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Microbiological profile and antibiotic sensitivity pattern of post-operative orthopaedic Implant infections in tertiary care hospital

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Abstract

Background: A correct information about the most common causative organism and its sensitivity pattern in that clinical setup is essential for designing empirical therapy. The present study has been designed to study the microbiological profile and antibiotic sensitivity pattern of post-operative orthopaedic Implant infections in a tertiary care teaching hospital.

Material and Method: This prospective observational study. Patients who presented with the signs and symptoms of infections, confirmed by laboratory and other routine investigations, were included in the present study. The demography, microbiological data sensitivity to an antimicrobial agent of organism was recorded.

Result: The most common pathogen isolated was *Pseudomonas aeruginosa* that is 52(43.3 %), followed by staphylococcus aureus, that is 50(41.66%). *Pseudomonas aeruginosa* was sensitive to Piperacillin tazobactam 42(80.7%), Imipenem 40(76.9%), Imipenem+cilastatin 42(80.7%) and Meropenem 43(82.7%). Methicillin-resistant staph aureus was sensitive to Cotrimoxazole 6(50%), Clindamycin 9(75%), Vancomycin 11(91.7%) and Linazolid 10 (83.4%).

Conclusion: The implant of femur was most commonly infected. Staphylococcus Aureus (MSSA) was commonly associated with biofilm formation, followed by Staphylococcus Aureus (MRSA). *Pseudomonas aeruginosa* isolated from implant infections were sensitive to Piperacillin+ tazobactam, Imipenem, Imipenem+cilastatin and Meropenem.

Keywords: Orthopaedic implant infections, antibiotic sensitivity, microbiological profile

Introduction

Implants in orthopaedics surgery are mainly used to restore the function of load-bearing joints and decrease the pain so that patients can be mobilised early and the duration of stay in the hospital can be reduced. Implant-related infection is the major problem which leads to implant failure [1, 2]. It is a type of surgical site infections (SSIs) that can double the length of time a patient stays in hospital, significantly increase healthcare expenditure and in severe cases it may lead to amputation and mortality [3]. To treat orthopaedic implant infections is a challenging task. Implant-associated infections are the result of adhesion of bacteria to implant surface and subsequent biofilm formation at the implantation site. Once biofilm is formed it is difficult by host defence and ordinary antimicrobial therapy to remove it [4, 5]. The incidence of implant infection in elective orthopaedic surgery is in the range of 0.7% to 4.2% [6, 7]. Mundhada AS, Tenpe S *et al.* has reported that orthopaedic implant infection in India is 6 % [8]. In spite of availability of good aseptic operation theatre, rational preoperative antibiotic prophylaxis and global guidelines for the prevention of surgical site infection, implant related infections are common [9]. A correct information about most common causative organism and its sensitivity pattern in that clinical setup is essential for designing empirical therapy.

From literature survey we have found that there is diversity in the conclusion of various researchers about causative organism and its susceptibility to anti-microbial agent. Mousa HA *et al.* from Iraq has concluded that *Pseudomonas aeruginosa* and Staphylococcus epidermidis were the most common causative agents [10]. Abulfotooh M Eid *et al.* from Egyptian has concluded that Staphylococci, both coagulase positive and coagulase negative (epidermis),

constitute the majority of the offending organisms [11]. Fernandes A, Dias M from India has concluded that Staphylococcus SPP are the commonest isolates [12].

Present study has been designed to study the microbiological profile and antibiotic sensitivity pattern of post-operative orthopaedic Implant infections in tertiary care teaching hospital.

Material and method

This prospective observational study was carried out in the Department of orthopaedics and department of Microbiology, at Konaseema institute of medical science Amalapuram A.P. India, for a period of three years, from July2017-June 2020.

Ethics: Approval from institutional ethics committee was taken before start of study. A written informed consent was obtained from all patients before enrolling them for study.

Selection of patients

The patients admitted in the department of orthopaedics for implant or prosthesis surgery, who presented with the signs and symptoms of infections, confirmed by laboratory and other routine investigations, were included in present study. The specimens having polymicrobial flora were excluded from study.

Sample size: As per selection criteria 120 patients were

enrolled for this study.

