

Original Research Article

A prospective study of surgical site infection of orthopedic implant surgeries

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ABSTRACT

Background: Surgical-site infection accounts for approximately 10% of all hospital-acquired infections, which are estimated to double the cost of care and result in an additional mean of 6.5 days of hospital stay. We did prospective study of surgical site infection of orthopaedic implant surgeries.

Methods: The aim of the study is to assess the clinical and microbiological outcome of 125 patients who had open reduction and internal fixation with implants and prosthesis at Southern Railway Hospital from January 2006 to January 2007, and its strength of association with major risk factors using univariate analysis. In our study, Patients were allocated in to three groups as NINS risk index group 0, 1 and 2 with risk factors as duration of surgery >2 hours and ASA class ≥ 3 . Post-operative wound infection was diagnosed based on the criteria of Center of Disease Control and assessed for the period of 6 weeks using National Nosocomial Infections Surveillance Risk Index.

Results: There were 87 male and 38 females in the study. From 125 Patients, 13 patients had post-operative superficial surgical site infection and presented within 21 days of operation. The infection rate was 10.4%. Two Patients developed deep infection after 6 weeks of study. All the cases with superficial infection were followed at regular intervals, 11 cases resolved with regular dressing and antibiotics but 2 cases continued to discharge sinus up to 3 months.

Conclusions: The study showed that the risk of infection rate increased significantly with ASA score, duration of surgery, obesity and NINS risk index. There was no significant association of infection rate with age, diabetes and smoking.

Keywords: Surgical Site Infection, NINS risk index, ASA class

INTRODUCTION

Open reduction and internal fixation of fractures with implants and prosthesis has become the first line in the management of fractures in most trauma centres. This is not only because of the better understanding of the biomechanics of implantable materials but more importantly because of the better functional outcome in these patients.¹ Surgical-site infection accounts for

approximately 10% of all hospital-acquired infections, which are estimated to double the cost of care and result in an additional mean of 6.5 days of hospital stay.¹

This category of patients is particularly vulnerable because open reduction and internal fixation interferes with the blood supply to the bones and implants are foreign bodies, which provide surfaces for bacterial adherence.² The microbiology of post-operative wound infections in all surgical services has changed very little

over the years. *Staphylococcus aureus* is the single most commonly encountered organism. Others included aerobic gram negative organisms such as *Escherichia Coli*, *Pseudomonas* species, *Proteus* species and *Enterococcus*.

Cure of an infection associated with an implant is usually achieved by debridement of all devitalized tissue, long-term antimicrobial treatment and removal of the implant and associated cement. Whyte et al found that the source of contamination was the patient's skin in 2% of cases and theatre personnel in 98% of cases. In the latter, 30% of contaminants reach the wound directly via the air and 70% reach the wound via hands of the surgical personnel or the instruments used.³

The study on the efficacy of nosocomial infection control demonstrated that well-organised surveillance programs for infection control including feedback of the rates of infection to surgeons were associated with significant reduction in surgical site infection.⁴

METHODS

This is a prospective study of 125 patients who had open reduction and internal fixation with implants and prosthesis that satisfied a set of inclusion criteria in southern railway headquarters hospital, Chennai between January 2006 to January 2007. There were 87 male and 38 females in the study.

Inclusion criteria

All closed fractures, patients with osteoarthritis of hip and knee treated with arthroplasty, duration of post-operative superficial surgical wound infection of less than 6 weeks, good condition of surrounding soft tissue and bone stock pre-operatively, a stable implant on radiological examination post-operatively, patient treated with Cefazolin and Garamycin as a perioperative prophylaxis.

Exclusion criteria

All compound fractures, presence of skin infection at the site of incision preoperatively, patient treated with antibiotic prophylaxis other than cefazolin.

Pre-operative evaluation

Pre-operatively patients were assessed of their comorbid conditions like diabetes mellitus, Obesity etc. and were categorized according to ASA class. Blood sugar was monitored preoperatively with periodic checkup and controlled for strict glycemic level during surgery and peri-operative period.

