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Meta-Analysis

Surgical site infection and associated risk factors in elderly patients undergoing hip arthroplasty: a systematic review and meta-analysis

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ABSTRACT

Fracture of the femoral neck, prevalent among the elderly, is typically managed through total hip arthroplasty or hemiarthroplasty. In this demographic, there is an increased risk of surgical site infections (SSIs), contributing to extended hospital stays, increased morbidity, and mortality. This study aims to determine the incidence rate of SSIs following hip surgery in the elderly and to identify associated risk factors. A comprehensive search of MEDLINE/PubMed, Embase, and the Cochrane Library was conducted for relevant studies published up to May 2024. Observational studies reporting the incidence rate of SSIs and associated risk factors were included in this analysis. The primary outcome was the incidence rate of SSIs post-hip surgery, along with potential risk factors. This study is registered with PROSPERO (ID: CRD42024583178) and adheres to the PRISMA guidelines. Seven studies were included in the analysis. The pooled incidence rate of hip SSIs was 1.98% (95% CI: 0.96-4.11). Analysis of risk factors revealed that patients with a BMI≥35 had a significantly increased risk of SSIs in the hip joint [OR 4.01 (95% CI: 2.55-6.31)]. However, the pooled analysis indicated that diabetes mellitus [OR 1.65 (95% CI: 0.80-3.39)] and age≥67 years [OR 1.85 (95% CI: 0.29-11.75)] were not significantly associated with an increased risk of hip SSIs. Our study concludes that obesity is a significant risk factor for the development of surgical site infections in elderly patients following hip surgery.

Keywords: Elderly, Hip, Surgical site infection, Obesity, Arthroplasty

INTRODUCTION

In the elderly population, femoral neck fractures pose a substantial risk of morbidity and mortality.[1] This demographic is particularly susceptible to osteoporosis and fragility fractures. Hip fractures in the elderly are typically managed through procedures such as total hip replacement or hemiarthroplasty.[2] Surgical site infections (SSIs) account for 20% of healthcare-associated infections and occur in approximately 2% of surgical procedures. Globally, the incidence of SSIs ranges from 19.4% to 36.5%, ranking third among hospital-acquired infections, following urinary tract and respiratory tract infections.[3] SSIs can be classified as superficial incisional, occurring within 30 days post-operation and involving the skin and subcutaneous tissue, or as deep wound infections, occurring within 90 days post-operation and involving the fascia and muscular layers. The predominant pathogens responsible for SSIs include Methicillin-resistant Staphylococcus, Methicillin-sensitive Staphylococcus, and beta-hemolytic streptococci.[4,5] SSIs are more prevalent among elderly surgical patients, constituting a significant proportion of ward infections, and are associated with increased morbidity, extended hospital stays, and substantial financial costs.[6] In elderly patients, SSIs can lead to prosthesis loosening and eventually

failure of arthroplasty, necessitating revision surgery. The presence of comorbidities such as diabetes and peripheral vascular diseases in the elderly population increases the risk of SSIs.[7] Additional contributing factors include limited mobility, delayed healing processes, exposure to pathogens in healthcare settings, challenges in self-care, and delayed wound healing.[8] Evidence-based prevention strategies can prevent approximately half of SSIs.[9] An effective and cost-efficient strategy involves identifying risk factors, which may include diabetes, extended duration of surgery, morbid obesity, delay in surgery, and other relevant factors.[10] SSIs increase the likelihood of intensive care unit (ICU) admission and are associated with up to 11 times higher mortality.[11] SSIs account for 11% of all ICU deaths.[11] The incidence of SSIs can be mitigated through measures such as smoking cessation, effective diabetes management, judicious antibiotic use, meticulous surgical techniques, modern wound closure methods, and negative pressure wound therapy.[12] Treatment of SSIs may involve revision surgery, surgical debridement if necessary, and appropriate antibiotic therapy. This study was conducted to ascertain the frequency of infection in elderly patients undergoing hip surgery. Furthermore, the meta-analysis aimed to elucidate the impact of both modifiable and non-modifiable risk factors on the frequency of SSIs, providing orthopedic surgeons and healthcare professionals with valuable insights to enhance perioperative care.

