Original Article

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Early Post-operative Wound Infection in Patients Undergoing Orthopaedic Surgery with Implant

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Abstract

Introduction: Surgical site infections (SSIs) are important complications of orthopaedic procedures involving prosthetic implants.

Purpose: The aim of this study was to find out the different type of microorganisms causing early post-operative infection in case of implant surgery along with their antimicrobial susceptibility pattern.

Material and Methods: The study was conducted in Medical College, Kolkata, for a period of 1 year (February 2014–January 2015). Cases were selected in the Department of Orthopaedics, who had undergone surgery with an implant for close fracture and developed early post-operative wound infection (POWI). The wound was examined on day 3, day 7, and day 14 at discharge and subsequent follow-up visits. The criteria for the diagnosis of POWI were those used by the National Research Council of USA. Wound swabs were taken from the patient who presented with early post-operative SSI and was sent to the Department of Microbiology for isolation, identification, and antimicrobial susceptibility of the causative microorganisms.

Results: A total number of 80 patients were included in this study during the period of 1 year. Most cases presented within 8–21 days postoperatively. The most common organism isolated from early infection in the post-operative surgical site was *Staphylococcus aureus* 39% followed by *Klebsiella* spp. 17% and *Pseudomonas* spp. 15%. All *S. aureus* were sensitive to linezolid, vancomycin, and all *Klebsiella* spp. were sensitive to imipenem and polymyxin B.

Conclusion: Judicial use antibiotic in POWI is required only after proper culture and sensitivity report to prevent the emergence of more resistant strains of pathogens.

Key words: Implant surgery, Methicillin-resistant *Staphylococcus aureus,* Post-operative, Resistance, Wound infection

INTRODUCTION

In orthopaedics, surgical site infection (SSI) after implant surgery is a disaster both for the patient and surgeon. This leads to increased antibiotic use, prolonged hospital stay, repeated debridement, prolonged rehabilitation, and morbidity and mortality.[1] SSIs are important complications of orthopaedic procedures that involve prosthetic implants.

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The number of elderly and trauma patients requiring joint replacement or internal fixation devices is steadily increasing. Open reduction and internal fixation (ORIF) of fractures with implants and prosthesis have become the predominant modality of treatment of fractures in most trauma centers. This is not only because of the better understanding of the biomechanics of implantable materials but also more importantly because of the better functional outcome in these patients.[2] Incidentally, this is associated with post-operative wound infection (POWI) reported to be in the range of 0.8–13% for both deep and superficial infections with increasing morbidity and cost. This category of patients is particularly vulnerable because ORIF interferes with the blood supply to the bones and implants are foreign bodies, which provide surfaces for bacterial adherence.[3] Despite considerable progress in prevention and treatment of implant-associated infection,

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the absolute number of patients with such infections is rising due to the lifelong risk for bacterial seeding on the implant.[4] The SSI prolongs hospital stay on average for 2 weeks, doubles re-hospitalization rates, and costs can increase by over 300%. In addition, patients may have physical limitations and significant reduction in the quality of life.[5] The pathogenesis of infection in fracture fixation devices is related to microorganisms, which grow in biofilm, and therefore its eradication is difficult.[3]

In prosthetic joint infections, early infection is defined as manifestation of infection at the implant site during the first 3 months after surgery. Delayed infection is defined as the manifestation of infection 3–24 months after surgery. Late infection is defined as the manifestation of infection more than 2 years after surgery.[3]

This aim of this study was to find out the different type of microorganisms causing early (<3 month) post-operative infection in case of implant surgery along with their antimicrobial susceptibility pattern.

MATERIAL AND METHODS

After obtaining Ethical Clearance from the Institute and informed consent from the patients, this study was conducted in Medical College and Hospital, Kolkata, for a period of 1 year (February 2014–January 2015). Cases were selected by consecutive sampling among the patients, who were admitted or came for follow-up in the Department of Orthopaedics, who had undergone surgery with an implant for closed fracture and disease and developed early POWI. This included all those patients who had a history of closed fracture and were treated with open/closed reduction with the orthopaedic implant *in situ* or disease of bone/ligaments injury in which orthopaedic implant was used during operation. Arthroscopic surgery patients were also included in which implant had been used. Patients having an open fracture, POWI, soft tissue surgery, diabetes, or any other immunocompromised state and whose infection occurred after 3 months were excluded from the study.

The wound was examined on day 3, day 7, and day 14 at discharge and subsequent follow-up visits at the outpatient clinic or whenever patients complained of fever or burning sensation at operated site. The criteria for the diagnosis of POWI were those used by the National Research Council of USA who defined POWI as "the presence of pus in a wound which has either discharged spontaneously or has to be released by the removal of sutures or re-opening the incision."

