

Prevalence, Risk Factors and Microbial Profile of Orthopedic Implants Associated Infections in a Tertiary Care Hospital

Vepada Ravi Kiran¹, Gaurav Akhand², Ali Akbar Malik³, Niket Raj Garg⁴

¹Assistant Professor, Department of Microbiology, SRVS Government Medical College, Shivpuri, MP, India

²Assistant Professor, Department of Orthopaedic, NSC, Government Medical College, Khandwa, M.P, India

³Assistant Professor, Department of Orthopaedic, Index Medical College Hospital & Research Centre, Indore, M.P, India

⁴Assistant Professor, Department of Orthopaedic, Heritage Institute of Medical Sciences, Varanasi, U.P, India

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Corresponding Author: Dr. Niket Raj Garg

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Abstract

Objectives: Orthopaedic implants associated infections are the major problem of surgical site infection, lead to high morbidity and mortality. They are preventable if its risk factors, causative organisms and antimicrobial susceptibility patterns in the regional area are timely recognized.

Aim: This study is aimed at determining prevalence, risk factors and bacterial profile of orthopedic implants associated infection.

Methods: This was a cross sectional study. The study group comprised of 90 patients who had undergone orthopaedic prosthetic implant surgeries and presented with signs and symptoms of infections. The demographic data were recorded and all related risk factors were noted. Samples are taken from the infection site and processed in the laboratory for identification on microorganism as per the standard protocol.

Results: The prevalence of implants associated infection was 25.7% (90/350). Majority of the patients were 45-60 years predominantly male. Interlocking nails and dynamic compression plates were the most common used implants. Obesity, smoking, duration of the surgery, pre-operative blood transfusion and prolonged duration of hospital stay were the significant risk factors associated with the infections. Among overall isolated organism 60.1% was Gram negative bacilli and 39.9% were Gram-positive cocci Staphylococcus aureus (25.5%) was the predominant isolate followed by pseudomonas (15.5%), Klebsiella (12.3%) and Coagulase Negative staphylococci (11.1%).

Conclusion: obesity, smoking, duration of surgery and post-operative hospital stay were the significantly associated risk factors and Staphylococcus aureus was the most frequent isolates in orthopedic implants associated infections.

Keywords: Orthopaedic Implants infections, prevalence, risk factors, microbial profile

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Introduction

Implants are devices that are intended to replace missing body parts or deliver medication, monitor body function or provide support to organs and tissues [1]. Orthopaedic implants can be used to replace or provide fixation of bone, or articulating surfaces of a joint. These include prosthetic joint implants (PJI) and the fracture fixation devices [2]. The implants are highly susceptible to microbial infections which are associated with high rate of morbidity and medical costs. [3] Patients can suffer many interventions (implantation, removal, and reimplantation) along with long term anti-microbial treatment which in turn can be associated with complications such as prolonged hospitalization

and a possibility of renewed disability. [4] Implant related infections can be classified as early (10 weeks in fixation implants or >24 months in PJI), depending upon the duration of onset of symptoms. [5]

Biofilm formation and antibiotic resistance of adhering bacteria reflect the severity of implant-associated infections. ESBL and AmpC Beta Lactamase producing Enterobacteriaceae are considered as the most important factor for developing resistance towards the antibiotics like penicillins and cephalosporins which favours plasmid mediating resistance. MBL is the class B

type of beta-lactamase which mediates the resistance towards carbapenems among *Pseudomonas* spp. which causes severe septicemia and pneumonia. The rate of morbidity and mortality associated with MRSA infection is reported to be high due to its virulence and high rate of relapse [6-8]. In general, treating ESBL, AmpC, MBL and MRSA associated implant infections using commonly prescribed antibiotics results in treatment failure which also increases morbidity.

Diagnosis of orthopaedic implant related infections remains challenging and a strategy is required with a clear view of the pathogenesis of implant-related infections, with a special attention on the alarming phenomenon of antibiotic resistance. [9] This study was conducted to evaluate the relationship of various factors which are associated with orthopaedic implant infections.

