Assessment of Incidence of Superbugs and Antibiotic Resistance in Orthopaedics, A Cross-Sectional Study

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ABSTRACT

Objectives: Due to the presence of metallic implants, orthopedic surgeries are at increased risk of microbiological contamination and infection. Such infections require aggressive and prolonged use of antimicrobial therapy. The objective of our study is to determine the frequency of growth in cultures and identify patterns of new antibiotic resistance from culture growth of infected implant patients.

Methods: Total 188 patients were included in this study which was conducted in Liaquat National Hospital from July 2022 till July 2023. Suspected infections were confirmed biochemically when ESR ≥30mm/hour or CRP ≥10 mg/dl. Such patients underwent routine surgeries for infection eradication as per routine orthopaedic guidelines. Appropriate body tissue specimens were sampled for culture and sensitivity. Descriptive statistics were calculated.

Results: There were 64.4% male and 35.6% female patients. Mean age was 43.61±14.21 years. Mean ESR and CRP was 63.89±34.92 mm/hour and 6.11±4.54 mg/dl respectively. In 23.9% previous surgical procedure was ORIF. In our study, 87.8% of patients were found with culture growth while most common culture bacterium was MRSA found among 40.6% patients. Most sensitive antibiotic was Vancomycin (67.3%). 13.2% of patients showed no growth indicating significant covert or indolent bacteria.

Conclusion: Culture growth was observed in 87.8% patients with MRSA being the most common organism. Vancomycin was found as most sensitive antibiotic.

Keywords: Growth Cultures, Implant Infection, Antibiotic Sensitivity, Antibiotic Resistance.

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INTRODUCTION

Due to the presence of metallic implants, infections are amongst the highest prevalent complications in orthopedic surgeries, accounting to 15.6% of overall post-operative complications.(1) Orthopedic infections are one of the most debilitating morbidities and they are often deep seated, bone penetrating and metallic implant associated.(2) Extensive soft tissue stripping and de-vascularization due to manipulation during fixation, leads to deep seated infections and biofilm formation.(3) This biofilm is a glycocalyx layer, formed on the surface of the implants, creating a survival site for bacteria with reduced antibiotic sensitivity.(4)

The causes of these infections are multifactorial, resulting from retained foreign bodies, inflamed and infected tissue or bone, and inadequate debridement, treatment failure or, delayed or ineffective treatment of infection, especially the irrational use of over the counter antibiotics can therefore lead to high morbidity, prolong hospital stay, multidrug resistance, decreased limb function, reduced quality of life and may ultimately result in amputation.(5,6) The changing pattern of microbiological response, increasing resistance to common antibiotics and its long-term disease impact is still less familiar to most developing countries where infection control and prevention guidelines are still questionable.

In a study(7) regarding bacteriological profiles, antimicrobial susceptibility patterns, S. aureus is the most common isolated bacteria (76%). Methicillin-

resistant was present in 57.9% and 40% of isolated MRSA and coagulase-negative staphylococci, respectively. Of the isolated E. fecium, one third were vancomycin resistant (VRE). Overall, 67.1% were multidrug-resistant (MDR) and about 27.6% were strong biofilm producers.

In a developing country, with similar constraints and awareness level, there was a study conducted regarding incidence of surgical site infection (SSI) in surgically treated closed fractures[8], showed that age >50 years, prolonged pre-operative hospital stay of >10 days, diabetic patients, lengthy surgical procedure of >1.5 hours were found to be at a higher risk of SSI, and among the organisms isolated, 60% of the patients had S. aureus, 20% had Proteus vulgaris and another 20% had Klebsiella pneumonia infection.

In a study conducted[9] in Pakistan in a total of 504 patients, SSI was detected in 17(2.12%) of these patients. Rate of these infections was 5.8% in clean, 23.5% in clean contaminated and 70.5% in dirty surgeries. The prevalence of SSI was significantly raised ($p < 0.05$) in patients with pre-operative dirty wound. In another study[10], of 520 cases, 26 (5%) developed inflection. The commonest organism encountered was Sta. aureus in 18(69.2%) cases. In 5(19.2%) patients the likely cause of infection was the prolonged operative time (>2 hours) and 5(19.2%) patients had longer pre-operative stay in the ward (>2 weeks).

Therefore, the objective of this study is to determine the frequency of growth in cultures and to identify antibiotic sensitivity and resistance from culture growth of infected orthopedic population with metal implants.