Choice and timing of antibiotics

Cefazolin 1 g with Garamycin 80 mg used for antibiotic prophylaxis and administered sixty minutes prior to the

incisions and ideally as near to the time of the incision. Additional Intraoperative dose was given if the duration of the procedure exceeded 2 hours or if there was substantial loss of blood. Post-operatively, antibiotics continued for 24 hours and stopped.

Skin preparation

Hairs were removed with clippers or razor on the OT table just prior to the incision. Povidine iodine was used as an antiseptic for patients and for surgeons hand scrubbing.

Implants and prosthesis

All the cases were operated at an average of 3 days after admission (1-10 days). Of 125 patients, 32 patients were treated with dynamic compression plate, 23 with dynamic hip screw, 10 with bipolar hip prosthesis, 8 with total hip prosthesis, 8 with cancellous screws and others were given in the figure below.

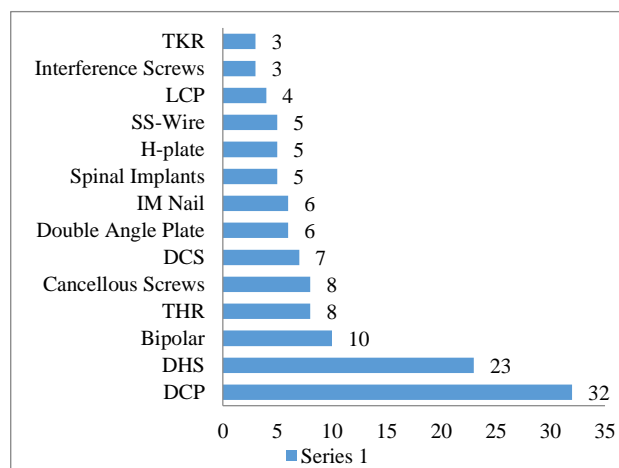


Figure 1: Implants and prosthesis included.

Post-operative protocol

Wound surveillance

The primary end-point of this study was six completed weeks following operation. Wounds were examined for presence or absence of Superficial surgical infection which met standard definition met by Center of Disease Control (CDC) on days three; seven, fourteen, at discharge and subsequent follow-up visits at the outpatient clinic. A wound proforma was completed for the patients included for this study during this periods. Clips were removed 10 days post-operatively.

NINS risk index

All the procedures were allocated a risk group based on NINS risk index of 0, 1, 2 or 3. This index is based on three risk factors: American Society of Anaesthesiologists score >3, duration of surgery of more

than 2 hours, and wound class. In our study all the Patients with clean wound taken, Hence NINS index evaluated with score of 0, 1, 2.

Statistical methods

A generalised linear model was used to determine significant, independent predictors of the risk of Surgical Site Infection, while taking into account the confounding effect of other predictors. Univariate analysis of infection rates for each categorical variable was compared by computing odds ratio risks along with 95% confidence intervals (CI). Length of stay could not be included in the linear model since it appeared after the outcome of SSI and was therefore not a predictor. The variables included in this study are sex, age (<70 or >70), ASA score (<3 or >3), duration of surgery (<120 min or >120 min), diabetes, obesity, NINS risk index (0, 1, 2) and smoking.

RESULTS

In the period between January 2006 to January 2007, 125 patients who were operated with implants and prosthesis taken in to prospective study. There were 87 male and 38 females in the study. From 125 patients, 13 patients had post-operative superficial surgical site infection and presented within 21 days of operation. 6 Males and 7 females developed surgical site infection. The infection rate was 10.4%. Two Patients developed deep infection after 6 weeks of study. Of 13 infection, most common infection identified was *Staphylococcus aureus* in 5 patients, MRSA in 3 patients and the rest are shown in the below figure.

Grade-0. Hence as the NINS risk Index increases, the infection rate increases.