Aims & Objectives: the objectives of the present study were to determine prevalence, their risk factors and microbial profile of orthopedic implants associated infection in a tertiary care hospital.

Material & Methods

This was a cross sectional study, conducted in the department of orthopedics with the support of the Department of microbiology in a tertiary care hospital, India. This study was done among patients visiting the hospitals for orthopedic care. The study participants were those that were clinically suspected for orthopedic infection and able to provide written informed consent/assent

Inclusion Criteria:

- Patients underwent surgery related to any orthopaedic trauma, who later developed purulent discharge with the signs and symptoms of infections
- Patients age 18 years or more
- Participants who provides written informed consent for the study

Exclusion Criteria:

- Patients < 18 years of age
- Patients with prior orthopedics skin and soft tissue infections, surgical site infections diagnosed by clinical or radiological criteria
- Patients admitted with implant infections who operated elsewhere
- Participants who not willing for the study

In case of early infections; patients may be presenting with fever, local persisting pain, erythema, hematoma and wound healing disturbance, whereas in case of late infections patients can be presented with joint pain, loosening of implant in delayed infections; sinuses, aseptic loosening and sepsis.

The patient demographic characteristics, co-morbid conditions, nature of trauma, type of implant, type and duration of procedure were recorded.

The pus aspirate, swabs, tissue, synovial fluid, and bone specimens were collected from the site of surgery under all aseptic precautions to avoid contamination and were immediately transported to the Department for culture and antibiotic sensitivity testing. All specimens were processed using standard microbiology techniques and inoculated into 5% sheep blood agar, MacConkey agar and incubated in 37°C in ambient air for 24 hours. A chocolate blood agar was inoculated and incubated in 37°C in 5-10% carbon dioxide for 24 hours. A separate sheep blood agar was inoculated and incubated in anaerobic condition for 48 hours. The causative organisms were identified by basic procedures included Gram staining, followed by identification of the isolates using standard microbiological techniques [10]. The causative organisms isolated were tested for antimicrobial susceptibility as recommended by Clinical and Laboratory Standards Institute (CLSI) M100 document using Kirby-Bauer disc diffusion and gradient diffusion E-test methods [11].

Statistical Analysis: The analysis was performed using SPSS software version 22.0. The results were analysed using the Chi-square test, Fisher's exact test and test of proportions, wherever applicable. The difference in proportion was considered if p-value was <0.05.

Results

A total of 350 patients came to the hospital for orthopedic care during the study duration. The prevalence of orthopedic implants associated infections was 25.7% (90/350). Among implant infected patients, most of them (36.7%) were 45-60 years age group, predominantly 65 (72.2%) were male. The majority (61.1%) of study participants resided in a rural area. 44.4% of the study participants were education up to primary school. Majority of cases (46.7%) was belongs to lower socio-economic class.

Table I: Socio-demographic characteristics of orthopedic implants infection patients (n=90)

Participant characteristics		Frequency	Percentage (%)
Age group	18-30	16	(17.8%)
	31-45	23	(25.5%)
	45-60	33	(36.7%)
	>60	18	(20%)
Gender	Male	65	(72.2%)
	Female	25	(27.8%)
Residence	Rural	55	(61.1%)
	Urban	35	(38.9%)
Level of education	Illiterate	25	(27.8%)
	Primary	40	(44.4%)
	Secondary school	20	(22.2%)
	Graduation	5	(5.6%)
Socio-economic level	Lower	42	(46.7%)
	Middle	34	(37.7%)
	Upper	14	(15.6%)

The risk factors found to be significantly associated with orthopaedic implants infection were obesity, smoking, duration of surgery, Post operative hospital stay and Pre-operative blood transfusion ($p < 0.05$). Majority of the cases (85.4%) received prolonged prophylactic antibiotics before surgical

site infections were diagnosed. There was no statistical difference between infected and non-infected groups in terms of gender, diabetes, hypertension, use of steroid and Prolonged antibiotics prophylaxis ($p > 0.05$).

