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Original Article

Surgery Section

Evaluation of Serum Cholesterol Level as a Risk Factor for Developing Surgical Site Infections following Clean Elective Surgery: A Prospective Cohort Study

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ABSTRACT

Introduction: Surgical Site Infection (SSI) is defined as an infection occurring in an incisional wound within 30 days of the procedure or within one year if a prosthesis is implanted. SSIs increase hospital stays, expenditures, morbidity and significantly impact patients' mental wellbeing, causing anxiety, stress and potential emotional distress. A multitude of patient-related, surgical and physiological variables contributes to the heightened risk of developing SSIs. Addressing patient-related risk factors for SSIs involves proactive measures such as optimising preoperative health, managing blood sugar and albumin levels and promoting healthy lifestyle choices such as smoking cessation.

Aim: To evaluate serum cholesterol levels as a risk factor for developing SSI.

Materials and Methods: A prospective cohort study was conducted at a tertiary healthcare centre from January 1st, 2023, to December 31st, 2023. It included 107 patients undergoing clean elective surgery. The relation of preoperative and postoperative serum cholesterol levels, serum High-Density Lipoproteins (HDL), serum Low-Density Lipoproteins (LDL), serum Very Low-Density Lipoproteins (VLDL) and serum triglycerides to SSI was studied. The data were analysed using Statistical Package for the Social Sciences (SPSS) software version 21.0 and the Student's t-test was employed to obtain the results.

Results: Out of 107 cases, SSI was observed in 23 patients (21.5%). Among these cases, there were 54 males and 53 females, with a mean age of 43.50±16.29 years. This study concluded that deranged HDL was associated with 65.22% of cases with SSI (p-value <0.001). Regarding preoperative cholesterol levels, 86.96% of patients without SSI had normal cholesterol, compared to 82.14% in those with SSI (p-value=0.585). For postoperative cholesterol levels, 91.3% of patients without SSI had normal cholesterol, versus 89.29% in those with SSI (p-value=0.778).

Conclusion: The association of preoperative and postoperative serum cholesterol levels in the development of SSI could not be established in this study. However, serum HDL emerged as a good prognostic indicator for SSI after clean elective surgery. It should be checked and optimised in all cases prior to surgery.

Keywords: High density lipoprotein, Lipid profile, Triglycerides

INTRODUCTION

SSI is defined as an infection occurring in an incisional wound within 30 days of the procedure or within one year if a prosthesis is implanted [1]. SSI is responsible for an increased economic burden on healthcare systems, including additional postoperative hospital stays and costs [2]. Based on the World Health Organisation's (WHO) regions, the overall pooled incidence of SSI is 2.7% (more than 30% of healthcare-associated infections are SSIs). The highest incidence was reported in the African region, which accounted for 7.2%, whereas the WHO report indicates that India has a lower incidence of SSI [3]. The SSI rates for laparotomy procedures are higher, ranging from 3.4 to 36.1% [4]. In India, among tertiary care hospitals, the incidence of SSI is 2.06% for Minimal Invasive Surgery (MIS) and 16.16% for Open Surgery (OS) [5].

The Centers for Disease Control (CDC) National Nosocomial Infections Surveillance (NNIS) system has defined and classified SSIs [6] as follows:

1. Incisional - It is further classified based on:
    - 1a) Involving only skin and subcutaneous tissue: Superficial incisional SSI.
    - 1b) Involving deeper soft tissues of the incision: Deep incisional SSI.
2. Organ/Space.

Numerous patient-related, surgery-related and physiological factors increase the risk of SSI. Patient-related risk factors can be modifiable or non modifiable. Non modifiable risk factors include increased age, recent radiotherapy and a history of skin or soft-tissue infections. Modifiable risk factors include diabetes, obesity, alcoholism, smoking, low serum albumin concentration and ischaemia secondary to vascular diseases. Surgical procedure-related risk factors include the duration of surgical scrub, preoperative preparation of the surgical site, duration of the operation, antimicrobial prophylaxis, sterilisation of instruments, skin antisepsis, surgical technique (including poor haemostasis, failure to obliterate dead space and tissue trauma), foreign matter in the surgical site and operating room ventilation [7].

Cholesterol influences gluconeogenesis and immune function. Its transport forms, known as lipoproteins, also act as carriers for fat-soluble vitamins, antioxidants, drugs and toxins. Additionally, lipids and lipoproteins can bind to and neutralise bacterial endotoxins, such as Lipopolysaccharides (LPS) [8]. LPS in the blood binds to LPS binding protein [9] and activates the cell surface CD14 receptor [10]. This leads to the release of a cascade of proinflammatory cytokines, including tumor necrosis factor-α, IL-1 and IL-6 [11]. If LPS endotoxin binds to lipoproteins (e.g., cholesterol), then cytokine release is decreased [12]. Hence, lipids play a crucial role in wound healing by providing structural components for cell membranes, facilitating the transport of nutrients and growth factors and modulating inflammation and immune responses. Their presence and balance are essential for optimising tissue repair and regeneration during the healing process.