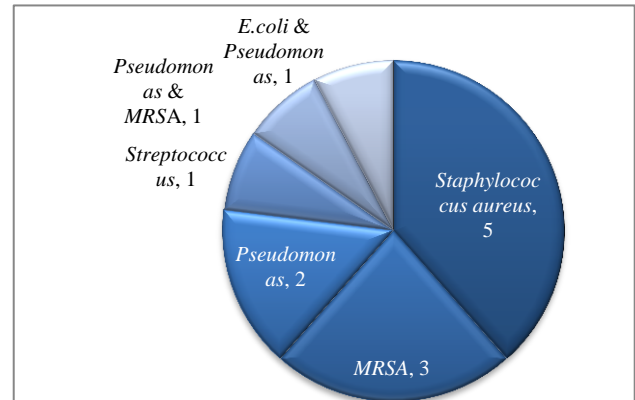


Figure 3: Distribution of organisms.

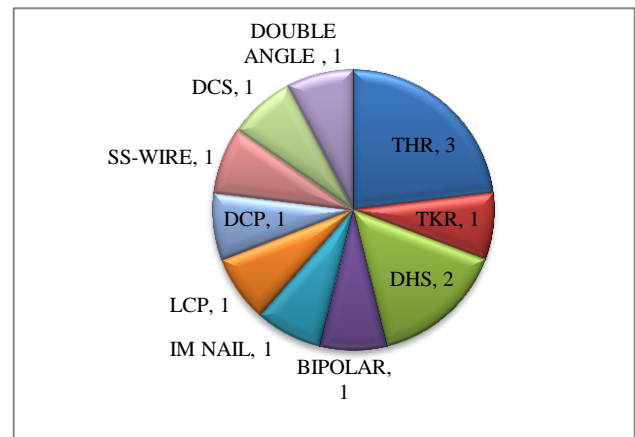


Figure 4: Implants vs. infection.

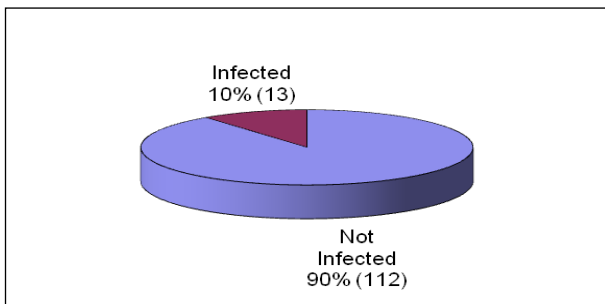


Figure 2: Percentage of patients infected.

Implants and prosthesis vs. infection

The distribution of prosthesis and implants and its incidence of infection rate in each implants are given below.

NINS risk index

In our study, Patients were allocated in to three groups as NINS risk index group 0,1 and 2 with risk factors as Duration of surgery >2 hours and ASA class ≥3. Of 13 infected patients, 8 patients had NINS risk index Grade-2, 4 patients had NINS risk index Grade-1 and 1 patient

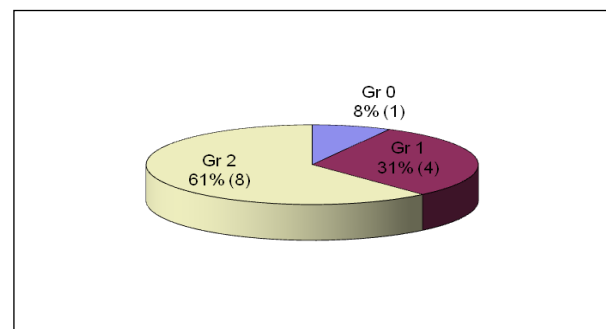


Figure 5: NINS risk index vs. infection.