METHODS

A cross-sectional study was conducted in Department of Orthopedics, Liaquat National Hospital, Karachi, from July 2022 to July 2023. Patients included were of either gender, age 18-65, with history of previous orthopedic surgery with metallic implants present and now having biochemically confirmed infection with ESR ≥ 30 mm/hour or CRP ≥ 1mg/dl identified during routine OPD screening.[11] Patients with previous surgical intervention for infection, with native osteomyelitis, without metallic implants were all excluded

After hospital ethical board, approval (RC 07-2022/70), a total 188 patients meeting inclusion criteria of study were evaluated. Previously operated patients who presented in OPD were routinely screened for infection clinically and ESR and CRP levels were sent for confirmation. After taking informed consent, these patients underwent routine surgeries for infection eradication in our setup, as per surgeon preference and orthopaedic guidelines. During surgery, appropriate body tissue specimens, including fluid, pus, tissue, and bone were sampled under aseptic measures, all the samples were then labeled with patient ID and tissue origin, date of collection, placed in sterile airtight container and immediately transported to the microbiology department for culture and sensitivity.

Patient`s age, gender, weight, co-morbidities, ESR & CRP levels, previous surgeries, previous antibiotics and duration, time since infection were recorded by orthopedic resident in a proforma (Appendix 1). Specimens were cultured to provide culture growth, identification of cultured bacteria, sensitivity / resistance to antibiotics as per standard hospital microbiology practice (using CLSI M100 antibiotic protocol[12] for Amoxicillin/ Clavulanate, Ceftriaxone, Ciprofloxacin, Clindamycin, Gentamycin, Meropenem, Piperacillin/ Tazobactam, Vancomycin). All test results were recorded in a proforma (Appendix 1), then complied using SPSS version 22, to produce an antibiogram (Table 1), with bacteria and their respective antibiotic sensitivity.

Descriptive statistics were calculated using SPSS version 22 (SPSS Inc, Chicago, IL). Frequency and percentage were compiled for gender, co-morbidities, previous antibiotics /implants /surgeries, culture growth, culture bacteria and antibiotic sensitivity. Mean and standard deviation were extracted for age, weight, antibiotic duration, ESR & CRP levels, and time since infection. P- Value ≤0.05 was considered as significant.

RESULTS

Among 188 patients, 64.4% were males and 35.6% were females. The overall mean age was 43.61 ± 14.21 years, whereas mean weight was 65.84 ± 13.34 kg. When assessing co-morbidities, 8% of the patients had diabetes, 13.8% had hypertension, 13.8% had cardiac diseases and 3.7% had kidney disease. The overall mean time since infection was 7.29 ± 4.63 months. The overall mean ESR and CRP was 63.89 ± 34.92 mm and 6.11 ± 4.54 mg/dl respectively.

Among 188 patients, 23.9% underwent ORIF while most of the patients had used ciprofloxacin (42%), followed by cefuroxime (25.5%), clindamycin (20.2%) and vancomycin (12.2%), before presenting to us in outpatient clinic for a mean duration of 2.01 ± 0.66 weeks. Most common bone involved was tibia

(22.9%) and second being the femur (20.2%). Most of the patients (56.4%) underwent debridement in our setup after being diagnosed with infection, followed by antibiotic beads (25%), rod (8.5%) and spacer (10.1%).

In our study, culture growth was seen in 87.8% of patients while most common organism isolated was MRSA (40.6%). Most sensitive antibiotic was Vancomycin (67.3%). (Figure-1 and Table-1).