Apart from various causes of hypocholesterolemia, malnutrition is an important secondary cause and is present in the majority of patients presenting in a government setup in India. Nutritional depletion leads to poor wound healing and an increased risk of postoperative complications. In surgical patients, the prevalence of protein-energy malnutrition is high, ranging from 10 to 54%. It is well known that malnourished patients have an increased risk of postoperative complications, particularly those related to wound healing [13].

In India, research has been conducted to investigate the incidence of SSIs in clean wounds as well as in sites that have been cleanly contaminated. Among the multitude of factors that increase a patient's risk of developing SSI, hypocholesterolemia is often overlooked. Considering this factor could lead to a significant decrease in this preventable complication, especially in a malnourished population. Therefore, this study was conducted to find the association between hypocholesterolemia and SSI.

MATERIALS AND METHODS

A prospective cohort study was conducted in the Department of General Surgery at Pt. BD Sharma Institute of Medical Sciences, Rohtak, Haryana, India from January 1st, 2023, to December 31st, 2023. Ethical clearance was obtained from the Institutional Ethical Committee (No: BREC/23/541). The study included 107 patients undergoing clean elective surgery. Detailed information was provided to the patients and informed consent was collected from them during Outpatient Department (OPD) visits and Inpatient Department (IPD) visits.

Inclusion criteria: Patients undergoing clean elective surgeries in the Department of Surgery, PGIMS, Rohtak were included in the study.

Exclusion criteria: Patients with immunocompromised states, such as those who are HIV positive or on corticosteroids, pregnant females, anaemic females, patients who were lost to follow-up were excluded form the study.

Study Procedure

Details of the patients were recorded, including their history (diabetes, hypertension, collagen disorders, tuberculosis) and clinical examination (nutritional status and hygiene). Preoperative investigations were performed, which included haemoglobin, bleeding and clotting times, viral markers and lipid profiles. Blood samples were obtained under fasting conditions and the cut-off values used were according to the Adult Treatment Panel III (ATP III) guidelines, as follows [14]:

Fasting triglyceride level:

Normal: <150 mg/dL

Mild hypertriglyceridemia: 150 to 499 mg/dL

Moderate hypertriglyceridemia: 500 to 886 mg/dL

Very high or severe hypertriglyceridemia: >886 mg/dL

LDL level:

Optimal: <100 mg/dL

Near optimal/above optimal: 100 to 129 mg/dL

Borderline high: 130 to 159 mg/dL

High: 160 to 189 mg/dL

Very high: <190 mg/dL

HDL level:

Low: <40 mg/dL

High: ≥60 mg/dL

Total cholesterol level:

Desirable: <200 mg/dL

Borderline high: 200-239 mg/dL

High:≥240 mg/dL

Operative wounds were examined on the 1st, 3rd and 5th postoperative days for signs of SSI. Incisional SSI, both superficial and deep, was defined according to CDC criteria [6] and recorded. SSI surveillance was extended to 30 days postsurgery, if required.

STATISTICAL ANALYSIS

Statistical testing was conducted using the Statistical Package for the Social Sciences (SPSS) version 17.0. Continuous variables were presented as mean±SD or median (IQR) for non normally distributed data. Categorical variables were expressed as frequencies and percentages. The comparison of normally distributed continuous variables between the groups was performed using the Student's t-test. Nominal categorical data between the groups were compared using the Chi-squared test or Fisher's exact test, as appropriate. For non normally distributed continuous variables, the Mann-Whitney U test was used for comparison. For all statistical tests, a p-value <0.05 was taken to indicate a significant difference.

RESULTS

Of the 107 subjects (54 males and 53 females, with a mean age of 43.50±16.29 years) [Table/Fig-1], a total of 23 subjects had SSI. Gram-positive organisms were isolated from only seven cases, while a majority of 11 cases had Gram-negative organisms on culture. In the remaining five cases, there was no growth on culture.

Age (years)	n (%)
16-25	20 (18.69)
26-35	14 (13.08)
36-45	27 (25.23)
46-55	26 (24.30)
56-65	9 (8.41)
66 years and above	11 (10.28)

[Table/Fig-1]: Distribution of patients according to age (N=107).

Laparoscopic cholecystectomy was the most common procedure performed, accounting for about 39 cases (36.45%).

It was observed that serum cholesterol levels were lower in cases with SSI, but the difference was not statistically significant (p-value >0.05). Similarly, serum triglycerides, HDL and LDL levels were also higher in cases without SSI and the differences between the two groups were not statistically significant [Table/Fig-2].

