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Original Research Article

Association between preoperative serum albumin and serum cholesterol with surgical site infection: a prospective observational study

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ABSTRACT

Background: Surgical site infection (SSI) is one of the most common healthcare-associated infections and a major cause of postoperative morbidity, prolonged hospital stays, and increased healthcare costs. While obesity and hypoalbuminemia are established risk factors for SSI, the roles of serum cholesterol and serum albumin remain controversial. This prospective observational study was conducted to evaluate the association of preoperative serum albumin and serum cholesterol with the incidence of SSI among patients undergoing elective clean-contaminated general surgical procedures at Heritage Institute of Medical Sciences, Varanasi.

Methods: This prospective observational study was conducted over two years at Heritage Institute of Medical Sciences, Varanasi. A total of 150 patients aged 18–65 years undergoing elective clean-contaminated general surgical procedures were enrolled. Demographic characteristics, comorbidities, and preoperative serum albumin and cholesterol levels were recorded. SSI was diagnosed according to Centre for Disease Control (CDC) criteria. Data were analyzed using SPSS version 26.0, and associations between variables were assessed using the Chi-square test, with $p<0.05$ considered statistically significant.

Results: SSI occurred in 51 (34.0%) of 150 patients. Hypoalbuminemia and abnormal serum cholesterol levels were significantly associated with SSI ($p=0.026$ and $p=0.030$, respectively), and postoperative hospital stay was significantly longer among patients with SSI.

Conclusions: Preoperative serum albumin and serum cholesterol are important predictors of surgical site infection following elective clean-contaminated general surgery. Their preoperative assessment and optimization may help reduce postoperative infectious complications and improve surgical outcomes.

Keywords: Surgical site infection, Serum albumin, Serum cholesterol

INTRODUCTION

Healthcare-associated infections (HAIs) represent one of the foremost threats to healthcare delivery worldwide, posing a serious risk to patient safety. Among the various HAIs, surgical site infection (SSI) is the most frequently reported, typically manifesting within 30 days of a surgical procedure or within one year in cases involving a prosthetic implant. The global pooled incidence of SSI has been estimated at 2.5%, with subgroup analyses by WHO region and survey period reporting incidences of 2.7% and 2.5%, respectively.[1]

SSIs are estimated to account for approximately 20% of all healthcare-associated infections, with the remainder attributable to infections arising from a range of other clinical procedures.[2] Given this substantial burden, the global incidence of SSI has been reported to affect up to one-third of surgical patients, contributing significantly to escalating healthcare costs as well as to overall patient morbidity and mortality.

Patients undergoing surgery have a 0.5% to 3% risk of developing SSI at or adjacent to the surgical site, and those affected typically require 7 to 11 days of additional hospitalization compared with patients who do not develop SSI. SSI most commonly arises from intraoperative bacterial inoculation of the surgical site, with additional contributory factors including the presence of foreign material, the patient's immune status, the degree of bacterial wound contamination, and the use of antibiotic prophylaxis. Several evidence-based strategies have been proposed to reduce SSI rates, including avoidance of razors for hair removal, decolonization with intranasal antistaphylococcal agents and antistaphylococcal skin antiseptics in high-risk procedures, maintenance of normothermia through active warming (e.g., warmed intravenous fluids), use of chlorhexidine gluconate–alcohol skin preparation, forced-air skin warming to maintain body temperature above 36°C, perioperative glycemic control, and negative pressure wound therapy.[3,4]

The objective of the present study was to evaluate the association between preoperative serum albumin and serum cholesterol levels and the occurrence of surgical site infection among patients undergoing elective clean-contaminated general surgical procedures. A secondary objective was to assess the influence of these biochemical parameters on the duration of postoperative hospital stay, with a view to facilitating early identification of high-risk patients and enabling targeted preoperative optimization strategies to reduce postoperative infectious complications and improve surgical outcomes.[5]

METHODS

This prospective observational study was conducted in the Department of General Surgery at Heritage Institute of Medical Sciences (HIMS), Varanasi, Uttar Pradesh, India, over a two-year period. Institutional Ethics Committee approval was obtained prior to study initiation (approval number HIMS/IEC/294).

Sampling method

A total of 150 patients undergoing elective clean-contaminated general surgical procedures, as classified by the Centre for Disease Control and Prevention (CDC), were enrolled through non-probability convenience sampling. The sample size was calculated using a reported SSI prevalence of 6% in India, with a 95% confidence interval and a 5% margin of error: Z=1.96 at 95% confidence interval, P=Prevalence, d=allowed error,

$$N=1.96\times1.96\times0.06\ (1-0.06)\ /\ (0.05\times0.05)=150.$$

Prevalence of SSI in India is reported to be around 6%.[6]

Inclusion criteria

Patients aged 18-65 years undergoing elective clean-contaminated general surgical procedures (as per CDC classification), irrespective of comorbidities. Patients who provided written informed consent to participate

Exclusion criteria

Patients undergoing emergency surgery, patients lost to follow-up and patients who declined to provide informed consent.

