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EVALUATION OF SERUM CHOLESTEROL LEVELS AS RISK FACTORS FOR DEVELOPING SURGICAL SITE INFECTION FOLLOWING ELECTIVE SURGERY

General Surgery

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ABSTRACT

Background: Surgical site infection (SSI) remains an important postoperative complication. Serum cholesterol influences cell-membrane function, inflammation and host immunity, but its association with SSI remains uncertain. **Methods:** This prospective cohort study included 90 patients undergoing elective general surgical procedures. Preoperative clinical and biochemical parameters, including serum cholesterol, were recorded and patients were followed for 30 days for SSI. **Results:** SSI occurred in 11 (12.2%) patients. Mean cholesterol was significantly higher in patients developing SSI than in those without infection (227.4±41.2 vs. 193.2±36.1 mg/dL; p<0.001). SSI increased from 4.5% at cholesterol <200 mg/dL to 27.8% at ≥240 mg/dL. ROC analysis demonstrated an AUC of 0.74, with an optimal cut-off of 215 mg/dL. **Conclusion:** Elevated preoperative serum cholesterol was significantly associated with SSI and showed moderate predictive ability.

KEYWORDS

Surgical Site Infection, Serum Cholesterol, Elective Surgery, Wound Infection.

INTRODUCTION

Surgical site infection (SSI) is one of the most important healthcare-associated complications following surgery. It may involve the skin and subcutaneous tissue, deeper fascia and muscle, or an organ/space manipulated during surgery[1]. Despite improvements in asepsis, antibiotic prophylaxis and perioperative care, SSI continues to increase morbidity, length of hospital stay and healthcare expenditure, particularly in low- and middle-income countries[2].

Development of SSI is multifactorial and depends upon the interaction between microbial contamination, surgical factors and host defense. Wound class, prolonged operative duration, obesity, nutritional deficiency and impaired immune function are established risk factors[2, 3]. Increasing attention has therefore been directed towards readily measurable biochemical markers that may improve preoperative risk stratification.

Cholesterol has important roles in membrane integrity, lipid-raft signaling, macrophage function and inflammatory regulation. Earlier studies predominantly associated low serum cholesterol with postoperative infection. Morimoto et al.[4] reported increased nosocomial infection among surgical patients with low total cholesterol while Sodavadiya et al.[5] observed a significant association between hypocholesterolemia and SSI in elective general surgery. However, recent studies have produced inconsistent results, suggesting that cholesterol–infection relationships may vary across populations and may not be strictly linear[6–8].

The present study was therefore undertaken to evaluate the association between preoperative serum cholesterol levels and development of SSI following elective surgery and to assess its potential usefulness as a predictive biochemical marker.

MATERIALS AND METHODS

This prospective cohort study was conducted in the Department of General Surgery, F.H. Medical College and Hospital, Agra, over 18 months. Ninety patients undergoing elective general surgical procedures and providing written informed consent were included.

Emergency surgeries, diabetes mellitus, pregnancy, immuno-compromised states, previously infected operative sites and patients with incomplete follow-up were excluded. Patients underwent detailed clinical evaluation and routine preoperative investigations including complete blood count, serum albumin, liver and renal function tests and lipid profile.

Procedures included inguinal/ventral hernia repair, cholecystectomy, breast surgery, colorectal surgery and other elective operations. Operative duration and wound classification were recorded. Patients were monitored during hospitalization and followed for 30 days. SSI was diagnosed according to CDC criteria, and wound status was assessed using the Southampton wound grading system[1].

Data were analyzed using SPSS version 17.0. Continuous variables were expressed as mean±SD and categorical variables as frequency and percentage. Student's t-test, Chi-square test or Fisher's exact test was applied as appropriate. ROC analysis assessed predictive performance of total cholesterol. A p-value <0.05 was considered significant.

RESULTS

A total of 90 patients were evaluated. Eleven patients developed SSI, giving an overall incidence of 12.2%. Nine patients (10.0%) developed superficial SSI and two (2.2%) developed deep SSI.

Hernia surgery constituted the largest procedural group with 30 patients (table 1), followed by cholecystectomy in 20, colorectal surgery in 18, breast surgery in 12 and other procedures in 10. SSI was most frequent following colorectal surgery, occurring in 4 of 18 patients (22.2%). Infection occurred in 3 of 30 hernia procedures (10.0%), 2 of 20 cholecystectomies (10.0%), 1 of 12 breast operations (8.3%) and 1 of 10 other procedures (10.0%). Procedure type itself was not significantly associated with SSI.

Table 1 Distribution of Elective Surgical Procedures and SSI

Procedure	Total n (%)	SSI n (%)	p-value
Inguinal/ventral hernia	30 (33.3)	3 (10.0)	0.746
Cholecystectomy	20 (22.2)	2 (10.0)	0.990
Breast surgery	12 (13.3)	1 (8.3)	0.990
Colorectal surgery	18 (20.0)	4 (22.2)	0.220
Other procedures	10 (11.1)	1 (10.0)	0.990
Total	90 (100)	11 (12.2)	—

Wound contamination showed a clear relationship with infection. SSI was observed in 6.7% of clean wounds, compared with 22.7% of clean-contaminated wounds and 25.0% of dirty wounds (table 2). Thus, infection increased progressively with increasing wound contamination.

Biochemical assessment demonstrated that preoperative leukocytosis and hypoalbuminemia were associated with higher SSI occurrence. Among 12 patients with TLC $>11\times10^3/\mu L$, four (33.3%) developed SSI compared with 7 of 71 patients (9.9%) with TLC within the reference range. Patients with albumin <3.5 g/dL showed an SSI rate of 30.0%, compared with 8.8% among those with albumin 3.5–3.9 g/dL and 5.6% among those with albumin ≥4.0 g/dL.