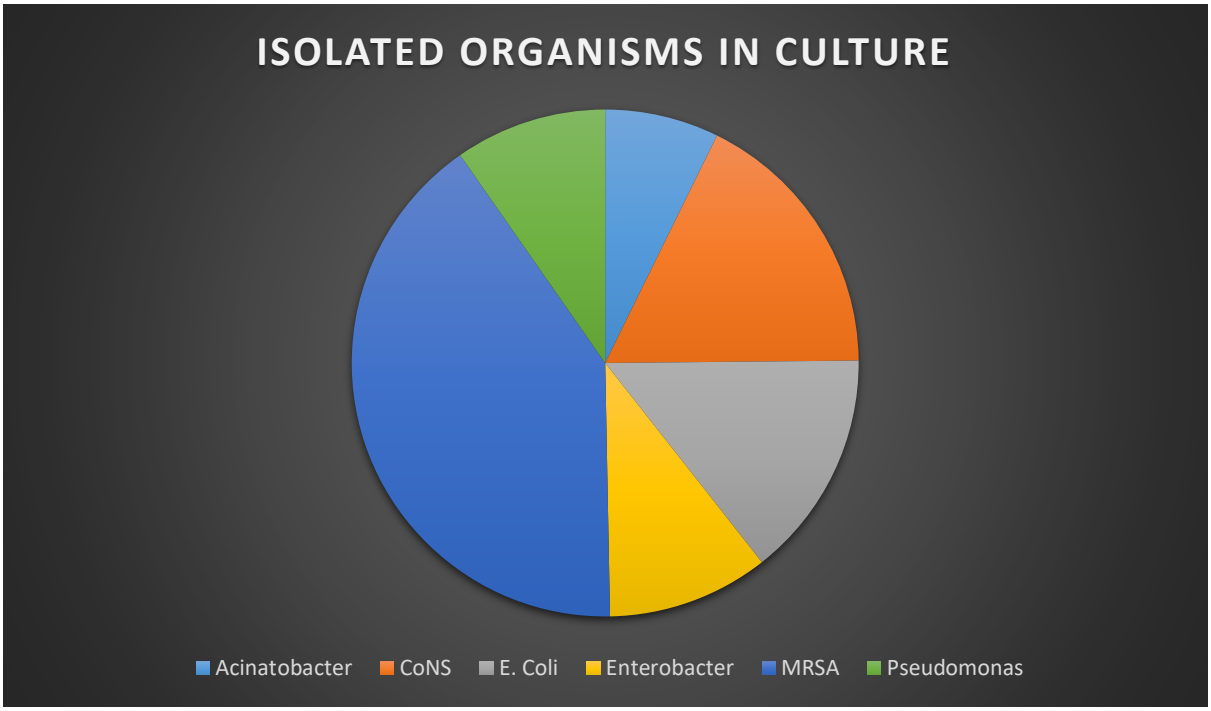

Figure 1: Isolated Organisms in Culture

Table 1: Antibiogram

ANTIBIOTICS	FREQUENCY N (%)	
	SENSITIVE	RESISTANT
Amoxicillin/Clavulanate	0 (0)	165 (100)
Ceftriaxone	18 (10.9)	147 (89.1)
Ciprofloxacin	25 (15.2)	140 (84.8)
Clindamycin	31 (18.8)	134 (81.2)
Gentamicin	31 (18.8)	134 (81.2)
Meropenem	68 (41.2)	97 (58.8)
Piperacillin/ Tazobactam	109 (66.1)	56 (33.9)
Vancomycin	111 (67.3)	54 (32.7)

DISCUSSION

In patients diagnosed with infection, successful management is directly proportional to the early diagnosis, identification of bacterial pathogens and effective antibiotic selection against the pathogen. Antibiotics play a major role in both, prophylaxis, and treatment of infectious diseases. The issues of their availability, selection, awareness regarding its resistance and correct use are of critical importance[13-15]. With the use of numerous antibiotics, the clinicians are often overwhelmed by the options, therefore determination of the organism holds the utmost importance in the selection of antibiotics. Clinical experience with such cases and taking infectious disease specialists' onboard especially where empirical treatment has to be started in infected patients with negative cultures.[16]

Most common isolated organism in our study was S. aureus, this infection may be due to contamination of surgical instruments or due to natural skin barrier disruption, which is a common

bacterium on surfaces, finding their way easily into surgical sites [11]. Some of the previous studies showed a higher number of cases of Gram-positive organisms, specifically S. aureus, which was the cause of SSI in different countries.[11-13] Our data shows 100% resistance to β-lactam amongst all antibiotics. This is alarming as all the patients are given second or third generation cephalosporins as prophylactic antibiotic pre-operatively. Ceftriaxone and cefotaxime are the most effective against S. aureus and their resistance expected soon. This is of great concern because if the use of these antibiotics continues to be like this, there would be very few therapeutic options left.[7,11]

In a study[14], regarding prevalence and predictive risk factors of SSI, showed that ORIF was the commonest procedure associated with SSI, HIV-infection, longer preoperative admission, ASA score >II and drain insertion were some of the significant factors associated with SSI. In another study[9], regarding factors affecting SSI showed that age >60 years, hypertension, diabetes mellitus and type III incisions (open surgeries with a higher chance of microbial contaminations) were risk factors for SSI.

Some of the other studies also highlighted intra-operative factors being risk factors of SSI, in which the theatre traffic during the surgeries being an independent predictor. Studies shows that surgeries of >3 hours lead to 4 times increased risk for SSI[15,16]. Prolonged procedure increases the wound susceptibility, due to high bacterial exposure and the extent of tissue trauma which is considered more traumatic than extensive surgical procedure and decreasing the levels and effect of the prophylactic antibiotics.

Channel of communication between the microbiology department, infectious disease and the surgeon is strongly recommended for the prevention and control of the SSI in less time and at minimal cost. This will encourage the rational use of antibiotics and help in the decline of antibiotic resistance[11].

Our study had few limitations. First being that some of the factors varied according to both hospital setups in this study and was not specified, which included the use and availability of antibiotics, equipment sterilization methods, mode of anesthesia, operating room conditions. Secondly, the impact of the operative time, smoking, prolong pre-operative stay, size of the incision and soft tissue condition prior to the first procedure were not analyzed due to the incomplete or missing data, as these factors have been risk factors for SSI in past few studies[15,16].

CONCLUSION

Despite latest available facilities in operating room, meticulous sterilization protocols and pre-operative antibiotic prophylaxis, SSI continues to be a major burden to the patient as well as to healthcare system. Our study results showed that culture growth was observed in 87.8% patients with MRSA as a most common culture bacterium. Vancomycin was found as most sensitive antibiotic. The rate of SSI can be decreased significantly selecting suitable preoperative and postoperative antibiotics, good patient care and following appropriate infection control protocols.

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