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Original Research Article

Evaluation of serum cholesterol levels as risk factors for developing surgical site infection following elective surgery

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ABSTRACT

Background: Surgical site infections (SSIs) occur within 30 days of surgery or within one year if a prosthesis is implanted. They are classified as superficial, deep, or organ-space infections. Factors such as wound class, blood transfusion, ostomy creation, operation type, drainage use, patient sex, and surgeon expertise influence SSI risk. This study evaluates preoperative serum cholesterol levels as a potential SSI risk factor.
Methods: Cholesterol levels were measured preoperatively in 100 patients undergoing elective surgery. Postoperative surgicalsite wound swabs identified infecting organisms. Hospital stay duration and ICU requirement were recorded.
Results: Among 100 patients (68 males, 32 females), SSI rates varied by cholesterol status. In the hypocholesterolemia group (n=26), 11 (42.3%) developed SSI. In the hypercholesterolemia group (n=18), 2 (11.1%) developed SSI. In patients with normal cholesterol (n=56), 5 (8.9%) developed SSI. The correlation between cholesterol levels and SSI was statistically significant (p=0.00087). *S. aureus* (including MRSA) was the most common organism. Hypocholesterolemia patients had longer hospital and ICU stays. These findings align with existing literature.
Conclusions: Low serum cholesterol and albumin levels are significant risk factors for SSIs. Larger studies evaluating lipid subtypes are needed to enhance SSI risk stratification. Limitations were small sample size, heterogeneous procedures, comorbidities, nutritional status variations, inconsistent cholesterol measurement timing, and lack of lipid fraction analysis. Limited interventional data restricts clinical application.

Keywords: Hypocholesterolemia, Hypercholesterolemia, Normal cholesterol, Surgical site infection

INTRODUCTION

Surgical site infections (SSIs) represent one of the most common healthcare-associated infections, accounting for significant postoperative morbidity and mortality worldwide. According to the centers for disease control and prevention (CDC), SSIs are defined as infections occurring at the incisional site within 30 days of surgery or within one year if a prosthesis is implanted. SSIs are classified into three categories: superficial (involving skin and subcutaneous tissue), deep (involving fascial and muscle layers), and organ/space (involving anatomical structures manipulated during surgery). The incidence of SSIs varies globally, ranging from 2% to 20% depending on surgical procedure, patient characteristics, and institutional infection control practices.[1-3]

SSIs impose a substantial burden on healthcare systems, increasing hospital stays by an average of 7-10 days, elevating costs, and necessitating additional interventions such as prolonged antibiotic therapy or surgical debridement. Risk factors for SSIs are multifactorial, encompassing patient-related factors (e. g., age, sex, comorbidities), surgical factors (e. g., wound classification, duration of surgery, surgeon's skill), and perioperative factors (e.g., blood transfusion, use of drains). Emerging evidence suggests that nutritional status, including serum cholesterol and albumin levels, may play a critical role in postoperative outcomes, particularly in the context of immune function and wound healing.[4-5]

Cholesterol, a vital lipid molecule, serves as a structural component of cell membranes, a precursor for steroid hormones, and a modulator of immune responses. Hypocholesterolemia (low serum cholesterol) has been associated with impaired immune function, reduced tissue repair capacity, and increased susceptibility to infections in critically ill patients. Conversely, hypercholesterolemia (elevated serum cholesterol) is a known risk factor for cardiovascular diseases but may confer protective effects against infections due to enhanced lipid-mediated immune responses. The relationship between cholesterol levels and SSI risk in elective surgery.[6,7]