Wound swab was taken from the patient who presented with early post-operative SSI and was sent to the Department of Microbiology, Medical College, Kolkata, for further processing. After performing a direct microscopy of the Gram-stained smear, the pus was inoculated on blood agar, MacConkey agar and thioglycollate broth. Isolation, identification of the microorganisms and their antimicrobial susceptibility was done using standard techniques.

RESULTS

A total number of 80 patients were included in this study during the period of 1 year (from February 2014 to January 2015) having early POWI. There were 45 (56.25%) male and 35 (43.75%) female patients.

Most patients in 6th, 5th, 4th, and 3rd decades had SSI [Figure 1].

In most cases, 27 (33.75%) surgery was done in 3rd week following injury followed by 2nd week seen in 18 (22.5%), then 8 (10%) each in 1st week, 4th week and after 6th week and 4 (5%) during 5th and 6th week following injury. Seven cases were associated with either disease or deformity so time interval could not be determined in those cases.

Maximum infections were detected, and wound swabs were sent for culture in 2nd week after surgery followed by 3rd week as shown in Table 1. Only 10% (8 cases) had infections beyond 8 weeks [Table 1].

The different implants and prosthesis that were used in the different surgery were plates with screws in 37 (46%), nails in 15 (19%), screw and wires in 15 (19%), and DHS/DCS in 7 (9%) cases. Infection in case of the hip prosthesis was seen in 6 (8%) which included four cases of hemiarthroplasty and two cases of total hip arthroplasty. Among the included cases, infection in femoral implants was most common in 19 (24%) cases. It also included intertrochanteric, sub-trochanteric and all extra-articular fractures of the femur. Humerus was second most common

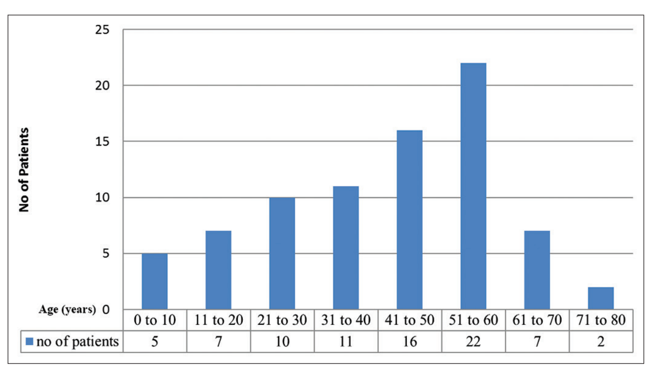

Figure 1: The age distribution of the patients

Table 1: The time interval after surgery with the number of cases detected

Time interval	Number of cases
0–7 days	2
8–15 days	26
16–21 days	20
22–28 days	8
29–35 days	2
36–42 days	5
43–49 days	5
50–56 days	4
>56 days	8
Total	80 cases

site seen in 13 (16%) cases. Tibia and radius/ulna were the third most common site, each 11 (14%) of cases. All intra-articular operation including knee, hip, ankle, elbow, shoulder comprised 26 (32.5%) cases with knee involved in 7, hip, ankle, and elbow involved in 6 each, and shoulder in one patient.

The most common organism isolated from early infection in the post-operative surgical site was *Staphylococcus aureus* 32 (39%) followed by *Klebsiella* spp. 14 (17%), *Pseudomonas* spp. 12 (15%), *Escherichia coli* 4 (5%), 3 *Proteus* spp., 2 each of *Acinetobacter* spp., *Enterococcus spp.*, coagulase-negative Staphylococcus, and 1 *Citrobacter* spp. In two specimen isolated organism was of mixed type (one it was *S. aureus* and *Proteus mirabilis* and in other it was Pseudomonas with Klebsiella). Significant portion ($n = 10$) of cultures had no growth.

Among the 32 isolates of *S. aureus,* all (100%) were sensitive to linezolid vancomycin followed by high susceptibility to clindamycin (81.2%), gentamicin (81.2%), amikacin (65.6%), doxycycline (65.6%), and amoxicillin/clavulanate (62.5%) [Table 2]. 24 (75%) of the isolates were methicillin-resistant *S. aureus* (MRSA). A total of 22 Enterobacteriaceae were isolated comprising 14 *Klebsiella* spp., 4 *E. coli*, 3 *Proteus* spp., and 1 *Citrobacter* spp. The isolates were 100% sensitive to imipenem followed by meropenem (86.4%). They were also sensitive (68.2%) to amikacin, gentamicin, and piperacillin/tazobactam. Sensitivity to piperacillin alone was 27.3% only, but its combination with tazobactam was 68.2%. Sensitivity to ciprofloxacin and levofloxacin was 63.6% [Table 2]. *Pseudomonas* species were most susceptible to piperacillin/tazobactam, imipenem, meropenem, tobramycin, polymyxin B, and levofloxacin [Table 2].