Risk factors associated with infection

Univariate analysis of Infection rates for each categorical variables was compared by computing odds ratio along with 95% confidence intervals (CI). The variables used are age >70, sex, ASA class ≥3, NINS risk Grade 1 & 2 against Grade 0, duration of surgery > 120 min, diabetes, obesity, and smoking. All analyses were performed with test of significance level of 5% i.e., A p≤0.05 as significant.

Table 1: Single variable analysis for risk factors of SSI.

No	Variables	SSI			Odds ratio	95% CI	P value	Significant
		Yes	No	%				
1	Sex							
	Male	6	81	7.5	0.328	0.102 to 1.053	>0.05	No
Female	7	31	18.4					
2	Age							
	>71	3	14	17.6	2.1	0.514 to 8.571	>0.05	No
<70	10	98	9.2					
3	Smoking							
	Yes	3	23	11.5	1.161	0.29 to 4.56	>0.05	No
No	10	98	10.1					
4	ASA score							
	Class ≥ 3	8	9	47	18.31	4.94 to 67.77	<0.05	Yes
Class <3	5	103	5					
5.	Obesity							
	Yes	4	4	50	12	2.562 to 56.186	<0.05	Yes
No	9	108	7.7					
6.	Diabetes							
	Yes	4	23	14.8	1.719	0.4859 to 6.086	>0.05	No
No	9	99	9.1					
7.	Duration of surgery							
	>120 min	11	27	28.9	17.31	3.611 to 83.03	<0.05	Yes
<120 min	2	85	2.3					
8.	NINS risk index							
	Grade 1 or 2	12	33	36.3	27.882	3.48 to 223.02	<0.05	Yes
Grade 0	1	79	1.2					

From the analysis, variables– ASA score, obesity, duration of surgery and NINS risk index were significantly associated with Superficial Surgical site infection. Variables- sex, age, smoking and diabetes were not associated with Infection.

Illustrative cases

Case 1: A 74 year old male, a diabetic and obese patient had an alleged H/O accidental fall at his home and DHS fixation done for hip fracture. NINS risk index– Grade- 2 (1 for ‘ASA class 3 ‘and 1 for duration for surgery). On 7th post-operative day, he developed serous discharge from Sutured wound, Culture report– *Escherichia coli* and *Pseudomonas aurogenosa* sensitive to Cefaperazone and Sulbactam. Patient was started on above antibiotics for 4 weeks and Wound healed at 5 weeks after daily dressing.

Case 2

A 41 Yr old male, a non-diabetic patient suffered Fracture Tibia and Intra- medullary Nailing done. NINS RISK INDEX – Grade- 1 (duration for surgery more than 120 min). On 11th post-op day, he developed serous discharge from lower leg Sutured wound. Culture report– methicillin resistant *Staphylococcus aureus* sensitive to

Vancomycin. He was started on above antibiotics for 4 weeks and wound healed at 5 weeks after daily dressing.

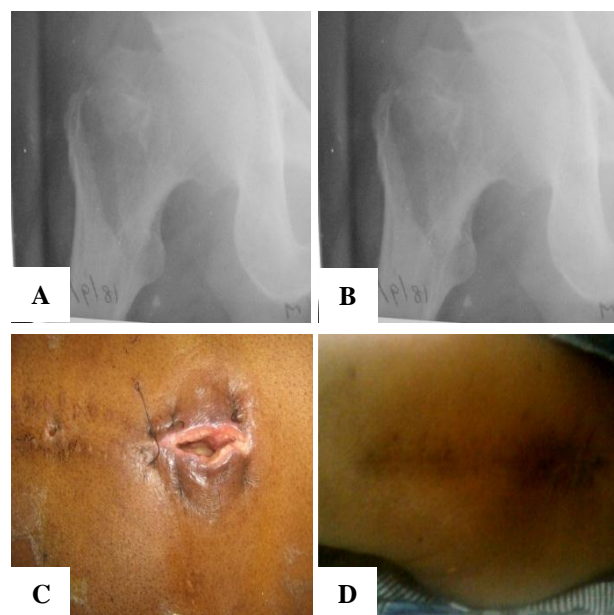


Figure 6: A= Pre-operative X-ray; B= Post-operative X-ray; C= Post-operative 2 weeks; D= Post-operative 5 weeks.



