CONCISE REPORT

Orthopaedic surgical site infections: A prospective cohort study

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ABSTRACT

Background: Orthopaedic surgical site infections (SSIs) are among the most common hospital-acquired infections, leading to serious health complications, hospital readmissions, and extended hospitalizations.

Objective: This study aimed to evaluate outcomes and assess the epidemiology of orthopaedic SSIs six months post-operation in patients with preoperatively intact sites of surgery.

Methods: The prospective cohort study was conducted in a tertiary hospital over two years. All patients with previously intact surgical sites were included (n = 9,318). The U.S. Centers for Disease Control and Prevention criteria for SSI diagnosis were used. Six-month post-surgery patients were assessed by orthopaedic medical residents. In questionable cases, wound inspections were validated by the investigating team.

Results: The incidence of SSIs was 0.91%. Diabetes, smoking, alcoholism, and prolonged retention of a drainage tube, along with implant-related surgeries, oncologic surgeries, and surgeries on areas with deep-seated infection had significantly higher rates of SSIs ($p < 0.05$). *S. aureus* was the most commonly detected bacteria, followed by gram-negative bacilli. At the six-month follow-up, 13 of 85 SSI patients had persistent infection and 39 were lost to follow-up.

Conclusion: Our study detected a 0.91% incidence of SSIs and statistically significant risk factors with significant morbidity at six months post-surgery.

KEYWORDS
Surgical site infections; orthopaedic infections; India; antibiotic resistance

INTRODUCTION

Surgical site infections (SSIs) are a serious complication in orthopaedic surgery. The problems faced by patients include but are not limited to prolonged hospital stay, multiple hospital visits, delay in functional recovery, increased mental stress, and a poor quality of life overall. A literature review indicates that a significant variability in the incidence of orthopaedic SSIs was noted between different studies, with reported rates as low as 1.9% in a study by Mabit et al. (2012) [1] to 22.7% in a study by Maksimović et al. (2008) [2]. The literature on orthopaedic SSIs in developing countries is neither extensive nor uniform. In our tertiary care hospital, we prospectively followed a cohort of orthopaedic patients for six months post-surgery, assessing incidence, risk status, risk factors, and outcomes.

METHODS

This prospective, single-centre cohort study was carried out in a tertiary care hospital in south-western India between September 2015 and September 2017. Orthopaedic surgery patients with preoperatively intact surgery sites were included in the study. Patients having open wounds at the site of surgery or having an American Society of Anesthesiologists (ASA) [3] score of five were excluded. The study was approved by the hospital's Institutional Ethics Committee and informed written consent was obtained from all study participants.

Of the 11,253 surgeries performed in the given time frame, 9,318 cases met the inclusion criteria. Their case files were reviewed and their preoperative details, demographic data, pre-morbidities, pre-anaesthetic workup chart, and diagnosis were recorded. For surgery details, the procedure notes and the anaesthetist charts were reviewed. Based on this data, the U.S. Centers for Disease Control and Prevention's (CDC) National Health and Safety Network's SSI risk index [4] was calculated for all patients. The 75th percentile cut-off value of time was established as 180 minutes for spine and arthroplasty, 90 minutes for amputation, and 120 minutes for fracture surgeries

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[4]. The wound class was based on the wound contamination classification as described by Altemeier et al. (1984) [5]. The site of surgery grade was as per the ASA.

Post-operatively, all patients were monitored for development of SSIs as per CDC criteria [6] at every wound inspection and the follow-up was performed by the operating surgeon. In the wards, the wounds would be regularly monitored by orthopaedic medical residents. If an SSI was suspected, the principal investigators were informed and a wound swab was collected for gram staining and culture, followed by antibiotic sensitivity. The details of the wound were recorded in the case file.

Culture and sensitivity reports were monitored and antibiotic therapy was initiated or modified based on the microbiology reports. SSI patients were again followed up at six months and were asked to attend an in-person assessment. If they were unable to attend, patients were evaluated remotely based on:

1. An evaluation report of their wounds by their local primary healthcare physician.
2. An over-the-phone questionnaire inquiring about fever, swelling, erythema, warmth, extent of wound involvement, edges of the wound, discolouration, foul smell, discharge from the wound, and induration.
3. Photographs of the wounds obtained over the phone.
4. Documentation of the patient's return to their preoperative functional status.

To compare risk factors, a control subset group of 87 non-infected surgical patients was randomly selected. The two groups were compared for pre-existing diabetes mellitus, history of alcoholism, body mass index (BMI), presence and duration of retention of a drainage tube, as well as the wound class.

To understand the strength of association between two categorical variables, a chi-squared test was carried out. For the scale parameters such as mean value, comparison was carried out using independent t-test analysis. A *p*-value of less than 0.05 was considered to be significant with a 95% confidence interval. To understand the variation in SSIs due to risk factors, a regression analysis was carried out.

RESULTS

At the end of the study period, a total of 11,253 surgeries were performed, of which 9,318 cases met the inclusion criteria and hence were followed up for development of SSIs. We detected 85 cases of SSIs, an incidence of 0.91%. The SSI incidence rate was 0.94% (n = 63) in males and 0.84% (n = 22) in females.