Our objectives were to determine the frequency of surgical site infection in elderly patients who underwent hip surgery and to identify the potential risk factors associated with SSI post-hip surgery in elderly patients.

METHODS

We conducted a comprehensive search of databases, including MEDLINE/PubMed, Embase, and the Cochrane Library, encompassing the CENTRAL (Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials) and the Cochrane Methodology Register, for studies published up to May 2024 that met the eligibility criteria for this review. The search employed meticulously selected keywords: Surgical site infection, elderly, risk factors, hip joint, and surgery. This study is registered with PROSPERO of the National Institute for Health Research, registration number CRD42024583178, and the PRISMA checklist was prepared.

Inclusion and exclusion criteria

This review included the observational studies that reported the incidence of surgical site infection and associated risk factors following orthopedic surgery in the hip joint of the elderly. Excluded were the articles with missing outcomes, conference proceedings, review articles, case reports, case series, and commentaries.

Data extraction

The two authors independently extracted data using a preformatted spreadsheet. Initially, abstracts were retrieved, and if necessary, the full text of articles was assessed for suitability. This process was facilitated using the web-based Rayyan software at https://www.rayyan.ai/.

Outcomes

The primary outcomes were the incidence rate of surgical site infections (SSI) and potential risk factors, with odds ratios and confidence intervals.

Data analysis

The quality of the included studies was evaluated using the Newcastle-Ottawa Scale. Studies scoring ≥6 were deemed of higher quality, while those scoring <6 were considered of lower quality. A random effects model was employed to estimate the pooled incidence rate of SSI, accounting for variability across different populations and mitigating the influence of outliers. The odds ratio was utilized to identify risk factors associated with SSI. All analyses were conducted using RevMan version 5.3 software. Heterogeneity was assessed using the χ^2 test with n-1 degrees of freedom and an α error of 5% for statistical significance. The I^2 test was employed to evaluate heterogeneity, with I^2 values of 25%, 50%, and 75% indicating low, medium, and high levels of heterogeneity, respectively.

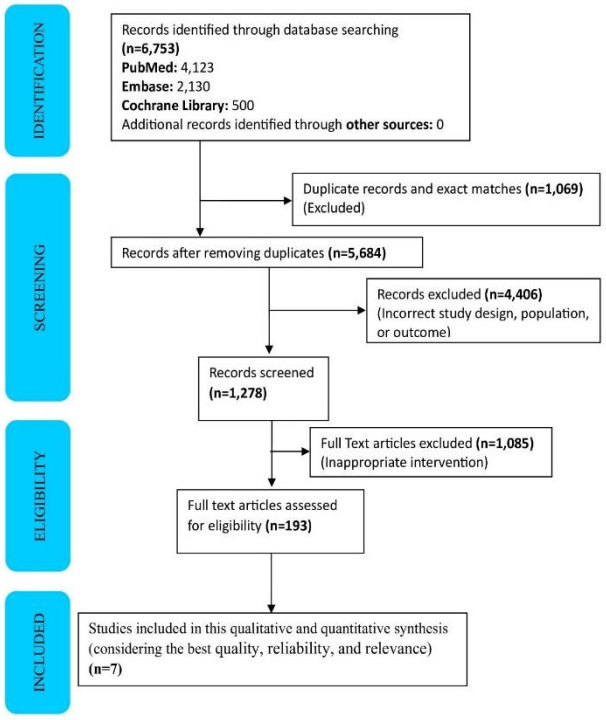


Figure 1: Flow chart of the study selection process.