Method

With all aseptic precautions sample was collected from the secretions of the infected orthopaedic wounds by using a sterile cotton swab and a sterile disposable syringe. The sample collected was immediately transported to the laboratory for culture and antibiotic sensitivity testing. Gram staining and acid fast staining of all samples were done. For isolation of aerobic bacteria the sample was inoculated blood agar and MacConkey agar. The media was incubated at 37°C for 24 to 48 hours. For isolation of anaerobic bacteria the sample was inoculated in Robertson's cooked meat broth. A standard microbiological procedure was used for identification of isolates. Kirby Bauer method was used for attesting antimicrobial susceptibility of isolates by using guidelines of the Clinical and Laboratory Standards Institute¹³. Tissue culture plate method and the Tube method was used for the detection of bacteriological biofilm detection as described by Manandhar, S., Singh, A., Varma, A. *et al.* and Mathur T, Singhal S, Khan S, Upadhyay DJ, Fatma T, Rattan A *et al.* [14, 15]. Statistical analysis: Data were recorded in excel sheet and statistical Analysis was done with software SPSS-14 version. Data were calculated as percentage and proportions.

Result

Table 1: Demography of patients

Variable	values	
Age (41.90 ± 15.94 years)	Less than 30	6
	31 to 60	84
	More than 60	30
Sex(m/f)	80/40	

As per selection criteria 120 culture-positive patients were enrolled for this study. The mean age of the patients was 41.90 ± 15.94 years and there was male predominance. Most of the patients were between 30 to 60 years of age. (Table 1)

Table 2: Microbiological profile of pathogen isolated

Organism isolated	Number (%)
<i>Pseudomonas aeruginosa</i>	52(44.3%)
Staphylococcus Aureus	38(31.57%)
Staphylococcus Aureus(MRSA)	12(10%)
Klebsiella SPP	10(8.34%)
E. Coli	8(6.6%)
Enterococcus SPP	4(3.3%)
Anaerobes	0

The most common pathogen isolated was *Pseudomonas aeruginosa* that is 52(43.3%), followed by staphylococcus aureus that is 38(31.57%). Among 50 Staphylococcus aureus, n=12 (10%) of the isolates were found to be MRSA (Methicillin resistant Staphylococcus aureus) and 38 isolates

were MSSA (Methicillin sensitive Staphylococcus aureus). Klebsiella SPP was isolated in 10 patients and *E.coli* was isolated in 4(3.3%). Enterococcus Spp was isolated in 4(3.3%) patients. (Table 2)

Table 3: Relation between frequency of pathogen isolated and site of infection,

Site of infection	Number (%)
Femur	44(36.67%)
Tibia	25(20.83%)
Foot	13(10.83%)
humorous	12(10.00%)
knee	12(10.00%)
Radius	8(6.67%)
Ulna	6(5%)

Femur was the most common site effected 44(36.67%) which was followed by tibia in 25(20.83%). Foot was affected in 10.83% and ulna was least commonly affected.

Table 4: Biofilm producing organism

Organism	Number (%) (N=24)
Staphylococcus Aureus	12(50%)
Staphylococcus Aureus(MRSA)	6(25%)
Klebsiella SPP	4(16.7%)
Enterococcus SPP	2(8.34%)

In present study, 24 isolates showed biofilm production by the Tissue Culture Plate Method. They required extensive antimicrobial therapy and in some implant was removed to cure infection. Staphylococcus Aureus (MSSA) was

commonly associated with biofilm formation followed by Staphylococcus Aureus (MRSA). Klebsiella SPP was 16.7% of total isolate. Enterococcus SPP was also 8.34% of total isolate.

Table 5: Antimicrobial susceptibility patterns organism isolated

Antimicrobial Agent	Organism isolated					
	<i>Pseudomonas aeruginosa</i>	<i>Staphylococcus Aureus</i>	<i>Staphylococcus Aureus (MRSA)</i>	<i>Klebsiella SPP</i>	<i>E.coli</i>	<i>Enterococcus SPP</i>
Cotrimoxazole	2(3.8%)	-	6(50%)	4(33.4%)	2(25%)	1(25%)
Amoxicillin+clavulanic acid	-	18(47.3%)	-	2(16.7%)	1(12.5%)	3(75%)
Ampicillin+sulbactam	-	-	-	2(16.7%)	2(25%)	2(50%)
Piperacillin tazobactam	42(80.7%)	-	-	-	8(100%)	4(100%)
Imipenem	40(76.9%)	-	-	10(100%)	7(87.5%)	-
Imipenem+cilastatin	42(80.7%)	-	-	10(100%)	8(100%)	-
Meropenem	43(82.7%)	-	-	10(100%)	-	-
Cefixime	-	5(13.1%)	-	1(10%)	-	-
Ceftriaxone	4(7.7%)	10(26.3%)	2(16.7%)	2(20%)	2(25%)	-
Cefoperazone+sulbactam	14(26.9%)	12(31.5%)	-	8(80%)	5(62.5%)	-
Ceftazidime	14(26.9%)	1(2.6%)	-	-	-	-
Cefipime	27(51.9%)	32(84.2%)	-	10(100%)	8(100%)	-
ciprofloxacin	14(26.9%)	11(28.9%)	2(16.7%)	5(50%)	3(37.5%)	2(50%)
ofloxacin	20(38.4%)	16(41.1%)	2(16.7%)	6(60%)	5(62.5%)	3(75%)
Tetracycline	-	-	-	-	1(12.5%)	-
Gentamycin	21(40.4%)	-	-	-	4(50%)	3(75%)
Amikacin	24(46.1%)	-	-	-	8(100%)	4(100%)
Tobramycin	26(50.0%)	-	-	-	-	4(100%)
Azithromycin	6(11.6%)	18(47.3%)	4(33.4%)	9(90%)	-	1(25%)
Clarithromycin	-	19(50%)	4(33.4%)	7(70%)	-	1(25%)
Clindamycin	-	28(73.6%)	9(75%)	10(100%)	-	-
Vancomycin	10(19.2%)	32(84.4%)	11(91.7%)	-	-	4(100%)
Linazolid	-	24(63.2%)	10(83.4%)	-	-	4(100%)