The highest number of surgeries was in the 31 to 45 age bracket, whereas the highest incidence of SSIs was in the 46 to 60 age bracket. In our study, deep incisional SSIs were the most common (56.5%), followed by organ/space infections (28.2%) and superficial incisional infections (15.3%). Of the 85 infected cases, 16 were upper limb surgeries (18.8%), 55 were lower limb surgeries (64.7%), and 14 were spinal surgeries (16.5%). The random sampling of the non-infected cases (n = 87), however, revealed 22 surgeries on upper limbs (25.3%), 50 surgeries on lower limbs (57.5%), and 15 spinal surgeries (17.2%).

The incidence of pre-existing diabetes mellitus type 2 was 24.7% in the 85 SSI cases, whereas in the non-infected cases (n = 87), the incidence was 12.6% ($p = 0.04$). A history of alcoholism ($p < 0.001$) and smoking ($p < 0.001$) pre-disposed patients to SSIs. However, our study did not find a significant correlation between the nature of the surgery (emergency vs. elective) or the BMI of the patient. Open reduction and internal fixation of a fracture was significantly associated with a higher risk of developing an SSI ($p < 0.001$) compared to closed reduction, internal fixation, and soft tissue surgeries. The mere presence of a post-operative drainage tube was not a statistically significant factor for increasing the risk of SSI occurrence. However, the duration of post-operative drainage tube retention was found to be significantly more important ($p = 0.008$). The presence of a pre-existing focus of infection at the surgical site was significantly associated with an increased risk of an SSI ($p < 0.05$).

The most common organism detected was *S. aureus* (24%) and 55% of the isolates were methicillin-resistant *S. aureus* (MRSA). The next most common organisms were gram-negative bacilli (*P. aeruginosa* and *E. coli* were the most common). Antibiotic sensitivity and resistance patterns were studied for all the detected bacteria. All MRSA were found to be sensitive to linezolid, vancomycin, and teicoplanin, whereas clindamycin sensitivity was noted in only half of the isolates. The gram-negative bacteria were noted to have two sensitivity patterns and almost half of the isolates were multidrug-resistant.

Mean duration of hospitalization was 30 days and 13 days in patients with and without SSIs, respectively ($p < 0.001$). Of the 85 SSI cases, 12 patients did not return for assessment and hence the wound status could not be assessed by us. Of these, four patients' medical records documented control of infection at the last follow-up, which meant that the patient would not need further interventions. In the remaining 73 patients (out of 85), it was found that 13 patients had a persisting infection.

DISCUSSION

Our study revealed an incidence rate of 0.9% for SSIs in preoperatively closed cases – a rate only slightly higher than those reported in studies carried out in developed parts of the world [1]. Our study's relatively lower incidence rate when compared to that of other studies conducted in developing countries can be attributed to the exclusion of open wounds and seemingly low detection of superficial SSIs.

The results of our study show a significantly increasing trend in the rate of SSI occurrence as the patient's age increases. Published literature stands divided with respect to advancing age and the risk of SSIs. Several authors have reported statistically significant association between an increase in age and higher SSI risk [7-9]. At the same time, some studies could not prove a significant association [10, 11]. The general trend, including our study, shows an increase in the rate of SSIs with patients aged up to and around 60 years old, following which there is a small decline in the incidence rate. There may be three possible reasons for these results:

1. The hardy survivor effect [9], wherein it is hypothesized that the elderly population has already survived long and may have a physiological advantage over the younger population, which leads to a lower SSI risk.
2. Selection bias.
3. Patients' increased amount of vehicular travel and work-load up to their retirement age are followed by accidental falls at home and other such low-energy mechanisms of injury, which take over as the leading cause of trauma requiring fixation.

The patients undergoing orthopaedic oncology surgeries showed the highest proportion of SSIs (4.7%) in our study. It has been reported by Gradl et al. (2014) [12] that increasing age, total number of preceding procedures, pre-existing implants, infection at another site on the date of surgery, malignant disease, a hip region that is affected, and duration of the procedure were significantly associated with increased SSI risk. Orthopaedic oncology patients in our study who developed an SSI were noted to have prolonged procedure duration, malignant disease, and a hip region that was more often involved, with the use of mega-prosthesis in many instances.

There is a general consensus that implant-related surgeries are majorly affected by SSIs and soft tissue surgeries do not get infected as easily as the implant-associated ones. The presence of a post-operative drainage tube has also been touted as a risk factor for development of an SSI because the tube serves as a foreign body [13]. Our results could not confirm this association significantly. However, the presence of a drainage tube for more than 3.5 days post-operatively as well as whether any implant was used for the surgery were significant risk factors.

The depth and, correspondingly, the severity of SSIs in orthopaedic settings in the U.S. [14], Brazil [15], and Poland [16] show a pattern of deep > superficial > organ SSIs, whereas China [17] and England [18] show a pattern of superficial > deep > organ level SSIs. Our study showed a pattern of deep>organ>superficial incisional SSIs.

Our study had limitations. Specifically, this was a single-centre study with a small sample of SSI cases studied and a portion of the sample was lost to follow-up.

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