Incidence Of Early Surgical Site Infection in Clean Orthopaedic Cases Undergoing Implant Surgeries: A Prospective Observational Study

Dr. T. Thirumalaiswamy[1], Dr. Madan Bharathi[2], Dr. Madan K. Nithik[3], Dr. Mohana[4], Dr. Mathesh Arun[5], Dr. Loganathan[6]

[1]*D. Ortho, MS (Gen), MCh, Department of Orthopaedics, Dhanalakshmi Srinivasan Medical College and Hospital (DSMCH), Perambalur, Tamil Nadu, India*

[2,3,4,5,6]*Department of Orthopaedics, Dhanalakshmi Srinivasan Medical College and Hospital (DSMCH), Perambalur, Tamil Nadu, India*

Abstract*—Introduction: Surgical site infection (SSI) is one of the most common and costly healthcare-associated infections following orthopaedic surgery, particularly in procedures involving implants. SSI is defined as infection occurring within 30 days of an operative procedure or within one year if an implant is placed. Early SSIs are associated with significant morbidity, prolonged hospitalization, and increased treatment costs. Aim: To estimate the incidence of early SSI within 30 days of operation in clean orthopaedic implant surgeries and to identify associated risk factors and causative organisms. Methods: A prospective observational study was conducted over one year in the Department of Orthopaedics at DSMCH, Perambalur, Tamil Nadu, enrolling 50 patients who underwent clean orthopaedic implant surgeries. Patients were followed up for 30 days post-operatively. Data on type of surgery, risk factors, and microbiological culture results were collected and analyzed. Results: An overall SSI incidence of 8% (4/50) was observed. Joint Replacement carried the highest infection rate (20%), followed by Interlocking Nailing (10%). Key risk factors included smoking, emergency surgery, diabetes mellitus, and surgery duration exceeding two hours. Staphylococcus aureus was the predominant organism isolated (50% of cases). Conclusion: The incidence of SSI in clean orthopaedic implant surgeries was 8%, comparable to existing literature. Modifiable risk factors such as smoking and diabetes should be optimized pre-operatively. Rigorous aseptic techniques and antibiotic stewardship protocols are essential to minimize SSI rates.

***Index Terms*—Surgical site infection, orthopaedic implants, SSI incidence, risk factors, microbiology, ORIF, interlocking nail, joint replacement**

I. INTRODUCTION

Surgical site infection (SSI) is defined as an infection occurring at or near the surgical incision within 30 days of an operative procedure, or within one year if a foreign implant has been placed within the patient's body. SSIs are classified as superficial incisional, deep incisional, or organ/space infections based on the anatomical depth of involvement, as per the Centers for Disease Control and Prevention (CDC) criteria.

In the field of orthopaedic surgery, particularly procedures involving metallic implants such as plates, nails, screws, and prostheses, SSI represents one of the most feared and consequential complications. The presence of a foreign body significantly impairs the local immune response, facilitating bacterial colonization and biofilm formation, which renders these infections notoriously difficult to treat. The consequences include prolonged hospitalization, repeated surgical interventions, implant failure, osteomyelitis, systemic sepsis, and in severe cases, amputation or death.

The global incidence of SSI in orthopaedic surgeries varies from 1% to 10% depending on the type of procedure, patient population, and institutional infection control practices. In developing countries, the burden may be higher due to resource constraints and healthcare infrastructure limitations. With the rising volume of orthopaedic implant surgeries driven by trauma, degenerative joint disease, and an ageing population, understanding the local epidemiology of SSI is of critical public health importance.

Despite advances in surgical techniques, laminar airflow operating theatres, perioperative antibiotic prophylaxis, and sterile implant technology, SSI continues to impose a significant clinical and economic burden. Identifying patient-specific and procedure-specific risk factors is the cornerstone of any effective infection prevention strategy.

This study was conducted at the Department of Orthopaedics, Dhanalakshmi Srinivasan Medical College and Hospital (DSMCH), Perambalur, Tamil Nadu, with the objective of prospectively estimating the incidence of early SSI in clean orthopaedic implant surgeries, characterizing associated risk factors, and identifying the causative microorganisms.

II. AIM AND OBJECTIVES

2.1 Primary Aim

To estimate the incidence of early surgical site infection (occurring within 30 days) among patients undergoing clean orthopaedic implant surgeries at a tertiary care teaching hospital.

2.2 Secondary Objectives

1) To analyze the distribution of SSI across different types of orthopaedic implant surgeries.
2) To identify and evaluate patient-related and procedure-related risk factors associated with the development of SSI.
3) To determine the microbiological profile of organisms isolated from infected surgical sites.
4) To provide evidence-based recommendations for SSI prevention in the institutional context.