Pseudomonas aeruginosa was sensitive to Piperacillin tazobactam 42(80.7%), Imipenem 40(76.9%), Imipenem+cilastatin 42(80.7%) and Meropenem 43(82.7%). *Staph aureus* was sensitive to Cefipime 32(84.2%), clindamycine 28(73.6%), Vancomycin 32(84.4%) and linazolid 24(63.2%). Methicillin resistant *staph aureus* were sensitive to Cotrimoxazole 6(50%), Clindamycine 9(75%), Vancomycin 11(91.7%) and Linazolid 10 (83.4%). *Klebsiella Spp* was 100 % sensitive to Imipenem, Imipenem+cilastatin, Meropenem Cefipime and Clindamycine. *E.coli* was 100 % sensitive to Piperacillin tazobactam, Imipenem+cilastatin, Cefipime and amikacin. *E coli* were less sensitive to Cefoperazone+sulbactam, ofloxacin and Gentamycin. *Enterococcus Spp* was highly sensitive to Piperacillin tazobactam, Amikacin, Tobramycin, Vancomycin and linazolid. It was sensitive to fluoroquinolones as well.

Discussion

Orthopaedic and trauma device-related infection is a major problem in orthopaedics leading to implant failure. Despite of best sterilisation and infection control practice device-related infection are common [16, 17]. Orthopaedic Implant infections continue to be an important patient safety problem and increase the financial and social costs to the patients [18].

In present study mean age of the patients were 41.90 ± 15.94 years and there was male predominance this finding is similar to the study of Benazir *et al.* and Sarangi Samir K, Padhi Sanghamitra *et al.* [19, 20].

The most common pathogen isolated was *Pseudomonas aeruginosa* that is 52(43.3 %), followed by *staphylococcus aureus* that is 50(41.66%). Mousa HA *et al.* has reported that from his study that *Pseudomonas aeruginosa* and *Staphylococcus epidermidis* were the most common causative agents which support our study [10]. Sarangi Samir K, Padhi Sanghamitra has reported that *Staphylococcus aureus* was found to be the most common aerobic isolate (31.1%) followed by *Pseudomonas aeruginosa* which corroborated

with our study [20]. A Deny, C. Loiez, V *et al.* has reported that patients who had undergone bone fixation had a lower rate of MRSA infections than patients, who had undergone arthroplasty 13% vs. 30% [21]. Muley VA, Ghadage DP *et al.* has reported that rate of MRSA isolation in his study was 12% [22]. This two study support our study that is 10 % of total isolate. Latha T, Anil B, Manjunatha H, *et al.* has reported that 57.3% of *Staphylococcus aureus* as MRSA which does not support our study [23]. *Klebsiella Spp* was isolated in 10 patients and *E.coli* was isolated in 4(3.3%) this finding is supported by the work of Chouhan V. Qivas *et al.* and Pfang BG, García-Cañete J, García-Lasheras J, *et al.* [24, 25]. *Enterococcus SPP* was isolated in 3.3% patient, which is supported by the work of Andreas F. Widmer *et al.* [26].