Table 2: Risks factors in infected and non-infected orthopaedic implant patients

Risk factors		Infected (n=90)	Non infected (n=260)	P value
Gender	Male	65 (72.2%)	175 (67.3%)	0.386
	Female	25 (27.8%)	85 (32.7%)	
Obesity	Obese	22 (24.4%)	35 (13.5%)	0.015
	Non obese	68 (75.6%)	225 (86.5%)	
Hypertension	Present	18 (20%)	47 (18.1%)	0.685
	Absent	72 (80%)	213 (81.9%)	
Diabetes mellitus	Present	16 (17.8%)	40 (15.4%)	0.593
	Absent	74 (82.2%)	220 (84.6%)	
Steroid use	Yes	13 (14.4%)	44 (16.9%)	0.583
	No	77 (85.6%)	216 (83.1%)	
Prolonged antibiotics prophylaxis	Given	76 (84.4%)	235 (90.4%)	0.122
	Not given	14 (15.6%)	25 (9.6%)	
Duration of surgery	<2 hours	69 (77.7%)	165 (63.8%)	0.021
	≥2 hours	21 (23.3%)	95 (36.5%)	
Post operative hospital stay	< 7 days	37 (41.1%)	185 (71.2%)	0.047
	≥7days	53 (58.9%)	75 (28.8%)	
Smoking	Smoker	39 (43.3%)	43 (16.5%)	0.034
	Non smoker	51 (56.7%)	217 (83.5%)	
Pre-operative blood transfusion	Yes	29 (32.2%)	45 (17.3%)	0.002
	No	61 (67.8%)	215 (82.7%)	

The most common implants used in orthopedics surgery were Interlocking nail (28.9%), Dynamic compression plate (28.9%), Dynamic hip screw (7.8%) and 16.7% was others plate and screws. Details of types of implants shown in table: 3.

Table 3: Distribution and type of implant used for internal fixation of fractures

	Type of implant	Frequency (%)
Plates and screws	Dynamic compression plate (DCP)	20 (22.2%)
	Distal femoral locking plate	1 (1.1%)
	Angle blade plate	1 (1.1%)
	PHILOS plate	3 (3.3%)
	Dynamic hip screw	7 (7.8%)
	Dynamic condylar screw	5 (5.6%)
	Multiple screws	2 (2.2%)
	Calcaneal plate	1 (1.1%)
	TBW/K wire	2 (2.2%)
	Others	15 (16.7%)
Nails	Interlocking nail	26 (28.9%)
	Reconstruction nail	4 (4.5%)
	Proximal femoral nail antirotation	3 (3.3%)

The microbial profile of orthopedic implants associated infection: staphylococcus aureus (25.5%) followed by Pseudomonas aeruginosa (15.5%), Klebsiella (12.3%) and Coagulase negative Staphylococcus (CoNS) in 11.1% were the most common isolates. (Figure: 1).