Experimental procedure

All enrolled patients underwent a comprehensive preoperative clinical evaluation. Baseline demographic characteristics, comorbidities, serum albumin, serum cholesterol, diagnosis, surgical procedure, and American Society of Anesthesiologists (ASA) physical status were recorded using a standardized data collection form. Patients were followed prospectively until hospital discharge, during which postoperative wound assessments were performed at regular intervals. Wounds were graded using the Southampton Wound Grading System, and surgical site infections were diagnosed and classified in accordance with CDC criteria. Patients who developed SSI underwent further evaluation to determine the association between preoperative clinical and biochemical parameters and the occurrence of postoperative infection.

Validation and scoring

Total serum cholesterol levels were categorized into three groups: Hypocholesterolemia (<151 mg/dl), Normal (151–240 mg/dl) and Hypercholesterolemia (>240 mg/dl).

Total serum albumin levels were categorized into three groups: Hypoalbuminemia (<3.5 mg/dl), Normal (3.5–5.5 mg/dl) and Hyperalbuminemia (>5.5 mg/dl)

Statistical analysis

Data were entered into Microsoft Excel 2019 (Microsoft Corporation, Redmond, WA, USA) and analyzed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the study population. Continuous variables, including age, serum albumin, serum cholesterol, and duration of hospital stay, were expressed as mean±standard deviation (SD), whereas categorical variables were presented as frequencies and percentages. Associations between SSI and categorical variables including age group, comorbidities, serum albumin level, and serum cholesterol category

were evaluated using the Chi-square test. Cross-tabulation analysis was performed to compare the distribution of study variables between patients with and without SSI. Statistical significance was set at a two-tailed p-value of <0.05, with 95% confidence intervals considered throughout the analysis.

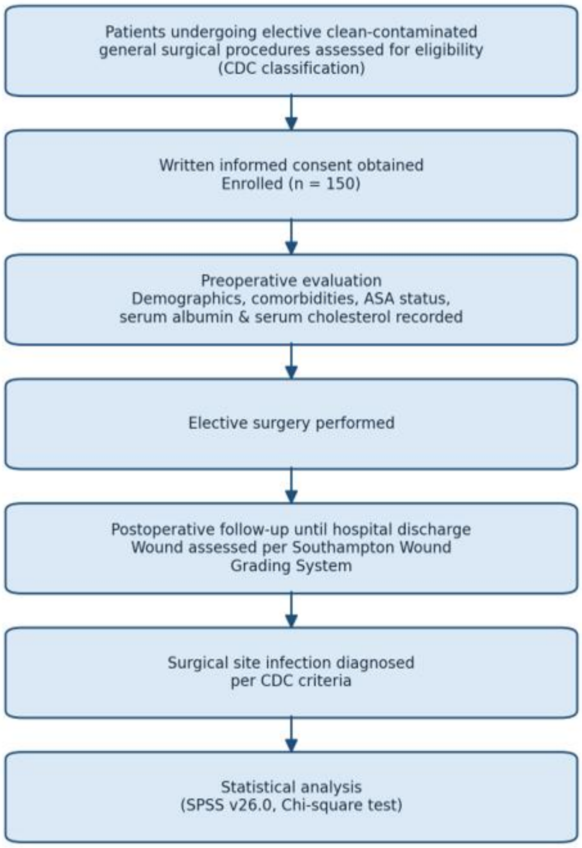

Figure 1: Overview of the study.

RESULTS

The study population comprised an equal proportion of male and female patients (50.0% each, n=75). The largest age group was 40–49 years (26.0%, n=39), followed by 30–39 years (25.3%, n=38), 50–59 years (24.7%, n=37), and 18–29 years (24.0%, n=36). With respect to body mass index (BMI), 37.3% (n=56) of patients had a normal BMI, while 25.3% (n=38) were overweight, 22.7% (n=34) were obese, and 14.7% (n=22) were underweight. Comorbidities were present in 52.7% (n=79) of patients and absent in 47.3% (n=71).

To determine the correlation between hypoalbuminemia and development of SSI

Table 2 demonstrates that hypoalbuminemia was more prevalent among patients with SSI (54.9%, n=28) than among those without SSI (26.3%, n=26); none of the study participants had hyperalbuminemia. Conversely, normal serum albumin levels were observed in 73.7% (n=73) of patients without SSI, compared with 45.1% (n=23) of patients with SSI.