III. MATERIALS AND METHODS

3.1 Study Design and Setting

This was a prospective observational and follow-up study conducted over a period of one year in the Department of Orthopaedics at Dhanalakshmi Srinivasan Medical College and Hospital (DSMCH), Perambalur, Tamil Nadu, India. The institution is a tertiary care teaching hospital serving a predominantly rural population across the Perambalur and surrounding districts.

3.2 Study Population

A total of 50 patients who underwent clean orthopaedic implant surgeries during the study period were enrolled after obtaining written informed consent. Clean surgeries were defined as elective, non-traumatized operative procedures in which no inflammation was encountered and the respiratory, gastrointestinal, biliary, and genitourinary tracts were not entered.

3.3 Inclusion Criteria

Patients of any age undergoing elective or emergency clean orthopaedic implant procedures (Open Reduction and Internal Fixation, Interlocking Nailing, Joint Replacement, and External Fixation); patients who provided written informed consent; patients with no pre-existing wound infection at the time of surgery; and patients available for 30-day post-operative follow-up.

3.4 Exclusion Criteria

Patients with active infections at the surgical site prior to operation; patients who underwent contaminated or dirty surgical procedures; patients who were lost to follow-up; and patients who declined to participate in the study.

3.5 Sample Size Calculation

Based on a reported SSI prevalence of approximately 8-10% in orthopaedic implant surgeries from existing literature, with 95% confidence level and 5% absolute precision using the standard formula n = Z^2 * P(1-P) / d^2, the minimum estimated sample size was calculated. For this pilot observational study, a convenient sample of 50 patients was enrolled.

3.6 Data Collection

Pre-operative data collected included patient demographics (age, sex, co-morbidities), body mass index, pre-operative hospital stay duration, American Society of Anesthesiologists (ASA) grade, pre-operative antibiotic prophylaxis details, and type of surgery planned. Intra-operative data included duration of surgery, use of drain, and type of implant used.

Post-operatively, all patients were reviewed daily during in-patient stay and at 2 weeks and 30 days following discharge. Wound assessment was performed at each visit using the CDC/NHSN criteria for SSI classification. Any signs of erythema, warmth, swelling, discharge, or wound dehiscence were documented.

3.7 Microbiological Assessment

In patients developing SSI, wound swabs and/or aspirated fluid were sent for aerobic and anaerobic culture and sensitivity testing as per standard microbiological protocols. Organisms were identified using conventional biochemical methods and, where available, MALDI-TOF mass spectrometry.

3.8 SSI Definition

SSI was defined according to CDC/NHSN criteria as infection occurring within 30 days of an operative procedure in the part of the body where surgery was performed, resulting in purulent drainage, positive cultures, and/or clinical signs of infection necessitating reopening of the wound or antibiotic therapy.

3.9 Ethical Considerations

The study protocol was approved by the Institutional Ethics Committee (IEC) of DSMCH, Perambalur. Written informed consent was obtained from all participating patients. Patient confidentiality and data privacy were maintained throughout the study.

3.10 Statistical Analysis

Data was entered and analyzed using SPSS version 23.0 (IBM Corp.). Descriptive statistics including frequencies, percentages, and means were computed. The SSI incidence rate was calculated as the number of infected cases divided by the total number of cases, expressed as a percentage. Risk factor analysis was performed using chi-square test or Fisher's exact test as appropriate, with $p < 0.05$ considered statistically significant.

IV. RESULTS

4.1 Overall SSI Incidence

Among the 50 patients who underwent clean orthopaedic implant surgeries and were followed up for 30 days, a total of 4 patients developed SSI, yielding an overall SSI incidence rate of 8.0% (4/50 x 100 = 8%). This is consistent with incidence rates reported in comparable studies from tertiary care institutions in India and internationally.

4.2 Distribution Based on Type of Surgery

Table 1 presents the distribution of cases and infections according to the type of orthopaedic implant surgery performed.

Table 1: Distribution of SSI Based on Type of Surgery

Type of Surgery	Number of Cases	Infected (n)
Open Reduction and Internal Fixation (ORIF)	30	2 (6.7%)
Interlocking Nailing	10	1 (10.0%)
Joint Replacement	5	1 (20.0%)
External Fixation	5	0 (0.0%)
Total	50	4 (8.0%)

Open Reduction and Internal Fixation (ORIF) was the most commonly performed procedure, accounting for 60% (30/50) of all cases, with 2 infections (SSI rate: 6.7%). Joint Replacement surgeries, although fewer in number (5 cases), had the highest proportional infection rate of 20.0% (1 infection), reflecting the inherently higher risk associated with prosthetic implants and extended operative exposure. Interlocking Nailing recorded an SSI rate of 10.0% (1/10), while External Fixation had no infections (0/5).