Figure 7: A= Pre-operative X-ray; B= Post-operative X-ray; C= Post-operative 12th day; D= Post-operative 5 weeks.

DISCUSSION

The biomaterial itself then has become the focus of infection. These infections are mainly caused by direct contamination during surgery, but they can also be caused by haematogenous spread of bacteria from an infection site somewhere else in the human body.⁵ The clinically important step of bacterial attachment to the surface of a biomaterial is then followed by aggregation of other bacteria, growth and multiplication of the bacteria, resulting in biofilm formation.⁶

Risk factors for surgical site infection

The most critical factors in the prevention of post-operative infections are the sound judgement and proper technique of the surgeon and surgical team, as well as the general health and disease state of the patient.⁷ The risk of infection in each patient can be evaluated by considering both patient-dependent factors and Surgeon-dependent factors.

Patient dependent factors

Various patient-related risk factors are inherent to the host and cannot be altered, whereas others may be reduced or eliminated by preoperative screening and appropriate preventive measures.

1. Malnutrition,
2. Secondary cell-mediated deficiencies due to steroid therapy, malnutrition, lymphoma, autoimmune deficiency syndrome predisposing to fungal and mycobacterial infections.

3. Obesity,
4. Diabetes mellitus,
5. Smoking.

Surgeon related factors

1. Pre-operative factors

Skin preparation: Preoperative skin preparation is an important factor in the prevention of infection, but it removes only up to 80% of skin flora. Selwyn S et al showed that the preparation bacterial counts among inpatients who received preoperative hexachlorophene showers were significantly lower than that of outpatients who did not receive preoperative showers.⁸ The standard surgical antisepsis involves scrubbing the skin with antiseptic solutions. Scrubbing with chlorhexidine significantly reduced hand bacterial counts compared with povidone-iodine.⁹

Preoperative hair preparation: Shaving immediately before the procedure decreased the infection rate compared with shaving within 24 hours, which is probably the result of microscopic abrasions that house bacteria.⁹

2. Intraoperative factors

Operating room: Infection rates have been shown to correlate with the number of airborne bacteria within 30 cm of the wound. The source of the environmental bacteria in the operating room has been shown to be the operating room personnel, and the quantity of environmental bacteria is related directly to the amount of bacteria the personnel shed and the number of people present: 30% of people are colonized by *S.aureus*, and people shed about 106 skin scales loaded with bacteria per day.¹⁰

A cohort study by Knobben et al demonstrated that, compared with the use of conventional airflow systems, use of a laminar flow system significantly decreases the rates of bacterial wound contamination, prolonged wound discharge, and superficial surgical site infection.¹¹

The greatest source of airborne bacteria is the operating room personal, with ears and beard being the two areas most likely to shed bacteria. The number of bacteria shed by operating room personnel can be decreased by using air exhaust systems or completely covering ears and beards.¹²

Duration of surgery: When operating room time for orthopedic procedures increases, the rate of infection also increases. Pryor F et al found that surgical time of <1 hour is associated with an infection rate of approximately 0.3%, doubling the surgical time triples the infection rate, a surgical time of 3 hours results in an infection rate of approximately 5%, and 6 hours of surgery has an infection rate of approximately 9%.¹³

Blood loss: In orthopedic surgery, blood loss tends to be substantial because of the nature of muscle tissue and the inability to cauterize bleeding bony surfaces, especially during procedures such as revision hip replacement and spinal surgery. Other factors that can influence the amount of blood loss include anesthetic type, use of medications, and use of fibrin sealant.

