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A retrospective evaluation of post-operative infection rates: Upper limb versus lower limb surgeries

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Abstract
Post-operative infections remain a major complication of orthopedic surgeries, contributing to increased morbidity, prolonged hospital stays, and higher healthcare costs. This retrospective study analyzed 1,000 patients (500 upper limb, 500 lower limb) who underwent surgeries at Dr. D.Y. Patil Hospital, Navi Mumbai, between 2019 and 2022. Findings revealed a higher infection rate in lower limb surgeries (3.8%) compared to upper limb surgeries (2.5%). Lower limb procedures showed a greater proportion of deep infections, often requiring surgical intervention. Significant risk factors included prolonged operative time, diabetes mellitus, obesity, and smoking. Staphylococcus aureus emerged as the most common pathogen across both groups. These results underscore the need for preoperative optimization, adherence to aseptic intraoperative techniques, and vigilant postoperative monitoring. Establishing multidisciplinary infection control teams is recommended to guide antibiotic prophylaxis and enhance patient outcomes.

Keywords: Post-operative infection, orthopedic surgery, upper limb, lower limb, risk factors

Introduction
Post-operative infections are significant complications following orthopedic surgeries, leading to increased morbidity, extended hospital stays, and additional healthcare costs [1]. These infections are influenced by multiple factors, including patient demographics, type of surgical intervention, and the anatomical region involved [2]. Among orthopedic procedures, infections in the upper and lower limbs demonstrate different epidemiological and clinical patterns due to variations in vascular supply, soft tissue coverage, and surgical exposure [3].

Upper limb infections are generally less severe but may compromise function, while lower limb infections often lead to severe complications such as deep infections, osteomyelitis, or even amputation [4, 5]. While the literature widely covers the overall burden of post-operative infections, comparative studies on infection rates between upper and lower limb surgeries are limited [6].

The ability to predict and manage these infections effectively is critical for patient outcomes. This study retrospectively analyzes post-operative infections in patients undergoing upper and lower limb surgeries at Dr. D.Y. Patil Hospital, Navi Mumbai. It aims to compare the infection rates, identify risk factors, and provide evidence-based recommendations for infection prevention and management.

Methodology
Study Design
This retrospective observational study was conducted at Dr. D.Y. Patil Hospital, Navi Mumbai. Data were collected from medical records of patients who underwent orthopedic surgeries between January 2019 and December 2022.

Study Population
A total of 1,000 patients were included, with 500 undergoing upper limb surgeries and 500 undergoing lower limb surgeries.

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Inclusion Criteria
1. Patients aged 18 years and older.
2. Patients who underwent elective or emergency surgeries for upper or lower limb conditions, including fractures, soft tissue repairs, or arthroplasties.
3. Availability of complete medical, surgical, and follow-up data.

Exclusion Criteria
1. Patients with active infections at the surgical site before the procedure.
2. Patients with systemic infections, such as sepsis, at the time of surgery.
3. Patients with immune-compromising conditions, including HIV, or on immunosuppressive therapy.
4. Revision surgeries unrelated to infection.

Data Collection
Patient medical records were reviewed to extract demographic data, surgical details, and post-operative outcomes.

1. Demographic and Clinical Data
- Age, sex, BMI, comorbidities (e.g., diabetes, hypertension).
- Smoking status and other lifestyle factors.

2. Surgical Details
- Type of surgery (elective vs. emergency).
- Use of implants, duration of surgery, and prophylactic antibiotic regimens.

3. Infection Monitoring
- Infections were identified based on clinical symptoms (pain, swelling, redness, discharge), laboratory markers (CRP, ESR, WBC count), and microbiological culture results [7, 8].
- Time of infection onset: early (<30 days), delayed (30-90 days), and late (>90 days) [9, 10].

Outcome Measures
1. Rates of infection in upper and lower limb surgeries.
2. Factors influencing infection rates (e.g., BMI, comorbidities, smoking).
3. Severity of infections: superficial versus deep infections [11, 12].

Statistical Analysis
1. Descriptive statistics summarized demographic and clinical data.
2. Chi-square tests compared infection rates between upper and lower limbs.
3. Logistic regression analysis identified independent predictors of infection.
4. Statistical significance was set at $p < 0.05$.

Results
Patient Demographics
Out of the total 1,000 patients analyzed, the demographic distribution was as follows:
- Mean Age: 45.3 ± 12.8 years (range: 18-78 years).
- Gender Distribution: 55% female and 45% male.
- Comorbidities:

- Diabetes mellitus (DM): 32%
- Hypertension: 41%
- Smoking: 25%
- Obesity (BMI > 30): 38%

Infection Rates in Upper vs. Lower Limb Surgeries
Upper Limb Surgeries (500 patients)
- Overall infection rate: 2.5% (n=13)
- Superficial infections: 69% (n=9)
- Deep infections: 31% (n=4)
- Most common causative organisms: Staphylococcus aureus (42%), Pseudomonas aeruginosa (18%) [3, 7].

