

Infected Orthopaedic Implants And Infectious Agents: MRSA Frequency And Infection Patterns, In A Tertiary Care Centre In Central Kerala.

¹Dr. Renjini Joseph, Consultant Microbiologist Lourde Hospital Ernakulam.

²Dr. Reena John, Additional Professor, Dept of Microbiology, Govt. Medical college Thrissur.

³Dr. Prithi Nair K. Prof. & H.O.D Dept of Microbiology Govt. Medical College Thrissur.

Correspondence Author: Dr. Reena John, Additional Professor, Dept of Microbiology, Govt. Medical College Thrissur.

Conflicts of Interest: Nil.

Abstract

Introduction:- Orthopedic implants have revolutionised treatment of bone fractures and non-infectious dysfunctional painful joint arthritis and have become an essential component of modern medicine. There is also an increasing number of surgeries for trauma related orthopaedic injuries like fractures which often require fixation with an implant which will be retained temporarily or permanently. Infections though uncommon seriously affect patient outcome

Objective:- To identify bacteria which cause infections in orthopaedic implants and to study their antibiotic susceptibility pattern with a focus on Gram positive bacterial isolates .

Materials and methods:- A Cross sectional study was conducted in patients who had undergone prosthesis or implant surgeries and presenting with signs and symptoms of infections in the orthopaedic department during one year period. Specimens included for the study were pus swabs, pus aspirates, tissue and screws. Identification was based on Gram staining and cultural characteristics as well as biochemical reactions of the isolate using standard laboratory procedures.

Results: Among the 105 cases studied, males were 79 % and females were 21% and in 95.2%, the indication for orthopaedic intervention was fracture, only

4.8 % were for arthritis. Among the culture positives for Gram positive bacteria 62 (91.2%), Staphylococcus aureus (MSSA)- 38 was the most common isolate CONS was 13, MRSA constituted 10, and one Enterococcus faecium.

Summary and Conclusion: Bone implant infections are associated with significant morbidity for the patient and also adds significantly to healthcare costs. Careful selection of antibiotics for pre-operative prophylaxis, taking into account the common etiological agents in this type of infection could be an important step to prevent its occurrence.

Keywords: Implant, CONS, MRSA

Introduction

Orthopedic implants have revolutionised treatment of bone fractures and non- infectious joint arthritis and have become an essential component of modern medicine. There is an increasing number of surgeries for trauma related orthopaedic injuries like fractures which often require fixation with an implant which will be retained temporarily or permanently. The number of elderly and trauma patients requiring joint replacement or internal fixation devices is steadily increasing. A prosthetic replacement and an implant surgery is commonplace in orthopaedic operations for successfully alleviating the pain and improving the mobility in damaged joints. Orthopaedic device related infections include infections of

Internal Fixation Devices and Joint Prosthesis. This is associated with significant morbidity for the patient and occasionally ends fatally. It also adds significantly to healthcare costs. The incidence of implant infections is now low. Internationally, it is 1%–2% in institutions with highly trained surgeons. But because of the increasing number of patients requiring implants, even a very low risk of infection can result in large number of patients with such infections.¹

Detection of infection after implant surgery is a diagnostic challenge. No test is 100% sensitive and 100% specific.² The safety and biocompatibility of these devices are excellent, and <10% of the patients at risk experience complications during their lifetime.^{2, 3} Diagnosis relies on the surgeon's judgement of the clinical presentation and the interpretation of investigation results. Prosthesis removal, which usually is necessary to treat these infections, produces large skeletal defects, shortening of the extremity, and severe functional impairment. The purpose of this study is to identify common Gram positive bacterial agents which cause infections in such implants and also to study their antibiotic susceptibility pattern.

Materials and Methods

A Cross sectional study was conducted on patients who had undergone prosthesis or implant surgeries and presenting with signs and symptoms of infections in the orthopaedic department in a tertiary care hospital in Kerala during a period of one year from 2014 March to February 2015. All orthopaedic patients who had undergone prosthesis or implant surgeries and clinically diagnosed with implant infections, attending the orthopedic inpatient department were included in the study. All patients with external fixation devices excluded from the study.

A total of 105 samples were collected from patients.. Specimens included for the study were pus swabs, pus

aspirates, tissue and screws. Swabs were collected from patients presenting with pus discharge or sinus at the implant site. Sample was obtained using sterile swabs after through cleansing of the site with normal saline. Pus aspirates and tissues were obtained by the surgeons during operation for removal of implants. Screws from implants which were removed were received in BHIB bottles. All pus swabs were inoculated into blood agar, MacConkey agar and Tellurite agar. Pus aspirates were inoculated into blood agar, MacConkey agar, chocolate agar, tellurite agar, BHIB and RCM. The screws received in BHIB bottles were incubated overnight, then vortexed and subcultures made onto blood agar, MacConkey agar and chocolate agar. Pus aspirates in BHIB were incubated at 37⁰ c overnight and subcultures were done onto blood agar, MacConkey agar and chocolate agar. The BHIB was also incubated at 37⁰ c. The plates were examined at the end of 24 and 48 hours for growth and colony characteristics. Identification was based on Gram staining and cultural characteristics as well as biochemical reactions of the isolate using standard laboratory procedures. Antibiotic sensitivity testing was done by Kirby Bauer disc diffusion method as per CLSI guidelines⁵

Results

A total of 105 cases with orthopaedic implant related infection were studied for a period of one year.