Other organisms isolated were two isolates each of coagulase-negative *Staphylococcus, Enterococcus* spp.*,* and *Acinetobacter* spp. Coagulase-negative *Staphylococcus* species were most probably from skin contamination during collection of samples. Isolated *Enterococcus* species were sensitive to ampicillin, amoxicillin, linezolid, vancomycin, doxycycline, and ticarcillin. Isolated *Acinetobacter* species were sensitive to imipenem, meropenem, ciprofloxacin, levofloxacin, and piperacillin/tazobactam.

DISCUSSION

Orthopaedic implants have revolutionized the treatment of bone fractures and non-infectious joint arthritis. Today, the risk for orthopaedic device–related infection (ODRI) is <1–2%. However, the absolute number of patients with infection continuously increases as the number of patients requiring such implants grow. Treatment of ODRIs most frequently includes long-term antimicrobial treatment and removal of the implant. With recent advances in infection prevention measures including pre-operative antimicrobial prophylaxis, improved sterilization techniques and aseptic measures, routine post-operative antibiotic prophylaxis, and even greater reduction in infection rate have resulted. Nevertheless, infection at the operative site may lead to a potentially devastating, even fatal, outcome.[1] Implant-related infection is an unresolved problem. Infections occur even after the orthopaedists perform thoroughly clean procedures and patients are carefully managed before and after surgery.[6] While colonization necessarily precedes infection, the presence of bacteria by itself does not constitute infection. This has been emphasized by the findings of a study on hardware removal in which 50% of cultures were positive in patients with no signs or symptoms of infection.[7]

In this study, positive culture was seen in majority of the cases (89%), which is similar to the finding of 89% by Zimmerli *et al.*[3] but more than that of Gomez *et al.* who reported positive cultures in 60%.[8] The causative organisms in the early post-operative implant infections were found to be *S. aureus* (39%), *Klebsiella* spp. (17%), and *Pseudomonas* spp. (15%). These findings are similar to that of an extensive study by Arciola *et al.* who reported Staphylococci as the most prevalent organism.[9] In another study in India by Agrawal *et al.* it was found that the most common infecting organism was *E. coli* (34.4%) followed by *Pseudomonas* spp. and then *S. aureus*. This is in contrast to our study wherein we found more *S. aureus* than *E. coli* and Pseudomonas spp. However, their study was regarding all sorts of orthopedic infections including bedsores, osteomyelitis, and open fractures.

All the *S. aureus* isolates were sensitive to linezolid and vancomycin though these are kept as reserve drugs and should be used as last resort for fear of the emergence of resistant organisms. The results of our study are contradictory to the results of Thool *et al.*[10] wherein they had found that 12 out of 51 isolated *Staphylococcus*

Table 2: The susceptibility of organisms isolated

Antimicrobial agent	*Staphylococcus aureus* *n*=32 (%)	*Klebsiella* sp (*n*=14)	Other Enterobacteriaceae (*n*=8)*	*Pseudomonas* spp. (*n*=12)
Amoxicillin	1 (3.1)	NA	NA	NA
Ampicillin	NA	0	1 (12.5)	NA
Piperacillin	NA	2 (14.3)	4 (50)	1 (8.3)
Ticarcillin	NA	NA	NA	6 (50)
Amoxicillin/clavulanic acid	20 (62.5)	3 (21.4)	2 (25)	NA
Piperacillin/tazobactam	NA	8 (57.1)	7 (87.5)	10 (83.3)
Cefoxitin	8 (25)	NA	NA	NA
Cefoperazone	NA	5 (35.7)	3 (37.5)	NA
Cefuroxime	NA	2 (14.3)	0	NA
Ceftriaxone	NA	3 (21.4)	4 (50)	NA
Cefepime	NA	6 (42.8)	5 (62.5)	3 (25)
Ceftazidime	NA	NA	NA	2 (16.7)
Imipenem	NA	14 (100)	8 (100)	10 (83.3)
Meropenem	NA	11 (78.6)	8 (100)	11 (91.7)
Amikacin	21 (65.6)	7 (50)	8 (100)	NA
Gentamicin	26 (81.2)	7 (50)	8 (100)	3 (25)
Tobramycin	NA	NA	NA	11 (91.7)
Ciprofloxacin	9 (28.1)	8 (57.1)	6 (75)	9 (75)
Levofloxacin	12 (37.5)	8 (57.1)	6 (75)	11 (91.7)
Doxycycline	21 (65.6)	1 (7.1)	3 (37.5)	NA
Polymyxin B	NA	14 (100)	NA	12 (100)
Trimethoprim/Sulfamethoxazole	9 (28.1)	NA	NA	NA
Clindamycin	26 (81.2)	NA	NA	NA
Erythromycin	11 (34.4)	NA	NA	NA
Linezolid	32 (100)	NA	NA	NA
Vancomycin	32 (100)	NA	NA	NA