Implants in femur and tibia are most commonly infected. Implants in foot, humerus and knee are equally infected which is supported by the work of Fernandes A, Dias M. *et al.* [12]. Biofilm formation by organism is a complex process. Initially there occur adhesion of organism to implant surface followed by multi-layered bacterial cell proliferation and adhesion of cells in an extracellular polysaccharide matrix. This biofilm is responsible for chronic infection, resistant to treatment with antibiotics and a chronic inflammatory response at the site of the biofilm [1]. In present study *Staphylococcus Aureus (MRSA)* was commonly associated with biofilm formation followed by *Staphylococcus Aureus (MSSA)* which corroborates with the study of Choong PF, Dowsey MM, Carr D, Daffy J, Stanley P *et al.* and Teterycz D, Ferry T, Lew D, Stern R, Assal M, Hoffmeyer P, *et al.* [27, 28].

Regarding antimicrobial susceptibility patterns organism *Pseudomonas aeruginosa* isolated from implant infections were sensitive to Piperacillin+ tazobactam, Imipenem, Imipenem+cilastatin and Meropenem. Among aminoglycosides sensitivity to Tobramycin was high in comparison to amikacin and Gentamycin. Among cephalosporin, 51.9% of isolated *Pseudomonas aeruginosa* were sensitive to Cefipime, sensitivity to quinolones were

less. This finding corroborates with the study of Perumal A, Kumar CA, and Doris TS *et al.* [29]. *Staphylococcus aureus* was sensitive to Cefipime, clindamycine, Vancomycin and linazolid. Sensitivity *staphylococcus aureus* to Amoxicillin+clavulanic acid, Azithromycin and clarithromycin was around 50 % which is supported by the work of Shekhar Pal, Ashutosh Sayana, Anil Joshi, Deepak Juyal *et al.* [30]. In our study *staphylococcus aureus* (MRSA) are sensitive to clindamycine, Vancomycin and linazolid. We have also observed that 50 % *staphylococcus aureus* (MRSA) isolated from implant infection were sensitive to Cotrimoxazole. This finding corroborates with the study of Latha T, Anil B, Manjunatha H, *et al.* and Tandra Chadha, Syeda Nazia Kulsum *et al.* [23, 31]. Study of Gitau, W., Masika, M., Musyoki, M. et a and Jain S, Chowdhury R, Datta M, Chowdhury G, Mukhopadhyay AK *et al.* supports our finding [32, 33]. *Klebsiella Spp* was 100% sensitive to Imipenem, Imipenem+cilastatin, Meropenem Cefipime and Clindamycine. *Klebsiella SPP* were sensitive to fluoroquinolones. This is supported by the work of Raquel Silva, MD, Mauro Costa Salles *et al.* [34]. *E.coli* was sensitive to Piperacillin tazobactam, Imipenem+cilastatin, Cefipime and amikacin but they were less sensitive to Cefoperazone+sulbactam, ofloxacin and Gentamycin. Study of Benazir *et al.* corroborates with our finding [35]. *Enterococcus Spp* was highly sensitive to Piperacillin tazobactam, Amikacin, Tobramycin, Vancomycin and linazolid but biofilm forming *Enterococcus Spp* was difficult to treat. Rasouli MR, Tripathi MS *et al.* has concluded that Management of *Enterococcus PJI* is challenging and multiple operations may need to be performed to control the infection [36]. Holmberg A, Mörgelin M *et al.* has concluded that ciprofloxacin or linazolid with rifampicin have a good effect on *Enterococcus Spp* which support our study [37]. E.Tornero, E.Senneville *et al.* has reported that failure of treatment was less with linazolid and Vancomycin which again support our study [38].

Conclusion

From this study we can conclude that the most common pathogen isolated from post-operative orthopaedic Implant infections was *Pseudomonas aeruginosa*. Implant of femur was most commonly infected. *Staphylococcus Aureus* (MSSA) was commonly associated with biofilm formation followed by *Staphylococcus Aureus* (MRSA). *Pseudomonas aeruginosa* isolated from implant infections were sensitive to Piperacillin+ tazobactam, Imipenem, Imipenem+cilastatin and Meropenem. *Staphylococcus aureus* was sensitive to Cefipime, clindamycine, Vancomycin and linazolid. *Staphylococcus aureus* (MRSA) are sensitive to clindamycine, Vancomycin and linazolid. We have also observed that 50% *staphylococcus aureus* (MRSA) isolated from implant infection were sensitive to Cotrimoxazole. *Klebsiella Spp* was sensitive to Imipenem, Imipenem+cilastatin, Meropenem Cefipime and Clindamycine. *E.coli* was sensitive to Piperacillin tazobactam, Imipenem+cilastatin, Cefipime and amikacin. *Enterococcus Spp* was highly sensitive to Piperacillin tazobactam, Amikacin, Tobramycin, Vancomycin and linazolid.

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