RESULTS

A total of 6753 articles were identified through the databases. After the removal of 1069 duplicate records, 5684 articles remained for screening. A total of 4406 records were excluded due to incorrect study design, population, or outcome. An additional 1085 articles were excluded due to inappropriate interventions. The remaining 193 articles were assessed for eligibility in full text. Ultimately, 7 articles were included in this review and analysis considering their quality, reliability, and relevance (Figure 1). Key information regarding the characteristics of these studies and their respective Newcastle-Ottawa Scale (NOS) scores is presented in Table 1.[13]

The pooled incidence rate of hip SSI was 1.98% (95% CI: 0.96-4.11) (Figure 2). Considering risk factors, patients with a BMI≥35 exhibited a significant risk of surgical site infection in the hip joint [OR 4.01 (95% CI: 2.55-6.31)] (Figure 3). We also showed that the pooled analysis of Diabetes mellitus [OR 1.65 (95% CI: 0.80-3.39)] (Figure 4) and age≥ 67 years [OR 1.85 (95% CI: 0.29-11.75)] (Figure 5) was not significantly associated with the risk of hip surgical site infection.

Table 1: Characteristics of the included studies.

Author, year	Country	Type of study	patients	outcome	NOS
Choong et al, (2009)[4]	Australia	Prospective observational	Patients who underwent hip joint replacement	Incidence rate of SSI, RF(Age≥67)	6
Dowsey et al, 2008[14]	Australia	Retrospective observational	Patients who underwent hip arthroplasty	Incidence rate of SSI	6
Font-Vizcarra et al, 2011[5]	Spain	Prospective observational	Patients who underwent hip arthroplasty	Incidence rate of SSI, RF(Age≥67, BMI≥35)	5
Gupta et al, 2023[15]	USA	Retrospective observational	Patients who underwent hip hemi arthroplasty	Incidence rate of SSI, RF(BMI≥35)	7
Lau et al, 2013[16]	Singapore	Retrospective observational	Patients who underwent hip hemi arthroplasty	Incidence rate of SSI, RF (Diabetes mellitus)	5
Gajda et al, 2023[17]	Poland	Retrospective observational	Patients who underwent hip arthroplasty	Incidence rate of SSI, RF (Age≥67, Diabetes mellitus)	6
Liang et al[18]	China	Retrospective observational	Patients who underwent hip hemi arthroplasty	Incidence rate of SSI, RF (BMI≥35, Diabetes mellitus)	5

Note: RF=Risk factor(s)

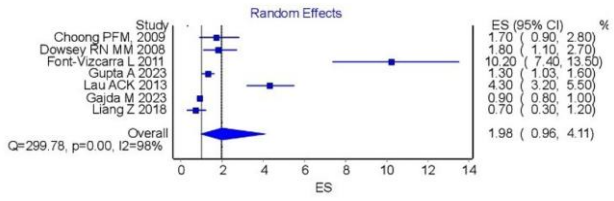


Figure 2: Forest plot showing the incidence rate (%) of hip surgical site infections.

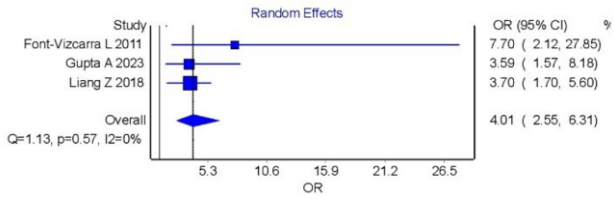


Figure 3: Forest plot showing risk factor BMI>35.

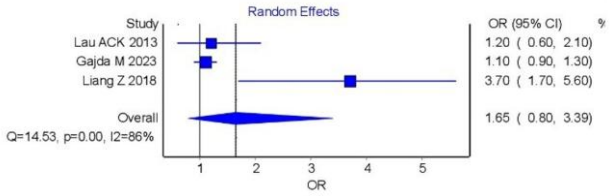


Figure 4: Forest plot showing risk factors for diabetes mellitus.

