedic surgical site infection and also the antibiotic sensitivity pattern of these causative organisms which were obtained from microbiology lab by Kirby-Bauer disc diffusion method. All patient data including demographic details, diagnoses, types of surgical intervention, length of hospital stay and implant used were collected from the patient file. As a standard practice prophylactic intravenous antibiotics were given before the induction of anesthesia in the operating room. The data was categorized and analyzed to identify the common causing microorganism in various orthopedic infections and also the antibiotic sensitivity pattern was done. The infection was assessed by the infective organism and sensitivity of the antibiotics according to the culture sensitivity report.

3.Results

A total of 34 out of 1445 patients who had orthopedic or trauma operations in a six month period contracted an implant related infection.

Table 1 Demographic data

Parameters	Clinical Characteristic	n	%
Gender	M/F	25/9	73.5%
Age(Years)	>50 40-49 30-39 20-29 <20	5 4 11 10 4	14.7% 11.7% 32.3% 29.4% 11.7%
Types of Surgery	Elective Emergency	29 5	85.2% 14.7%

The demographic and clinical characteristics are given in Table 1, and the types of surgeries performed are given in Table 2. The incidence of SSI was 2.35%. There were 25 males and 09 females with positive cultures of postoperative orthopedic infected implant.

Table 2 Type of surgery

	n	%
Intramedullary nailing Tibia	10	29.4%
Intramedullary nailing Femur	6	17.6%
Plate and screws Tibia	7	20.5%
Plate and screws Femur	3	8.8%
Plate and screws Radis/Ulna	2	5.8%
Others	6	17.6%

A higher rate of infection was seen in patients who underwent plating or intramedullary nailing of fracture Tibia, 29.4% and 20.5% respectively.

Table 3: Resistance pattern of gram-positive bacteria to common antibiotic agents.

Antibiotics	*Staphylococcus aureus* *n*=16	*Enterococcus* spp. *n*=1	MRSA *n*=2
Amoxicillin	6(37.5)	1(100)	-
Ampicillin	5(31.2)	1(100)	-
Penicillin	9(56.2)	1(100)	-
Ceftriaxone	3(18.7)	-	2(100)
Cefepime	2(12.5)	-	1(50)
Cefotaxime	3(18.7)	-	1(50)
Cefradine	5(31.2)	-	2
Ciprofloxacin	10(62.5)	1(100)	1(50)
Levofloxacin	9(56.2)	-	-
Moxifloxacin	7(43.7)	-	-
Gentamicin	5(31.2)	-	-
Amikacin	3(18.7)	-	-
Imipenem	2(12.5)	-	2(100)
Meropenem	-	-	2(100)
Ertapenem	-	-	2(100)
Tigecycline	3(18.7)	-	-
Piperacillin/tazobactam	4(25)	-	2(100)
Colistin sulfate	2(12.5)	-	-
Co-trimoxazole	8(50)	1(100)	2(100)
Minocycline	3(18.7)	-	2(100)
Linezolid	2(12.5)	-	-
Fcidic Acid	-	-	-
Amoxicillin/clavulanic acid	7(43.7)	1(100)	2(100)
Doxycycline	2(12.5)	1(100)	1(50)

Thirty-two patients (94.11%) cultured a single organism,2 patients (5.88%) had 2 infecting organisms. The most common causative organism of infection was Staphylococcus aureus, 16 patients (47.05%); including Methicillin resistant staphylococcus aureus, 02 patients (5.88%); Klebsiella species, 03 patients (8.82%); and Enterococcus species, 01 patient (2.94%); Escherichia coli, 07 patients (20.58%) and Pseudomonas aeruginosa in 05 patients (14.70%).

Table 4. Resistance pattern of gram-negative bacteria to common antibiotic agents

Antibiotics	E.Coli *n*=7	Psedomonas aeruginosa *n*=5	Klebsiella spp *n*=3
Amoxicillin	1(14.2)	2(40)	2(66.6)
Ampicillin	3(42.8)	3(60)	2(66.6)
Penicillin	2(28.5)	3(60)	1(33.3)
Ceftriaxone	3(42.8)	4(80)	2(66.6)
Cefepime	-	3(60)	1(33.3)
Cefotaxime	4(57.1)	2(40)	2(66.6)
Cefradine	4(57.1)	3(60)	2(66.6)
Ciprofloxacin	3(42.8)	3(60)	2(66.6)
Levofloxacin	2(28.5)	2(40)	1(33.3)
Moxifloxacin	2(28.5)	1(20)	1(33.3)
Gentamicin	1(14.2)	2(40)	2(66.6)
Amikacin	1(14.2)	-	2(66.6)
Imipenem	-	1(20)	-
Meropenem	1(14.2)	1(20)	-
Ertapenem	-	-	-
Tigecycline	2(28.5)	1(20)	-
Piperacillin/ tazobactam	3(42.8)	2(40)	1(33.3)
Colistin sulfate	-	-	-
Co-trimoxazole	4(57.1)	3(60)	2(66.6)
Minocycline	1(14.2)	-	-
Linezolid	1(14.2)	1(20)	-
Fcidic Acid	-	-	-
Amoxicillin/ clavulanic acid	4(57.1)	2(40)	2(66.6)
Doxycycline	-	-	-

Data also revealed that gram-positive bacteria were isolated in 19 patients (55.88%), while gram-negative microorganisms were found in 15 patients (44.11%).