Lipid profile parameters		Mean±SD		p-value (Student's t-test)
		SSI present (n=23)	SSI absent (n=84)	
Serum Triglycerides (mg/dL)		157.31±27.11	173.91±36.2	0.062
Serum HDL (mg/dL)		42.26±9.61	44.8±8.5	0.251
Serum LDL (mg/dL)		90.89±26.67	105.01±39.22	0.138
Serum Cholesterol (mg/dL)	Preoperative	164.58±39.04	184.75±49.81	0.101
	Postoperative	125.98±30.33	134.36±32.91	0.311

[Table/Fig-2]: Comparison of serum lipid profile according to the incidence of Surgical Site Infection (SSI) (N=107).

Additionally, deranged HDL levels were present in 65.22% of cases with SSI, while they were present in only 22.62% of cases without SSI. This difference was statistically significant, indicating a significant association between HDL levels and the incidence of SSI [Table/Fig-3].

Lipid profile		SSI present	SSI absent	p-value (Student's t-test)
HDL	Normal (40-60 mg/dL)	8 (34.78%)	65 (77.38%)	<0.001
	Deranged	15 (65.22%)	19 (22.62%)	
LDL	Normal (<100 mg/dL)	19 (82.61%)	66 (78.57%)	0.671
	Deranged	4 (17.39%)	18 (21.43%)	
Triglycerides	Normal (<150 mg/dL)	12 (52.17%)	20 (23.81%)	0.008
	Deranged	11 (47.83%)	64 (76.19%)	
Preoperative cholesterol	Normal (<200 mg/dL)	20 (86.96%)	69 (82.14%)	0.585
	Deranged	3 (13.04%)	15 (17.86%)	
Postoperative cholesterol	Normal (<200 mg/dL)	21 (91.3%)	75 (89.29%)	0.778
	Deranged	2 (8.7%)	9 (10.71%)	

[Table/Fig-3]: Distribution of cases according to derangement of lipid profile with presence of Surgical Site Infection (SSI) (N=107).

DISCUSSION

This study highlighted that even in clean elective surgery, a significant number of patients develop SSIs. Since these patients underwent similar procedures in comparable environments, these SSIs could be attributed to patient factors. Therefore, it is crucial to identify these factors to gain a better understanding of SSIs and to reduce or eliminate the risk of SSIs associated with them.

In present study, the prevalence of SSI in surgical patients was 21.5%, which was higher than the prevalence reported by Gelaw A et al., which was 6.8% [15]. However, it was lower than the rates reported by Mekhla and Borle FR, who found a cumulative incidence rate of 39% for superficial SSI [16]. In present study, it was observed that serum cholesterol levels were lower in cases with SSI, but the difference was not statistically significant (p-value >0.05). Manjunath BD et al., found a significant association between cholesterol levels and the occurrence of SSI, with the majority of individuals with SSI having hypocholesterolemia, which was statistically significant (p-value <0.001). The factors associated with the development of superficial or deep SSI included hypocholesterolemia; the lowest tertile (<160 mg/dL of total cholesterol) had a rate of 34.92% (n=22) compared to 7.5% (n=9) in the normal tertile (160-240 mg/dL) and 11.4% (n=4) in the higher tertile (>240 mg/dL) [17].

Singh RK mg%; p-value=0.94 observed that the mean cholesterol levels were comparable in cases with and without SSI (155.57 vs. 156.18 mg%; p-value=0.94) [18]. The incidence of SSI was 36.4% in cases with low cholesterol levels, which was slightly higher than in cases with normal cholesterol levels (33.3%) and in cases with high levels (22.2%). However, the difference was not statistically significant (p-value=0.134) [18].

Delgado-Rodríguez M et al., observed that among lipid fractions, HDL-C and LDL-C levels showed independent, significant (p-value=0.001) and inverse relationships with length of stay and were associated with the incidence of nosocomial infections [19]. No significant association was found with total cholesterol levels. Nowshad M et al., studied whether there was an association between preoperative levels of cholesterol and postoperative SSI [20]. High cholesterol levels were found in 87 patients, with only 3 (1%) developing SSI (p-value >0.05).

Contrary to the current findings, Sodavadiya KB et al., reported a strong correlation between cholesterol levels and the occurrence of SSI, with the majority of SSI patients having hypocholesterolemia and this correlation was statistically significant (RR=3.98, CI=2.28 to 6.95, p-value=0.001) [21].

Canturk NZ et al., found an association between low HDL-C levels and nosocomial infections, such as surgical site and pulmonary infections (p-value <0.05 in both) [22].

Limitation(s)

The study could have been more inclusive with a larger sample size and a longer duration to enhance its relevance.

CONCLUSION(S)

Present study analysis suggested that individuals with hypocholesterolemia are more likely to develop SSI; however, the association between serum cholesterol levels and SSI results was not statistically significant. Serum HDL has emerged as a valuable prognostic indicator for SSI following elective clean surgery, underscoring the importance of assessing and optimising its levels before surgery in all cases.

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