Antimicrobial prophylaxis: The use of antimicrobial agents for prophylaxis represents the most effective method of reducing the prevalence of wound infection after orthopedic surgery and should be considered essential to the overall prevention approach.¹⁴⁻¹⁷ The most common organisms are *Staphylococcus aureus* and coagulase negative *Staphylococcus epidermidis*. Therefore either cefazolin or cefuroxime should be used in conjunction with hip or knee arthroplasty, fixation of closed fractures, and most elective orthopaedic procedures.^{18,19}

Table 2: Recommendation by the American academy of orthopaedic surgeons for repeat dose of antibiotics.²¹

Antibiotics	Frequency of administration
Cefazolin	Every 2-5 hours
Cefuroxime	Every 3-4 hours
Clindamycin	Every 3-6 hours
Vancomycin	Every 6-12 hours

Antibiotics should be administered within sixty minutes prior to the incision and ideally, as near to the time of the incision as possible. An additional intraoperative dose is advised if the duration of the procedure exceeds one to two times the half-life of the antibiotic or if there is substantial blood loss during the procedure.^{20,21}

The postoperative duration of routine antibiotic use has decreased from multiple days to twenty-four hours. Research by Nelson et al supports prophylactic administration for 24 hours after total hip or knee arthroplasty or hip surgery.²² Heydemann et al showed that there is no significant difference in the rate of surgical site infection between the group that had received a single dose of antibiotics and groups that had received prophylaxis for two, three or seven days.²³

Postoperative hematoma: A postoperative hematoma after orthopedic surgery may be an important contributing factor in the development of prolonged drainage, delayed wound healing, or wound infection. Closed deep suction drainage of wounds after many orthopedic procedures has become an established routine procedure, with the aim of preventing wound hematomas and thereby reducing wound complications and infection.

Comparative studies

Onche and Adedeji prospectively studied two hundred and fifty-four patients who had open reduction and internal fixation with implants and prosthesis. The

infection rate was 7.5%. Plates and screws were the commonest implant. Thirty-six bacterial isolates were recovered. *Staphylococcus aureus* was the commonest in 16 cases.²⁴

Marculescu et al prospectively gathered clinical, operative and infection data on in patients from 102 hospitals by the single variable analysis of THRs and concluded that Age, female gender, American Society of Anaesthesiologists (ASA) score, body mass index, trauma, duration of operation and pre-operative stay were significantly associated with the risk of Surgical Site Infection (p<0.05).²⁵

Olsen et al performed a retrospective case-control study and by univariate analyses showed that serum glucose levels, preoperatively and within five days after the operation, to be significantly higher in patients in whom surgical site infection developed than in uninfected control patients. Diabetes was associated with the highest independent risk of spinal surgical site infection, and an elevated preoperative or postoperative serum glucose level was also independently associated with an increased risk of surgical site infection.²⁶

Table 3: Comparative studies.

No	Study	Inference
1	Onche and O. Adedeji et al ²⁴	Infection rate: 7.5% <i>S. aureus</i> commonest
2	Marculescu et al ²⁵	Age, female gender, American Society of Anaesthesiologists (ASA) score, body mass index, trauma, duration of operation and pre-operative stay were significantly associated with the risk of Surgical Site Infection
3	Olsen et al ²⁶	Elevated preoperative or postoperative serum glucose level was also independently associated with an increased risk of surgical site infection.
4	Our study	Infection rate : 10% <i>S. aureus</i> commonest ASA score, duration of surgery, obesity and NINS risk index were significantly associated with the risk of surgical site infection.

CONCLUSION

In our study we conclude that *Staphylococcus aureus* remains the most important organism responsible for Post-operative wound infections in Orthopaedic Implants and prosthesis. Nearly two-thirds of isolates of *S. aureus* were methicillin-resistant, which has important implications for both antimicrobial prophylaxis and the treatment of superficial surgical site infection in orthopaedic surgery. The risk of infection rate increased

significantly with 1. ASA score, 2. Duration of surgery, 3. Obesity and 4. NINS risk index.

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Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

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