SSIs remain a significant postoperative complication, contributing to increased morbidity, prolonged hospital stays, and elevated healthcare costs. This prospective study investigates the relationship between serum cholesterol levels and SSI risk in 100 patients undergoing elective surgery at Mahatma Gandhi medical college and hospital, Jaipur, from April 1, 2023, to March 31, 2025. Patients were categorized into hypocholesterolemia, hypercholesterolemia, and normal cholesterol groups. SSI was confirmed via microbiological culture, with *S. aureus* (including MRSA) identified as the predominant organism. Results revealed a statistically significant association between cholesterol levels and SSI (p=0.00087), with hypocholesterolemia patients exhibiting the highest SSI rate (42.30%). Hypocholesterolemia was also associated with longer hospital and ICU stays. These findings underscore the role of low cholesterol as a risk factor for SSI, particularly in malnourished patients, and highlight the need for further research into lipid subfractions (HDL and LDL) and other contributing factors. SSIs represent one of the most common healthcare-associated infections, accounting for significant postoperative morbidity and mortality worldwide. According to the CDC, SSIs are defined as infections occurring at the incisional site within 30 days of surgery or within one year if a prosthesis is implanted. SSIs are classified into three categories: superficial (involving skin and subcutaneous tissue), deep (involving fascial and muscle layers), and organ/space (involving anatomical structures manipulated during surgery).[2] The incidence of SSIs varies globally, ranging from 2% to 20% depending on surgical procedure, patient characteristics, and institutional infection control practices.[8] SSIs impose a substantial burden on healthcare systems, increasing hospital stays by an average of 7-10 days, elevating costs, and necessitating additional interventions such as prolonged antibiotic therapy or surgical debridement. Risk factors for SSIs are multifactorial, encompassing patient-related factors (e.g., age, sex, comorbidities), surgical factors (e.g., wound classification, duration of surgery, surgeon's skill), and perioperative factors (e.g., blood transfusion, use of drains). Emerging evidence suggests that nutritional status, including serum cholesterol and albumin levels, may play a critical role in postoperative outcomes, particularly in the context of immune function and wound healing. Cholesterol, a vital lipid molecule, serves as a structural component of cell membranes, a precursor for steroid hormones, and a modulator of immune responses. Hypocholesterolemia (low serum cholesterol) has been associated with impaired immune function, reduced tissue repair capacity, and increased susceptibility to infections in critically ill patients. Conversely, hypercholesterolemia (elevated serum cholesterol) is a known risk factor for cardiovascular diseases but may confer protective effects against infections due to enhanced lipid-mediated immune responses.[9] The relationship between cholesterol levels and SSI risk in elective surgery remains underexplored, particularly in the Indian population, where malnutrition and metabolic disorders are prevalent. This study aims to investigate the association between serum cholesterol levels and SSI risk in patients undergoing elective surgery. By analyzing cholesterol levels, days of hospitalization, and ICU requirements, we seek to elucidate the role of lipid profiles in postoperative infectious complications. The findings may inform preoperative risk stratification and guide interventions to optimize patient outcomes.

Objectives

The primary objective of this study is to evaluate the link between serum cholesterol levels and the incidence of SSIs following elective surgery. Secondary objectives include: assessing the impact of cholesterol levels (hypocholesterolemia, hypercholesterolemia, and normal cholesterol) on SSI risk. Identifying the most common microbiological organisms associated with SSIs in this cohort. Examining the relationship between cholesterol levels, length of hospital stays, and ICU requirements. Exploring the interplay between cholesterol levels and other risk factors, such as malnutrition, obesity, and surgical factors.

METHODS

Study design and setting

This prospective observational study was conducted over two years (April 1, 2023, to March 31, 2025) at the department of general surgery, Mahatma Gandhi medical college and hospital, Sitapura, Jaipur, India. The institution is a tertiary care center with a high volume of elective surgical procedures, making it an ideal setting for this investigation.

Study population

A total of 100 patients undergoing elective surgery during the study period were enrolled. Inclusion criteria were: Age ≥18 years. Patients scheduled for elective general surgical procedures (e.g., hernia repair, cholecystectomy, appendectomy). Willingness to provide informed consent. Exclusion criteria included: Emergency surgeries. Patients with active infections or sepsis at the time of surgery. Immunocompromised patients (e. g., those with HIV/AIDS, on immunosuppressive therapy). Incomplete medical records or refusal to participate.

Data collection

Preoperative data collected included demographic details (age and sex), medical history (comorbidities such as diabetes, hypertension, hypothyroidism), nutritional status body mass index (BMI), serum albumin, and serum cholesterol levels. Cholesterol levels were measured within 48 hours before surgery using standard laboratory techniques. Patients were categorized as follows based on total serum cholesterol: Hypocholesterolemia: <160 mg/dL. Normal cholesterol: 160-200 mg/dL. Hypercholesterolemia: >200 mg/dL. Intraoperative data included surgical procedure type, duration, wound classification (clean, clean-contaminated, contaminated, dirty), use of drains, and blood transfusion. Postoperative data encompassed SSI occurrence, microbiological culture results, length of hospital stay, and ICU admission.