4.3 Risk Factors Associated with SSI

Table 2 outlines the distribution of known risk factors among infected and non-infected patients.

Table 2: Risk Factors Associated with Surgical Site Infection

Risk Factor	Infected (n)	Non-Infected (n)
Diabetes Mellitus	2	8
Smoking	3	12
Emergency Surgery	3	17
Surgery Duration >2 Hours	2	10

Smoking was the most prevalent risk factor encountered in infected patients (3 out of 4 SSI cases), present in 15 patients overall (3 infected vs 12 non-infected). Emergency surgery also featured prominently, with 3 of the 4 SSI cases having undergone emergency procedures (3 infected vs 17 non-infected). Diabetes Mellitus was present in 2 infected and 8 non-infected patients. Surgery duration exceeding 2 hours was noted in 2 infected and 10 non-infected patients, suggesting a positive association with prolonged operative time and SSI risk.

These findings highlight that modifiable risk factors such as smoking, poor glycaemic control, and emergency surgical context are closely associated with post-operative infection, consistent with the published literature.

4.4 Organisms Isolated

Wound cultures were obtained from all 4 SSI cases. Table 3 presents the microbiological isolates identified.

Table 3: Microbiological Profile of Organisms Isolated from Infected Wounds

Organism Isolated	Number of Cases
Staphylococcus aureus	2 (50%)
Klebsiella pneumoniae	1 (25%)
Pseudomonas aeruginosa	1 (25%)
Escherichia coli	0 (0%)
Total	4 (100%)

Staphylococcus aureus was the predominant organism, isolated in 2 of the 4 cases (50%), followed by *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*, each accounting for one case (25%). No *Escherichia coli* was isolated. The predominance of *S. aureus* is consistent with established literature, where it remains the leading cause of orthopaedic SSI globally, owing to its ubiquitous skin colonization and propensity for biofilm formation on metallic implants.

V. DISCUSSION

The overall SSI incidence of 8% in this study is consistent with rates reported in comparable orthopaedic implant surgery cohorts. Nag et al. (2015) reported an SSI rate of 9.6% in a similar Indian tertiary care setting, while international multicenter studies have reported rates ranging from 1.5% to 12% depending on the procedure type, institutional practices, and patient demographics.

The highest infection rate was observed following Joint Replacement surgery (20%), which is not unexpected given the extensive soft tissue dissection, longer operative duration, and the introduction of a large metallic prosthesis that provides a surface for bacterial adherence and biofilm formation. This aligns with published reports indicating that total joint arthroplasties carry the greatest SSI risk among orthopaedic procedures. The sequelae of prosthetic joint infection are particularly severe, often requiring staged revision arthroplasty and prolonged antibiotic therapy.

ORIF, despite being the most frequently performed procedure in this cohort (n=30), had a comparatively lower SSI rate of 6.7%, likely attributable to standardized operative protocols, proper draping, and consistent use of perioperative prophylactic antibiotics. Interlocking Nailing had a 10% infection rate (1/10), which may partly reflect the emergency nature of some of these procedures. Notably, External Fixation had zero infections, which may be attributed to minimal intramedullary violation and reduced implant-tissue interface.

Smoking was identified as the most significant risk factor in this study, with 3 of 4 infected patients being smokers. Nicotine causes vasoconstriction and impairs tissue perfusion, reduces neutrophil function, and delays collagen synthesis, collectively compromising wound healing and immune defenses. Pre-operative smoking cessation, ideally at least 4-6 weeks before elective surgery, is strongly recommended by multiple guidelines as an effective SSI mitigation strategy.

Emergency surgical context was another important risk factor, with 3 of 4 SSI patients having undergone emergency procedures. Emergency surgeries are often associated with inadequate bowel preparation, insufficient pre-operative skin decontamination, inability to optimize co-morbidities, and a higher proportion of contaminated wound classes. These factors cumulatively increase infectious risk.

Diabetes Mellitus was present in 2 of the infected patients. Hyperglycaemia impairs multiple facets of the innate immune response, including neutrophil chemotaxis, phagocytosis, and oxidative burst

activity, in addition to promoting small vessel disease that compromises tissue perfusion. Perioperative glycaemic optimization, targeting blood glucose levels below 180 mg/dL in the peri-operative period, has been shown to significantly reduce SSI rates.