NA: Not applicable. *Other Enterobacteriaceae includes 4 *E. coli,* 3 *Proteus* spp., and 1 *Citrobacter* spp.

were resistant to linezolid. The increasing prevalence of MRSA infections represent a significant health-care burden. Vancomycin and linezolid exhibit potent clinical and microbiological activity in MRSA infections.[11] In this study, there is a prevalence of 75% MRSA among the Staphylococcus aureus isolates.

Klebsiella spp. was the second most common (17%) microorganism isolated from the infected surgical site. Overall isolated Enterobacteriaceae were 22, comprising *Klebsiella* spp. 14, *E. coli* 4, *Proteus* spp. 3, and *Citrobacter* spp. 1. They were 100% sensitive to imipenem followed by meropenem (86.4%). However, meropenem and imipenem should not be used initially to prevent the emergence of resistance. Hence, piperacillin-tazobactam +amikacin/gentamicin or ciprofloxacin + amikacin/gentamicin are used in case of post-operative infection with Enterobacteriaceae family.

With the great increase in the level of orthopaedic surgery and with the evolution of techniques such as arthroscopy, recent advances in spine surgery and evolution of the modern arthroplasty the risk of infection is a great threat. It is always better to prevent the development of frank infection with prompt drugs and know the microbial profile of the infections in that area so that measures can be taken to prevent them. We all know that implant infections and osteomyelitis might just be the most difficult morbidities to treat. Osteomyelitis may even lead to amputation.

In general, in any orthopaedic case, a pair of antibiotics covering both the Gram-negative and Gram-positive infections should be employed. Whenever there is suspicion of an anaerobic infection, another antibiotic for anaerobes should be added. However, injudicious use of antibiotics may lead to antibiotic resistance and decreased patient immune response. Prompt use of the most sensitive antibiotics as early as possible as empirical therapy, to which most of the common infecting bacteria would succumb will help us in preventing frank life and limb-threatening infections.

Antibiotic treatment alone is quite often inadequate to treat prosthesis-related infections, especially when it comes to biofilm infections. In most cases, a combination of antibiotic therapy with surgical interventions, which can be divided into debridement with retention of the prostheses and staged exchange of the prostheses, is required.[12]

In our center, antibiotics to prevent infections in the post-operative period are given, and the chances of developing an infection after giving these empirical antibiotics are still present. Despite these, if infection develops postoperatively then before switching over to another antibiotic, wound culture must be done, and further antibiotics should be prescribed according to sensitivity reports keeping in mind reserve, and newer drugs should be the last resort.

With the overall drug sensitivity pattern, it is recommended that for empirical therapy we should start with a combination of amoxicillin/clavulanic acid or piperacillin + tazobactam along with gentamicin/amikacin as these drugs have been found to cover all bacteria including the Gram-positive Staphylococci or the Gram-negative Enterobacteriaceae or *Pseudomonas* spp. If resistance against these antibiotics is found then linezolid or vancomycin for Gram-positive *Staphylococci*, and meropenem/imipenem for resistant Enterobacteriaceae and *Pseudomonas* should be used.

CONCLUSION

For all orthopaedic surgical procedures with the implant, infection at the operative site has always been recognized as a potential complication. With recent advances in infection prevention measures including pre-operative antimicrobial prophylaxis, improved sterilization techniques and aseptic measures, routine post-operative antibiotic prophylaxis, even greater reduction of infection is possible. Nevertheless, infection at the operative site may lead to a potentially devastating, even fatal, outcome.

This study shows that *S. aureus* is the leading cause of early POWI in patients undergoing orthopaedic surgery with implant followed by *Klebsiella* spp. and *Pseudomonas* spp. as second and third most common pathogens, respectively. In case of *S. aureus,* the most sensitive antibiotics are linezolid and vancomycin and in Gram-negative bacteria, it is imipenem and polymyxin B, but these should not be used as initial drugs. It is worth mentioning here that, as we are entering into the post-antibiotics Era, it will be judicial to use antibiotics in POWI only after proper culture and sensitivity report to prevent the emergence of more and more resistant strains of pathogens.

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