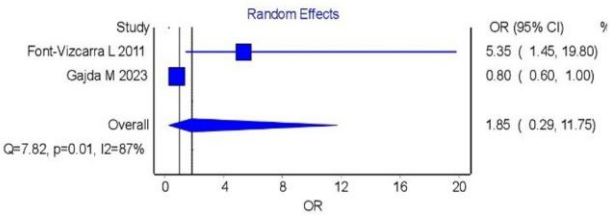


Figure 5: Forest plot showing risk factor age ≥67 years.

DISCUSSION

Our findings indicate that the pooled incidence rate of surgical site infection (SSI) following hip surgery was 1.98%. Patients with a body mass index (BMI) of ≥35 were found to be at a significantly elevated risk of SSI post-hip surgery. Other potential risk factors, such as diabetes mellitus and age ≥67, did not demonstrate an association with SSI risk in patients undergoing hip surgery. Among patients who underwent revision surgery for prosthetic joint infection following primary total hip arthroplasty, the one-year mortality rate was reported as 8% according to the Danish Hip Arthroplasty Register.[14] In this review, two studies documented patient mortality due to SSI following hip surgery, with one study reporting a mortality rate of 0.11% and another reporting 0.6%.[7,15] The incidence of SSI in our study exceeds that reported by Kong et al which was 1.17%.[19]

One of the studies included in this review reported an SSI incidence rate of 3.7%, which surpassed our findings.[5] In this review, SSIs were predominantly attributed to *Staphylococcus* (half of which were methicillin-resistant *Staphylococcus aureus*, MRSA) and Streptococcus organisms, consistent with other studies.[20,21] The development of SSI may result from surgical field contamination, influenced by the virulence of the microorganism, bacterial load, and the patient's immunological status. Our study highlights that obese patients are at an increased risk of SSIs following hip surgery. A meta-analysis by Yuan et al corroborates our findings, indicating that obese patients have a twofold risk of SSI following orthopedic surgery.[22] The release of several inflammatory cytokines and immune mediators from adipose tissues is considered a primary pathophysiological mechanism predisposing obese patients to infection.[23] Additionally, obese patients may experience reduced tissue oxygenation, further elevating the risk of post-surgical infection. Blood loss during surgery is greater in obese patients, and the resultant blood collection may become infected with bacterial microorganisms.[24]

Obesity can also complicate surgical procedures by necessitating excessive soft tissue dissection, complicating implant positioning, and prolonging the duration of surgery, thereby increasing the likelihood of deep tissue contamination.[25] One preventive strategy for obesity-associated SSI is the administration of double-dose antimicrobial prophylaxis to patients weighing 80 kg or more.[26] Our study did not establish a statistically significant relationship between diabetes and SSI, a finding that contrasts with a study by Kong et al which reported an increased risk of infection post-surgery in diabetic patients.[19] Generally, diabetic patients possess a compromised immune system, rendering them more susceptible to infection. Furthermore, diabetes mellitus may impede wound healing due to microangiopathic changes that can reduce tissue antibiotic concentrations and result in local tissue ischemia.

The following strategies can be followed to prevent surgical site infections. In case of obese patients, preoperative weight reduction to modify the BMI must be encouraged. The strict glycaemic control before, during, and following the surgery can reduce the chance of incidence of SSI. The operating surgeon must optimize the preoperative plan based on his expertise, limit the number of operating room staff, and shorten the duration of surgery to reduce the incidence of SSI.

Limitations

Though the meta-analysis was effectively conducted, there are some limitations. As the studies included here were either prospective or retrospective observational studies, this could have had some impact on the results. It is noted that the heterogeneity of included studies is high; the findings must be considered with caution while applying them in clinical practice.

CONCLUSION

Our study reports that the incidence rate of SSI post-hip surgery was 1.98%. It also points out that obesity is a high-risk factor for developing surgical site infections in patients who are undergoing hip surgery. The awareness about the risk factors will help the operating surgeon to optimize the preoperative condition of the patient and surgery, which can help to reduce the incidence of surgical site infections.

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