TABLE – 1: Age Incidence

Age group (Years)	Number of patients	Percentage (%)
10-19	2	1.9
20-29	12	11.5
30-39	10	9.5
40-49	28	26.7
50-59	22	21
60-69	18	17
70-79	8	7.6
80-89	5	4.8

Among the 105 cases studied, maximum frequency of infection was in the 40-49 age group, followed by the 50-

59 age group. This indicates that the frequency is more in the middle age group in this study.

Table 2: Gender Incidence

Gender	Number of patients	Percentage (%)
Male	83	79%
Female	22	21%

Among the 105 cases studied, males affected were 79 % and females were 21%.

Table 3: Type of Orthopaedic Intervention

Orthopaedic intervention	Number of patients	Percentage (%)
ORIF	62	59
IM Nailing	25	23.8
K wire fixation	11	10.5
Arthroplasty	7	6.7

In the present study, 59% of the surgeries were ORIF, 23.8 % were intramedullary nailing, 10.5% were Kwire fixation and 6.7 % were arthroplasty.

Table 4: Indication For Orthopedic Intervention

Indication	Number of patients	Percentage (%)
Fracture	100	95.2
Arthritis	5	4.8

Table 5: Timing of Surgery

Timing of surgery	Number of patients	Percentage (%)
Emergency	99	94.3
Elective	6	5.7

Among the 105 patients included in this study, 94.3% had undergone orthopaedic surgery as an emergency procedure, whereas 5.7% had undergone the surgery as elective procedure.

Table 6: Antibiotic Prophylaxis

Antibiotic prophylaxis	Number of patients	Percentage (%)
Received	74	70.5
Not received	0	0
Not known	31	29.5

Among the 10 patients, 70.5% had received antibiotic prophylaxis before surgery. This data could not be obtained for 29.5% of patients.

Table 7: Type of Implant Infection

Type of implant infection	Number of patients	Percentage (%)
Early	59	56.2
Delayed	41	39
Late	5	4.8

Based upon the timing of clinical presentation, 56.2% were early type, 39% were delayed type and 4.8% were of late type.

Table 8: Specimen Type

Specimen type	Number of samples	Percentage (%)
Pus swab	54	51.4
Pus aspirate	37	35.2
Tissue	8	7.6
Screws	6	5.8

Of the 105 samples processed, 51.4% were pus swabs, 35.2% were pus aspirates. 7.6% were tissue samples and 5.8% were screws from implants.

Table 9: Predisposing Conditions

Predisposing condition	Number of patients	Percentage (%)
None	77	73.4
Diabetes mellitus	23	21.9
Rheumatoid arthritis	0	0
Steroid intake	0	0
POWI	2	1.9
Advanced age (>80)	3	2.8
Psoriasis	0	0

Of the 105 patents included in the study, 73.4% did not have any predisposing condition. Among those who had associated predisposing condition, 21.9% had diabetes mellitus, 1.9% had post operative wound infection and 2.8% had advanced age.

Table 10: Culture Positivity

Bacterial isolate	Number of samples	Percentage (%)
Sterile	37	44.8
Culture positive	68	55.2

Among the 105 specimens processed, 55.2% had positive culture, 44.8% were sterile.

Table: 11 Distributions of Bacterial Isolates

Bacterial isolate	Number	Percentage (%)
Gram positive bacteria	62	91.2
Gram negative bacilli	6	7.8

Table: 12 Distributions of Grampositive Isolates

Gram positive cocci	Number	Percentage (%)
Staphylococcus aureus	38	61.3
CONS	13	21
MRSA	10	16.1
Enterococcus faecium	1	1.6
Total	62	100

Among the culture positives for gram positive organisms, Staphylococcus aureus was the most common isolate. 38 (61.3%). The percentage of CONS was 21%. MRSA constituted 16.1%. Enterococcus faecium, constituted 1.6% .

Table: 13 Correlation of Type Of Infection With Etiological Agent

Etiological agent	Type of infection (Percentage)		
	Early	Delayed	Late
Staphylococcus aureus	92.1	7.9	0
CONS	7.7	84.6	7.7
Enterococcus faecium	100	0	0
MRSA	0	0	100

92.1 % of infections due to Staphylococcus aureus presented early, and in 7.9% were delayed. In infections due to CONS, 84.6 were of delayed type, 7.7% were early type and 7.7 % were late type. Infections due to Enterococcus faecium presented early and MRSA were presented lately.