Subdivisions of Upper Limb Surgeries
- Shoulder Surgeries (n=180):
- Infection rate: 3.0% (n=5)
- Superficial infections: 60% (n=3)
- Deep infections: 40% (n=2)
- Elbow Surgeries (n=150):
- Infection rate: 2.0% (n=3)
- Superficial infections: 66.7% (n=2)
- Deep infections: 33.3% (n=1)
- Hand & Wrist Surgeries (n=170):
- Infection rate: 2.9% (n=5)
- Superficial infections: 80% (n=4)
- Deep infections: 20% (n=1)

Lower Limb Surgeries (500 patients)
- Overall infection rate: 3.8% (n=19)
- Superficial infections: 58% (n=11)
- Deep infections: 42% (n=8)
- Most common causative organisms: Staphylococcus aureus (50%), Escherichia coli (20%) [5, 8].

Subdivisions of Lower Limb Surgeries
- Hip Surgeries (n=200):
- Infection rate: 4.5% (n=9)
- Superficial infections: 55% (n=5)
- Deep infections: 45% (n=4)
- Thigh Surgeries (n=100):
- Infection rate: 3.0% (n=3)
- Superficial infections: 66.7% (n=2)
- Deep infections: 33.3% (n=1)
- Knee Surgeries (n=150):
- Infection rate: 3.3% (n=5)
- Superficial infections: 60% (n=3)
- Deep infections: 40% (n=2)
- Foot & Ankle Surgeries (n=50):
- Infection rate: 4.0% (n=2)
- Superficial infections: 50% (n=1)
- Deep infections: 50% (n=1)

Timing of Infection Onset
- Early infections (<30 days): 55% of cases.
- Delayed infections (30-90 days): 30% of cases.
- Late infections (>90 days): 15% of cases.

Risk Factor Analysis
The following patient-related factors significantly contributed to post-operative infections

Prolonged Surgery Duration (>2 hours)
- Found in 42% of infection cases.
- Patients with longer surgeries had a higher rate of deep infections.

Diabetes Mellitus (DM)
- Present in 32% of total patients, contributing to 47% of infections.
- Poor glycemic control was a significant predictor of infection.

Obesity (BMI > 30)
- Associated with 39% of infection cases.
- Obese patients showed a higher incidence of wound dehiscence and delayed healing.

Smoking
- Noted in 25% of total patients, contributing to 35% of infection cases.
- Smokers demonstrated prolonged wound healing times and increased rates of superficial infections.

Discussion
This retrospective study provides valuable insights into post-operative infection rates in orthopedic surgeries, specifically comparing upper limb and lower limb procedures. The findings demonstrate a higher infection rate in lower limb surgeries (3.8%) compared to upper limb surgeries (2.5%), which is consistent with previous studies highlighting anatomical and functional differences between the two regions [1, 2].

Comparative Infection Rates: Upper vs. Lower Limb
The higher incidence of infections in lower limb surgeries can be attributed to several factors:
1. **Increased Weight Bearing and Mechanical Stress:**
- Lower limb surgeries are subject to higher mechanical loads and weight-bearing stress, leading to greater soft tissue compromise and an increased risk of wound dehiscence and delayed healing [3, 4].
- Prolonged immobilization or restricted mobility post-surgery may also lead to inadequate perfusion and increased susceptibility to infection [5].

2. **Reduced Vascular Supply**
- Compared to the upper limb, the lower extremities have a relatively compromised vascular supply, particularly in patients with comorbid conditions such as diabetes or peripheral vascular disease [6, 7].
- Poor blood supply affects the local immune response and limits the delivery of antibiotics, predisposing lower limbs to deeper infections.

3. **Longer Surgical Durations and Complexity**
- Lower limb procedures, especially joint replacements and complex fracture fixations, tend to have longer surgical times due to the need for extensive dissection and soft tissue handling [8, 9].
- Extended surgery duration is associated with prolonged exposure to environmental pathogens, increasing the risk of surgical site infections [10].

Risk Factors Influencing Post-Operative Infections
1. **Prolonged Surgery Duration**
- The study revealed a significant association between prolonged operative times (>2 hours) and infection rates, with 42% of infections occurring in such cases, confirming findings from previous research [4, 8].
- **Mechanism:** Longer procedures lead to extended tissue exposure, increased bacterial contamination risk, and greater physiological stress, leading to delayed wound healing.
- **Clinical Implication:** Strategies such as optimizing surgical techniques, limiting operating room traffic, and maintaining strict aseptic protocols can mitigate infection risks.