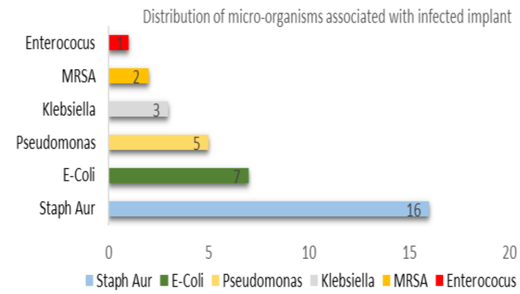

Fig.1 Distribution of micro-organisms associated with infected implant

Among gram positive bacteria the antibiotics with the greatest sensitivity were Fucidic acid, Linezolid, Doxycycline, Cefepime, and Meropenem, while for gram-negative bacteria the antibiotic with greater sensitivity were, Amikacin, Ertapenem, Imipenem, Linezolid and Doxycycline.

4.Discussion

The worldwide incidence of surgical site infections is between 2.6% to 41.9% [8]. In our study the surgical site infections rate was 2.35%, comparable rates were found in our study. Furthermore, the rate of infection was more common in younger patients between 20 to 40 years of age, probably due to high trauma rates associated with road traffic accidents in this age group, and it has been seen that preoperative soft-tissue damage is a leading risk factor for development of surgical site infection [9]. The Tibia with Intramedullary nailing, Plate and screws being the most commonly affected site. The *Staphylococcus Aureus* was the most common bacteria including Methicillin Resistant Staphylococcus Aureus, 16 patients (47.05%) and 02 patients (5.88%) respectively, is comparable with other studies [10]. This finding is in contrast to that reported by Latha et al. where MRSA was the most commonly identified organism in 27.7% of patients [11]. The gram-positive bacteria showed higher resistance to Penicillin, Ciprofloxacin, Levofloxacin, Moxifloxacin, Co-trimoxazole and Amoxicillin/Clavulanic acid. Xie et al. reported that *S. aureus* was resistant to penicillin which is in line with our findings [12]. Shariati et al. showed that *aureus* had higher rates of resistance with vancomycin and tigecycline however, our findings are in contrast with the above-mentioned findings [13].

The tibia is involved more because is commonly hit by bumper in RTA and is lying subcutaneously, making it prone to open fractures. Furthermore, heavy plates like DCP especially in proximal and distal thirds are not well tolerated. Anatomical plates, using minimally invasive periosteal osteosynthesis [MIPO] principles should be used in periarticular region of tibia to prevent further damage to already compromised soft tissue here [14].

Gram negative bacteria E.Coli was second most common cause of infection. Furthermore, gram negative bacteria showed higher resistance to Ceftriaxone, Ampicillin, Co-trimoxazole, Amoxicillin/Clavulanic acid and Gentamicin. Gram negative bacteria have developed a vast variety of mechanisms to counteract the effect of antimicrobials, such as β-lactamase production, minimizing antimicrobial penetration, and alteration of efflux pump and target site [15].

Antibiotic resistance is becoming a major global issue that has led to the 2.8millions patients with antibiotic-resistant infections and 35000 deaths in the United States alone each year. The emergence of this issue has led the Centers for Disease Control and Prevention (CDC) to utilize a list used as a reference in order to identify these pathogens and take appropriate measures to prevent the antimicrobial resistance [16]. The financial burden of surgical site infections is a worldwide huge challenge for the healthcare profession. In the US, it is estimated the third most expensive healthcare-related infection, an estimation of 20785 US dollars to treat it [17].

Our study showed that E. Coli bacteria is increasing their presence in the orthopedic and trauma wards, and this needs to be seen seriously. In addition, the presence of infection before operation is an important reason for early infection after operation; Since, some patients with open fractures who were operated were also included in our study, and probably the cause of these infection thus, it is necessary to screen or treat the occult infection to minimize the gram negative infection. Furthermore, most of the microorganism were sensitive with the Fucidic acid**,** Doxycycline and Linezolid, probably due to less commonly used antibiotics in routine practice and their use in routine practice for patient with infected implant to get better outcome of the patients. This is of prime importance due to the fact that there is no proper regulating system concerned with the proper use and dispensing of antibiotics in Pakistan.

Doxycycline is economical, has less side effects, easy to administer and has acceptable results as showed in our findings.

5. Conclusion

Our study revealed that the postoperative infection rate at Tertiary care hospital in Pakistan is comparable with that of worldwide post-operative orthopedic infection. Furthermore, *S. aureus* was the most common isolated bacteria. We recommend that the antibiotic agents should be carefully selected and need to strictly monitor according to the drug sensitivity and drug resistance patterns to minimize the antibiotic resistance.

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