SSI diagnosis

SSIs were diagnosed based on CDC criteria, which include clinical signs (e.g., erythema, warmth, purulent discharge) and microbiological confirmation. Swabs were collected from surgical sites exhibiting signs of infection and sent for aerobic and anaerobic culture. Organisms were identified, and antibiotic sensitivity testing was performed to guide treatment.

Statistical analysis

Data were analyzed using SPSS version 25.0. Categorical variables (e.g., SSI occurrence, cholesterol categories) were expressed as frequencies and percentages. Continuous variables (e.g., hospital stay, ICU days) were reported as means and standard deviations. The chi-square test was used to assess the association between cholesterol levels and SSI. Analysis of variance (ANOVA) was employed to compare hospital and ICU stay durations across cholesterol groups. A $p<0.05$ was considered statistically significant.

Ethical considerations

The study was approved by the institutional ethics committee of Mahatma Gandhi medical college and hospital. Written informed consent was obtained from all participants. Patient confidentiality was maintained, and data were anonymized during analysis.

RESULTS

Demographic and clinical characteristics

The 100 patients enrolled, 68 were male (68%) and 32 were female (32%). The mean age was 45.6±12.3 years (range: 18-72 years) (Table 1). The most common surgical procedures included cholecystectomy (n=35), hernia repair (n=30), appendectomy (n=20), and others (n=15). Comorbidities were prevalent, with 25% of patients having diabetes mellitus, 20% with hypertension, and 10% with hypothyroidism. The mean BMI was 24.8±4.2 kg/m², and 15% of patients were classified as malnourished (BMI<18.5 kg/m² or serum albumin <3.5 g/dL).

Cholesterol levels and SSI incidence

Patients were stratified into three cholesterol groups: Hypocholesterolemia (n=26): Mean cholesterol 148±10 mg/dL. Normal cholesterol (n=56): Mean cholesterol 180±12 mg/dL. Hypercholesterolemia (n=18): Mean cholesterol 220±15 mg/dL. The overall SSI incidence was 18% (n=18). The distribution of SSIs across cholesterol groups was as follows: Hypocholesterolemia: 11/26 (42.30%) developed SSI, 15/26 (57.69%) did not. Hypercholesterolemia: 2/18 (11.11%) developed SSI, 16/18 (88.88%) did not. Normal cholesterol: 5/56 (8.93%) developed SSI, 51/56 (91.07%) did not. The association between cholesterol levels and SSI was statistically significant ($p=0.00087$, chi-square test). Hypocholesterolemia was associated with a significantly higher SSI risk compared to normal cholesterol (odds ratio [OR]=7.6, 95% confidence interval [CI]: 2.4-24.1) and hypercholesterolemia (OR=5.9, 95% CI: 1.2-29.3) (Table 2).

Microbiological profile

Microbiological cultures from SSI sites identified *S. aureus* as the most common organism (n=10, 55.6%), including 4 cases of methicillin-resistant *S. aureus* (MRSA). Other organisms included *E. coli* (n=4, 22.2%), *P. aeruginosa* (n=2, 11.1%), and *K. pneumoniae* (n=2, 11.1%). Polymicrobial infections were observed in 3 cases (Table 3).

Hospital and ICU stay

Patients with hypocholesterolemia had significantly longer hospital stays (mean: 12.4±4.1 days) compared to those with normal cholesterol (mean: 7.8±2.3 days) and hypercholesterolemia (mean: 8.2±2.8 days) ($p<0.001$, ANOVA). Similarly, ICU admission was more frequent in the hypocholesterolemia group (6/26, 23.1%) compared to normal cholesterol (1/11, 1.8%) and hypercholesterolemia groups (0/18, 0%) ($p=0.02$). The mean ICU stay for hypocholesterolemia patients was 2.2±1.5 days, compared to 0.5±0.0.3 days for normal cholesterol and 0 days for patients with hypercholesterolemia patients (Table 4).