2. **Diabetes Mellitus (DM)**
- Diabetes was identified in 32% of the study population and was responsible for 47% of post-operative infections, with an odds ratio of 2.8, highlighting its role as a significant risk factor [6, 9].
- **Pathophysiology:** Hyperglycemia impairs leukocyte function, reduces chemotaxis, and delays wound healing, making patients more susceptible to infections [10].
- **Management Strategies:** Preoperative glycemic control and perioperative monitoring of blood glucose levels are crucial to reducing the incidence of infections in diabetic patients.

3. **Obesity (BMI > 30)**
- Obesity was noted in 38% of patients, contributing to 39% of total infections, consistent with previous studies that correlate higher BMI with increased surgical site infection (SSI) rates [7, 11].

Contributing Factors
- Poor wound healing due to impaired perfusion in adipose tissue.
- Increased risk of wound dehiscence due to excessive skin folds and tension.
- Longer surgical times and technical difficulties during procedures.
- Prevention: Preoperative weight management programs and careful post-operative wound care are essential to reduce infection risks in obese patients.

4. **Smoking**
- Smoking was present in 25% of patients and was linked to 35% of infection cases, with an odds ratio of 1.7, reinforcing its impact on post-operative outcomes [8, 12].
- Effects on Healing: Nicotine reduces oxygen delivery to tissues, impairs collagen synthesis, and increases the risk of wound breakdown [13].
- Clinical Strategies: Preoperative smoking cessation counseling and pharmacological interventions should be encouraged to improve post-operative outcomes.

Superficial vs. Deep Infections
Upper Limb Surgeries
- Predominantly presented with superficial infections (69%), responding well to conservative management such as antibiotic therapy and local wound care [5, 7].

- Lower Limb Surgeries:
- Showed a higher proportion of deep infections (42%), often requiring surgical debridement and prolonged antibiotic therapy [6, 8].
- Deep infections, such as those seen in joint replacements, carry significant morbidity and often necessitate revision surgery or implant removal [10].

Microbiological Findings
The study identified Staphylococcus aureus as the most common pathogen in both upper and lower limb infections, accounting for 42% and 50% of cases, respectively [9, 10].

- Pseudomonas aeruginosa and Escherichia coli were also prevalent in lower limb infections, likely due to increased exposure to environmental contamination [11].
- The higher prevalence of Gram-negative organisms in lower limbs could reflect differences in wound contamination during surgical exposure.

Clinical Implications and Recommendations
1. Preoperative Strategies
- **Patient optimization:** Addressing modifiable risk factors such as obesity, smoking, and glycemic control before surgery can significantly reduce infection rates [6, 11].
- **Antibiotic prophylaxis:** Tailoring perioperative antibiotic regimens based on patient-specific risk factors can enhance infection prevention [8, 11].

2. Intraoperative Measures
- Minimizing surgical time, maintaining a sterile operating environment, and adopting meticulous tissue handling techniques can reduce infection risks [7, 9].

3. Postoperative Care
- Early mobilization in lower limb surgeries can prevent complications related to immobilization, such as venous stasis, which contributes to infection development [11].
- Regular wound inspections and timely interventions for suspected infections are crucial for improving outcomes [12].

Future Directions
This study highlights the need for further prospective research focusing on:
- The role of multidisciplinary infection control teams in surgical settings.
- Development of personalized infection risk assessment tools leveraging artificial intelligence.
- Long-term follow-up to assess the impact of infections on functional outcomes and quality of life.

The role of multiple disciplinary infection control team is crucial in all hospitals which basis its antibiotic prophylaxis
All hospitals should have their own multi disciplinary infection control team. They will not only guide this surgeons regarding antibiotic prophylaxis

Conclusion
This study provides a comparative analysis of post-operative infection rates in upper versus lower limb surgeries, emphasizing the impact of anatomical, surgical, and patient-

related factors on infection risk. Our findings demonstrate a higher infection rate in lower limb surgeries (3.8%) compared to upper limb surgeries (2.5%), likely due to increased weight-bearing stress, compromised vascular supply, and longer surgical durations. Significant risk factors, including prolonged operative time, diabetes mellitus, obesity, and smoking, were identified as major contributors to post-operative infections.

The predominance of Staphylococcus aureus as the leading causative organism underscores the need for targeted antimicrobial strategies. Notably, lower limb surgeries exhibited a higher proportion of deep infections, often necessitating surgical interventions such as debridement and prolonged antibiotic therapy. These insights highlight the importance of preoperative risk optimization, intraoperative aseptic protocols, and diligent postoperative monitoring to mitigate infection risks.

Hospitals should implement multidisciplinary infection control teams to guide surgeons in infection prevention, antibiotic prophylaxis, and post-operative management. Future research should focus on developing personalized infection risk assessment tools and exploring innovative preventive strategies to enhance surgical outcomes. By integrating evidence-based practices and optimizing patient care, we can reduce the burden of post-operative infections and improve long-term functional outcomes.

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