Table 1: Demographic and clinical characteristics of study participants (n=150).

Variables	Category	N	%
Gender	Male	75	50.0
	Female	75	50.0
Age group (in years)	18-29	36	24.0
	30-39	38	25.3
	40-49	39	26.0
	50-59	37	24.7
BMI	Underweight	22	14.7
	Normal	56	37.3
	Overweight	38	25.3
	Obese	34	22.7
Comorbidities	Present	79	52.7
	Absent	71	47.3
Duration of hospital stay (days)	Mean±SD	[XX]± [XX]	–

*Mean±SD for duration of hospital stay to be completed by the authors.

Table 2: SSI × serum albumin - crosstabulation and chi-square.

Serum albumin level	With SSI		No SSI	
	N	%	N	%
Hypoalbuminemia (n=54)	28	54.9	26	26.3
Normal (n=96)	23	45.1	73	73.7
Hyperalbuminemia (n=0)	0	0	0	0
Total	51	100	99	100
Chi-square=2.600, p value=0.026*				

This association between serum albumin category and SSI was statistically significant (χ^2=2.600, p=0.026), indicating that hypoalbuminemia was associated with a higher likelihood of developing SSI.

To determine the correlation between serum cholesterol and development of SSI

Table 3 shows that hypercholesterolemia was present in 39.2% (n=20) of patients with SSI compared with 25.3% (n=25) of patients without SSI, while hypocholesterolemia was present in 19.6% (n=10) of patients with SSI compared with only 1.0% (n=1) of patients without SSI.

This association between serum cholesterol category and SSI was also statistically significant (χ^2=2.889, p=0.030), suggesting that deviation from normal cholesterol levels whether elevated or reduced was associated with an increased likelihood of SSI.

Table 3: SSI × cholesterol category - crosstabulation and chi-square.

Cholesterol category	With SSI		No SSI	
	N	%	N	%
Hypocholesterolemia (n=11)	10	19.6%	1	1.0%
Normal (n=94)	21	41.2%	73	73.7%
Hypercholesterolemia (n=45)	20	39.2%	25	25.3%
Total	51	100%	99	100%
Chi-square=2.889, p value=0.030*				

DISCUSSION

Hypoalbuminemia

Serum albumin demonstrated a significant association with SSI in the present study, with hypoalbuminemic patients more likely to develop postoperative wound infections than those with normal serum albumin levels. As a recognized marker of nutritional status and systemic physiological reserve, low serum albumin has been shown to impair collagen synthesis, delay wound healing, reduce immune competence, and heighten susceptibility to infection.[7,8] These findings underscore the value of preoperative nutritional assessment and, where feasible, correction of hypoalbuminemia to improve surgical outcomes and reduce postoperative infectious complications.

Serum cholesterol

The present study also identified a significant association between elevated serum cholesterol and the occurrence of SSI, with hypercholesterolemic patients exhibiting a higher incidence of postoperative infection suggesting that dyslipidaemia may adversely affect surgical recovery. Prior research indicates that elevated cholesterol contributes to endothelial dysfunction, impaired microvascular circulation, chronic low-grade inflammation, and reduced tissue oxygenation, each of which can compromise wound healing.[9,10] Preoperative identification and correction of lipid abnormalities may therefore constitute an additional, modifiable strategy for reducing postoperative infectious complications, particularly among high-risk surgical patients.

Limitations

This study is subject to several limitations. As a single-centre observational study conducted at one tertiary care institution, the generalizability of these findings to other healthcare settings and patient populations may be limited. In addition, intraoperative variables such as operative duration and blood loss were not assessed, and their omission may affect the accuracy of attributing SSI risk solely to the preoperative factors examined here.[11] Future studies incorporating microbiological evaluation including culture-based pathogen identification are warranted to further characterize the causative organisms and antibiotic resistance patterns associated with SSI.

CONCLUSION

Surgical site infection remains a significant postoperative complication shaped by multiple patient-related factors. This study demonstrated that hypoalbuminemia and hypercholesterolemia were each significantly associated with an increased risk of SSI, underscoring the central role of nutritional and metabolic status in postoperative wound healing, with advancing age and comorbidities further compounding this risk. By identifying preoperative serum albumin and serum cholesterol as accessible, low-cost biochemical predictors of SSI, this study adds to the existing evidence base and supports their incorporation into routine preoperative risk stratification, particularly ahead of major surgical procedures. Early recognition and correction of these modifiable risk factors through nutritional optimization, weight management, metabolic control, and comprehensive perioperative care may substantially reduce SSI incidence, improve surgical outcomes, lower healthcare expenditure, and enhance patient quality of life.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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