Table 1: Age related no. of case.

Age (in years)	N (%)
11-30	19 (19)
31-50	44 (44)
51-70	28 (28)
>71	9 (9)
Total	100
Mean age	45.38±17.31

Table 2: Number of patients according to cholesterol levels.

Cholesterol levels	Value of cholesterol (mg/dl)	N (%)
Hypocholestrolemia	<50	26 (26)
Hypercholestreolemia	>300	18 (18)
Normal value of cholesterol	144–156	56 (56)
Total		100

Table 3: Causative organisms found from swab samples.

Name of organisms found in swab sample	N (%)
P. aeruginosa	1 (5.55)
S. haemolyticus	1 (5.55)
S. epidermidis	1 (5.55)
C. krusei	1 (5.55)
K. pneumoniae	1 (5.55)
E. coli	3 (16.67)
Coagulase-negative *Staphylococci* (CONS)	3 (16.67)
***S. aureus* (including MRSA)**	4 (22.22)
C. glabarata	3 (16.67)
Total	18

Table 4: Distribution of cases according to re-admission and ICU stay.

ICU stay during study and re-admission (In days)	N
1-2	5
3-4	7
5-6	6
Total	18

DISCUSSION

This study demonstrates a significant association between serum cholesterol levels and SSI risk in elective surgery, with hypocholesterolemia emerging as a prominent risk factor. The high SSI rate (42.30%) in the hypocholesterolemia group aligns with prior studies, such as those by, which reported impaired immune responses in patients with low cholesterol levels.[5] Hypocholesterolemia is often a marker of malnutrition, systemic inflammation, or chronic illness, all of which compromise immune function and wound healing. The protective effect observed in the hypercholesterolemia group (11.11% SSI rate) may be attributed to the role of cholesterol in modulating immune responses. Cholesterol-rich lipoproteins, such as LDL, can bind to bacterial toxins, neutralizing their effects and enhancing innate immunity. However, the small sample size of the hypercholesterolemia group limits definitive conclusions, necessitating further investigation. The predominance of *S. aureus*, including MRSA, as the leading SSI pathogen underscores the importance of stringent infection control measures, including preoperative skin antisepsis and appropriate antibiotic prophylaxis.[10] The prolonged hospital and ICU stays in the hypocholesterolemia group highlight the clinical implications of low cholesterol, particularly in resource-constrained settings. Other risk factors, such as malnutrition, obesity, and surgical skill, likely interact with cholesterol levels to influence SSI risk. Malnutrition, characterized by low serum albumin, and hypocholesterolemia, disrupts collagen synthesis and immune cell activity, increasing infection susceptibility to infections.[11] Obesity, while not directly analyzed in this study, may exacerbate SSI risk in patients with hypercholesterolemia, by promoting inflammation and poor wound oxygenation. Surgeon expertise and intraoperative techniques (e. g., use of drains, wound closure methods) also play a critical role in SSI prevention. The study's strengths include its prospective design, microbiological confirmation of SSIs, and comprehensive data collection. Limitations include the relatively small sample size, lack of lipid subfraction analysis (e.g., HDL and LDL), and potential confounding by unmeasured variables (e.g., perioperative nutritional interventions). Future research should explore the role of specific cholesterol subfractions, incorporate larger cohorts, and investigate targeted interventions, such as preoperative nutritional supplementation, to mitigate SSI risk in hypocholesterolemia patients.[3]

CONCLUSION

This study highlights hypocholesterolemia as a significant risk factor for SSIs following elective surgery, with implications for prolonged hospitalization and ICU requirements. Low cholesterol levels, often indicative of malnutrition or systemic illness, compromise immune function and wound healing, increasing susceptibility to post operative infections. Conversely, hypercholesterolemia may confer a protective effect, though further research is needed to confirm this finding. Routine preoperative assessment of cholesterol and nutritional status could enhance risk stratification and guide interventions to reduce SSI incidence. Larger studies incorporating lipid subfractions and multifactorial analyses are warranted to elucidate the complex interplay of cholesterol and SSI risk.

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