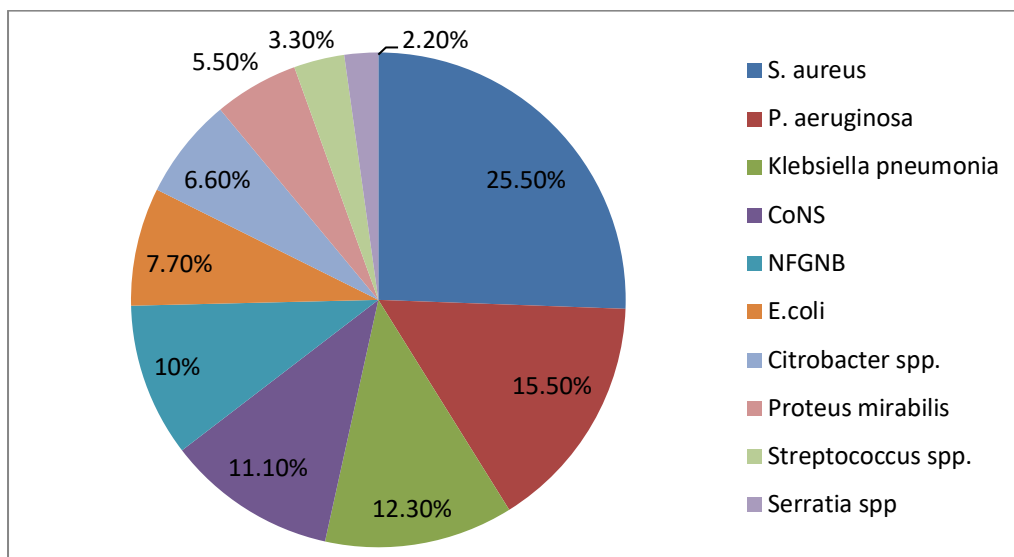


Figure 1: microbial profile of orthopaedic implant infection

Discussion

Orthopaedic implant surgeries are quite common in the modern era. Fixation implants are temporarily required while as prosthetic joints replace the irreversibly damaged articulating surfaces of a joint in patients with osteoarthritis or inflammatory arthritis. Microorganisms attached to these implants defy removal by host defenses. Patient may suffer multiple surgeries with a prolonged period of disability [12-13].

Despite strict aseptic techniques and infection control practices, implant associated infections are common. Orthopaedic implant associated infections emerge as an imperative patient safety problem, as it increases the financial and societal cost of the patients, hence prompt detection of microbial profile are play critical role in the treatment of infection [14].

In the present study, the overall prevalence of orthopedic implants associated infections was 25.7%, similar prevalence also reported by Tan LT, et al [15]. The prevalence of this study are higher than another study done in India, Fux CA et al [16] and Mulugeta T, et al [17], The high prevalence may be due to poor infection prevention, contamination of surgical instrument and number of personnel in the operating room. This study has lower prevalence compared to another study done in India 68%, the higher prevalence in the Indian study may be due to the specimen collected was from wound [18].

Implementing good infection prevention measures, decreasing operating room traffic and maintaining operating room air quality may help to minimize SSI in orthopedic surgeries in the future.

In our study, majority of the patients were males (72.2%), which correlated with the study of Khosravi D et al [19] and Vishwajith et al [20], reported male predominance were 68.5 % and 75.5% respectively.

Current study found most of the participants were 45-60 years age group, comparable with the Prathab AG et al [21]. This might be due to age differences between the American study and this study. Hematogenous orthopedic infection was more common in older adults in our study, whereas in the American studies hematogenous orthopedic infection was more common in children and after placement of orthopedic implants [22].

In this study, we have identified several risk factors which are found to be statistically significant are obesity and smoking. Obesity is a common and significant risk factor for surgical site infection in general, as well as in orthopaedic practice. This is consistent with the findings in Yuan et al [23] and Abdallah et al [24]. Possible explanation for this is that high body mass index is associated with reduced ambulation post-operatively.

Anemia, duration of operation and prolonged postoperative stay was found to be significantly associated with orthopaedic implants infections, our results were concordance with the Chua WC et al [25] and Voila et al [26].

In our study, the most common implants were used in orthopedics surgery were Interlocking nail and Dynamic compression plate, accordance to the Benazir S, et al [27].

In the present study, aerobic gram negative isolates were predominant than gram positive isolates accounted for about 60.1% and 39.9% respectively, in agreement with the G Perumal et al [28] and Anisha F, et al [29].

Current study reported that staphylococcus aureus was the most prevalent isolates from orthopedic implants infection followed by *P. aeruginosa* and *Klebsiella* spp. Similar results were obtained by many other researchers: Gatti, M, et al [30], Cheemala SS, et al [31] and Shen H, et al [32].

S. aureus was considered as one among the principal causative agents of pathogens in orthopaedic implant infections which causes septic arthritis and osteomyelitis, which leads to the destruction of joint and bone.

Conclusion

The prevalence of orthopaedic implants associated infection in our area was higher (25.7%). We found that obesity, smoking, pre-operative blood transfusion, duration of surgery and prolonged hospital stay were significantly associated risk factors of orthopaedic implants infections. *Staphylococcus aureus* accounted for a vast

majority of the causative organisms. It is evident from our study that specific interventions along with proper infection control measures need to be taken on priority basis to decrease the infection rates in orthopaedic implant patients

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