The microbiological findings, with *S. aureus* being the predominant isolate, are consistent with published data across multiple international SSI surveillance studies. The concurrent isolation of Gram-negative organisms such as *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* in a subset of cases underscores the importance of broad-spectrum antibiotic coverage in empirical treatment and suggests potential environmental or nosocomial acquisition. Antibiotic sensitivity patterns should guide definitive therapy, particularly given the increasing prevalence of methicillin-resistant *S. aureus* (MRSA) and multi-drug resistant (MDR) Gram-negative organisms in healthcare settings.

This study has certain limitations, including its single-centre design, relatively small sample size, and the absence of long-term follow-up beyond 30 days. The study did not account for detailed nutritional status, duration of pre-operative hospital stays, or specific antibiotic prophylaxis regimens, all of which may independently influence SSI risk. Future studies with larger multicentric cohorts and extended follow-up are warranted.

VI. CONCLUSION

This prospective study demonstrates an overall early SSI incidence of 8% in clean orthopaedic implant surgeries at a tertiary care teaching hospital in Tamil Nadu, India. Joint Replacement surgeries carry the highest infection risk, followed by Interlocking Nailing and ORIF. Smoking, emergency surgery, diabetes mellitus, and prolonged operative duration are the predominant risk factors identified. Staphylococcus aureus remains the leading causative pathogen, with Gram-negative organisms also contributing to the microbiological burden.

A multidisciplinary approach encompassing pre-operative optimization of modifiable risk factors, strict perioperative asepsis, standardized antibiotic prophylaxis protocols, and robust post-operative surveillance is essential to reduce SSI rates. These findings provide a valuable institutional baseline for benchmarking and developing targeted infection prevention programs in orthopaedic surgical practice.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the support of the Department of Orthopaedics, Department of Microbiology, and the nursing staff of the Operation Theatre Complex at DSMCH, Perambalur, for their invaluable assistance in patient care and data collection.

Conflicts of Interest: None declared.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

REFERENCES

[1] J. Mangram, T. C. Horan, M. L. Pearson, L. C. Silver, and W. R. Jarvis, “Guideline for prevention of surgical site infection, 1999. Hospital Infection Control Practices Advisory Committee,” *Infection Control and Hospital Epidemiology*, vol. 20, no. 4, pp. 250–278, 1999.

[2] National Healthcare Safety Network (NHSN), “Surgical Site Infection (SSI) Event,” Centers for Disease Control and Prevention, Atlanta, GA, USA, updated 2023.

[3] D. W. Bratzler, E. P. Dellinger, K. M. Olsen, et al., “Clinical practice guidelines for antimicrobial prophylaxis in surgery,” American Journal of Health-System Pharmacy, vol. 70, no. 3, pp. 195–283, 2013.

[4] S. M. Kurtz, E. Lau, J. Schmier, K. L. Ong, K. Zhao, and J. Parvizi, “Infection burden for hip and knee arthroplasty in the United States,” The Journal of Arthroplasty, vol. 23, no. 7, pp. 984–991, 2008.

[5] V. L. Nag, J. Agarwal, and M. Singh, “Bacteriology of surgical site infections in orthopaedic surgeries,” Journal of Clinical and Diagnostic Research, vol. 9, no. 9, pp. DC08–DC11, 2015.

[6] D. J. Anderson, D. J. Sexton, Z. A. Kanafani, G. Auten, and K. S. Kaye, “Severe surgical site infection in community hospitals: Epidemiology, key procedures, and the changing prevalence of Staphylococcus aureus,” Infection Control and

Hospital Epidemiology, vol. 28, no. 9, pp. 1047–1053, 2007.

[7] V. P. Patel, M. Walsh, B. Sehgal, C. Preston, H. DeWal, and P. E. Di Cesare, "Factors associated with prolonged wound drainage after primary total hip and knee arthroplasty," The Journal of Bone and Joint Surgery, vol. 89, no. 1, pp. 33–38, 2007.

[8] J. Spiliotis, K. Tsiveriotis, A. D. Datsis, et al., "Wound dehiscence: Is still a problem in the 21st century: A retrospective study," World Journal of Emergency Surgery, vol. 4, p. 12, 2009.

[9] A. M. Moller, N. Villebro, T. Pedersen, and H. Tonnesen, "Effect of preoperative smoking intervention on postoperative complications: A randomised clinical trial," The Lancet, vol. 359, no. 9301, pp. 114–117, 2002.

[10] S. Kwon, R. Thompson, P. Dellinger, D. Yanez, E. Farrohki, and D. Flum, "Importance of perioperative glycemic control in general surgery: A report from the Surgical Care and Outcomes Assessment Program," Annals of Surgery, vol. 257, no. 1, pp. 8–14, 2013.