Although SSI showed a declining trend with increasing hemoglobin, from 33.3% among patients with Hb <10 g/dL to 5.6% at Hb ≥14 g/dL, the association was not statistically significant.

Operative duration was another important determinant. Six of 15 patients undergoing procedures lasting ≥120 minutes developed SSI, giving an infection rate of 40.0% (p=0.003).

Table 2 Major Clinical and Biochemical Factors Associated with SSI

Factor	Patients n	SSI n (%)	p-value
Clean wound	60	4 (6.7)	0.038
Clean-contaminated wound	22	5 (22.7)	—
Dirty wound	8	2 (25.0)	—
TLC >11×10³/µL	12	4 (33.3)	0.037
Albumin <3.5 g/dL	20	6 (30.0)	0.013
Hb <10 g/dL	6	2 (33.3)	0.155
Operative duration ≥120 min	15	6 (40.0)	0.003

The principal finding concerned serum cholesterol. Mean preoperative total cholesterol was 227.4±41.2 mg/dL among patients developing SSI (table 3) compared with 193.2±36.1 mg/dL among those without infection (p<0.001).

A graded increase in infection was observed across cholesterol categories. Only 2 of 44 patients (4.5%) with cholesterol <200 mg/dL developed SSI, compared with 4 of 28 (14.3%) having levels of 200–239 mg/dL and 5 of 18 (27.8%) with cholesterol ≥240 mg/dL.

ROC analysis produced an AUC of 0.74 (95% CI 0.61–0.87; p=0.004). The optimal threshold was 215 mg/dL, providing 63.6% sensitivity and 70.9% specificity for discrimination of SSI.

Table 3 Serum Cholesterol and Prediction of SSI

Parameter	Result
Mean cholesterol in SSI	227.4±41.2 mg/dL
Mean cholesterol without SSI	193.2±36.1 mg/dL
SSI with TC <200 mg/dL	2/44 (4.5%)
SSI with TC 200–239 mg/dL	4/28 (14.3%)
SSI with TC ≥240 mg/dL	5/18 (27.8%)
ROC AUC	0.74
95% CI	0.61–0.87
Optimal cut-off	215 mg/dL
Sensitivity	63.6%
Specificity	70.9%
ROC p-value	0.004

DISCUSSION

The present prospective study demonstrated an overall SSI incidence of 12.2% following elective general surgery. The most important observation was the progressive increase in infection with increasing preoperative total cholesterol. Patients who subsequently developed SSI had a mean cholesterol concentration approximately 34 mg/dL higher than patients without infection.

This finding differs from several earlier studies. Morimoto et al. reported that low preoperative cholesterol was associated with increased postoperative infection after gastrointestinal surgery[4]. Sodavadiya et al. similarly observed that hypocholesterolemia increased SSI risk almost fourfold[5]. These findings were generally explained by impaired nutritional status, reduced lipoprotein-mediated neutralization of bacterial products and altered immune responses.

However, subsequent studies have not shown a uniform association. Singh et al. reported no significant difference in total cholesterol between SSI and non-SSI groups, although serum albumin remained strongly associated with infection[6]. Arora et al. also found that total cholesterol was not independently associated with SSI, while abnormalities in HDL showed a stronger relationship[7]. Conversely, recent Indian data continue to demonstrate significant associations between abnormal cholesterol profiles and postoperative infection[8].

The increasing SSI frequency from 4.5% at cholesterol <200 mg/dL to 27.8% at ≥240 mg/dL in the present study suggests that higher cholesterol may identify a metabolically vulnerable subgroup. The apparent disagreement with studies linking low cholesterol to infection may indicate a non-linear relationship. Earlier work has suggested that both low and markedly elevated cholesterol values may be associated with adverse infectious outcomes[3,4]. Thus, total cholesterol should probably be interpreted within the wider metabolic and nutritional profile rather than as an isolated marker.

Other findings reinforce the multifactorial nature of SSI. Hypo-albuminemia was associated with a 30.0% infection rate. Sodavadiya et al. similarly reported substantially higher infection among hypoalbuminemic surgical patients[5], while other contemporary studies have recognized albumin as a useful marker of postoperative infectious risk[6,9].

Preoperative leukocytosis was also associated with SSI, with one-third of patients having TLC >11×10³/µL developing infection. Prolonged surgery showed an even stronger relationship; 40.0% of procedures lasting ≥120 minutes were complicated by SSI. Increasing wound contamination was accompanied by infection rates rising from 6.7% in clean wounds to 25.0% in dirty wounds, consistent with established SSI risk models and prevention guidelines[1,2,10].

The ROC AUC of 0.74 indicates that total cholesterol had moderate discriminatory ability. A threshold of 215 mg/dL provided sensitivity of 63.6% and specificity of 70.9%. Cholesterol therefore cannot substitute established clinical assessment, but because it is inexpensive, routinely available and objectively measurable, it may contribute to preoperative identification of patients requiring closer surveillance.

CONCLUSION

Elevated preoperative serum cholesterol was significantly associated with SSI following elective surgery. Infection increased progressively across cholesterol categories, and a threshold of 215 mg/dL showed moderate predictive performance. Serum cholesterol may therefore serve as an adjunctive biochemical marker when interpreted together with nutritional status, leukocyte count, wound class and operative factors. Larger multicentric studies are required to validate the observed relationship and determine clinically applicable thresholds.

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