Table: 14 Species Identification of Cons

CONS species	Number	Percentage (%)
Staphylococcus epidermidis	11	84.6
Staphylococcus hemolyticus	2	15.4

Among the 13 CONS isolated, 11 (84.6%) were Staphylococcus epidermidis and 2 isolates (15.4%) were Staphylococcus hemolyticus

Table: 15 Antibiotic Sensitivity Pattern Of Grampositive Cocci

Antimicrobials tested	MSSA (38)		MRSA(10)		Enterococcus faecalis (1)		CONS(13)	
	Number (Sensitive)	Percentage	Number (Sensitive)	Percentage	Number (Sensitive)	Percentage	Number (Sensitive)	Percentage
Pencillin (10 IU)	2	5.3	0	0	NT	NT	1	7.7
Ampicillin(10µg)	NT	NT	NT	NT	1	100	NT	NT
Gentamicin (10µg)	22	57.9	0	0	1 (120µg)	100	1	7.7
Cephalosporin First gen (30µg)	38	100	0	0	NT	NT	10	76.9
Trimethoprim-sulphamethoxazole (1.25+23.75)	22	57.9	0	0	NT	NT	9	69.2
Erythromycin (15µg)	14	36.8	0	0	NT	NT	6	46.2
Cefoxitin (30µg)	38	100	0	0	NT	NT	10	76.9
Vancomycin (MIC)	NT	NT	10	100	1	100	13	100
Clindamycin (2µg)	23	60.5	0	0	NT	NT	10	76.9
Linezolid (30µg)	38	100	10	100	1	100	13	100

NT - Not tested

Discussion

A total of 105 patients who were investigated for bone implant infection in the orthopaedic department were studied during the period of one year.

The age range was from 16- 85 and mean age was 49.63. Age wise distribution of implant infection showed that the incidence was highest in the middle age group, that is 40-49 age group.

In the present study , out of the orthopedic interventions which the patients had undergone, which included ORIF, Intramedullary nailing, K wire fixation and arthroplasty, 59% belonged to ORIF. An increased frequency of infection in ORIF compared to the other 3 interventions was observed. This could be because of the fact that many of these surgeries are performed in an emergency setting and it involves considerable soft tissue damage and periosteal stripping.

In this study, among the 105 patients who presented with bone implant infections, 95.2% had implant surgeries for fracture fixation and only 4.8% had it for treatment of arthritis. This indicates that large number of orthopedic interventions are done for trauma related fractures in our hospital setup compared to the joint replacement surgeries. Also in this study, among the patients who had orthopedic intervention for fracture fixation, despite that the patients with open fractures tend to have a higher risk of bone infection due to easy access of bacteria into the bone, than those with closed fractures, the incidence of infection in open fractures were only 15 % and was 81% in closed fractures. In the study by Khosravi et al⁶, also results were comparable to ours with the incidence of infection in open and external fractures as only 17.6%, while 82.4% of implant infections occurred in closed and internal fractures. In the study by Fernandez et al,⁷ Out of 50 cases which were studied, 30(22.5%) were open fractures with extensive tissue damage, which led to infections.

In the present study, information from patient records showed that 94.3% had undergone the orthopedic intervention in the emergency setting and 5.7% had it as elective procedure. In the emergency setting increased infection rates may be related to inadequate disinfection procedure to eliminate microorganisms from the environment, contamination of surgical instruments and /or contaminated implants. In the present study 70.5% of patients had received antibiotic prophylaxis prior to surgery.

In the present study, we looked into any possible association between incidence of infection and factors like diabetes mellitus, post operative wound infection, steroid intake, rheumatoid arthritis, psoriasis and advanced age. It was found that 73.4% did not have any of the above predisposing conditions. Among those who had an associated predisposing condition, diabetes mellitus was a factor in 21.9% of patients and 1.9% had a history of post operative wound infection, 2.8% had advanced age. So diabetes mellitus was the most common risk factor in this study.

In the study by Khosravi et al,⁶ advanced age was a predisposing condition in 1.92%. In the study by Fernandez et al⁷ also advanced age was responsible for the infections in 8.09% (although it was not shown to be an independent contributing factor). In their study, diabetes was also a predisposing factor in 6.62%.

Although gram staining has poor sensitivity in the context of diagnosis of implant infections, in the present study, there was good correlation between gram stain findings and culture positivity. Among the 29 cases which had pus cells with gram positive cocci in Gram stain, 89.7% had a positive culture, while 10.3 % were sterile.

Based upon the timing of clinical presentation, implant infections have been classified into early, delayed and late. In our study, 56.2% were of early type, 39% were delayed

type and 4.8% belonged to late infection. In the study by Khosravi et al⁶, most prevalent infection was early onset 72.9%, 22.6% delayed and 4.5% late. In the study by Fernandez et al⁷, 26% had early, 18% had delayed and 56% had late infections.

In the present study, Gram positive aerobic cocci were isolated in 91.2% (62) of cases. Gram positive aerobic cocci isolates in the study by Khosravi et al⁶, were 33.5%.

In the study by Fernandez et al⁷, aerobic Gram positives cocci accounted for 60.9% (39) cases . Our results are similar to this study.

In the present study, among the bacterial isolates obtained, *Staphylococcus aureus* was 55.9% . The second most common isolate was CONS 19.1%. MRSA accounted for 7.7 % of isolates. . *Enterococcus faecium* was 1.4% . In the study by Khosravi et al⁶, among Gram-positive cocci, *S. aureus* was the most common isolate. *S. aureus* was the most common isolate in the study by Fernandez et al⁷ also. Our results are similar to both Khosravi et al and Fernandez et al studies. The distribution of isolates in samples in our study is similar to those in Fernandez et al study. The above data show that in implant infections, there is a predominance of *Staphylococcus aureus* as the pathogen. CONS is also important in causing these type of infections.

In the present study we also looked into the correlation between the bacterial isolate and the type of infection . So in our study, 92.1% of infections due to *Staphylococcus aureus* were of early type. In the cases with CONS as etiological agent, 84.6 % of the infections were of delayed type. Infections due to *Enterococcus faecium* were early type. In the study by Fernandez et al⁷, 69% of *Staphylococcus aureus*, 50% of CONS infections were of delayed type. In the study by Khosravi et al⁶, 47.1% of *Staphylococcal* infections, 64.3% of CONS, caused early type of infection. Our findings are more in comparison

with the findings of Fernandez et al. This could be due to the fact that more virulent organisms like *Staphylococcus aureus*, and MRSA lead to clinical symptoms and signs much earlier than those organisms which take more time to manifest as infection.

In the present study, the antimicrobial susceptibility testing revealed high rate of resistance of *Staphylococcus aureus* to Penicillin(94.7%) and erythromycin (63.2%). Among CONS, 92.3% were resistant to penicillin. 20.8% of *Staphylococcus* and 23.1% of CONS were methicillin resistant.

Summary and Conclusion

A total number of 105 patients who were investigated for bone implant infection in the orthopedic inpatient department of a Tertiary care centre. Increased incidence of infection were observed in the middle age group males .Infections were maximum in patients underwent ORIF. Infections were more for implant surgeries for fracture fixation .Incidence of infection was more in closed fractures. Infections were more in the emergency setting. Diabetes mellitus was the most common predisposing factor. Gram staining and culture results were well correlating. *Staphylococcus aureus* and CONS were the commonest isolates.

Bone implant infections are associated with significant morbidity for the patient and also adds significantly to healthcare costs. Detection of infection after implant surgery is a diagnostic challenge. Removal of the implant is required for treatment in many instances, which produces severe functional impairment. Careful selection of antibiotics for pre operative prophylaxis, taking into account the common etiological agents in this type of infection could be an important step to prevent its occurrence. Removal of the implant itself in case of fracture fixation devices after proper bone healing could also reduce the occurrence of infections.

References

- [1]. Spangehl MJ, Younger AS, Masri BA, et al. Diagnosis of infection following total hip arthroplasty. Instr Course Lect 1998; 47:285–95.
 - [2]. Goel S C. Infection following implant surgery. Indian J Orthop 2006;40: 133-7
 - [3]. Steckelberg JM, Osmon DR. Prosthetic joint infections. In: Bisno AL, Waldvogel FA, eds. Infections associated with indwelling medical devices. 2nd ed. Washington, DC: American Society for Microbiology, 1994:59–90.
 - [4]. Koneman's Color Atlas and Textbook of Diagnostic Microbiology, 6th edition.
 - [5]. CLSI. Performance standards for antimicrobial susceptibility testing : twenty –fourth informational supplement. CLSI document M100-S24. Wayne, PA: Clinical and laboratory standards institute: 2014
 - [6]. A.D. Khosravi, F. Ahmadi, S. Salmanzadeh, A. Dashtbozorg and E. AbasiMontazeri,. Study of Bacteria Isolated from Orthopedic Implant Infections and their Antimicrobial Susceptibility Pattern. Research Journal of Microbiology 2009, 4: 158-163.
 - [6]. Fernandes A, Dias M. The Microbiological Profiles of Infected Prosthetic Implants with an emphasis on the Organisms which Form Biofilms Journal of Clinical Diagnostic and Research. 2013 February, Vol-7(2): 219-223
-