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Original Research Article

Evaluation of serum cholesterol and serum albumin level as a risk factor for developing surgical site infections following elective surgery – A hospital based cross-sectional study

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ABSTRACT

Introduction: Surgical site infections (SSI) are an important global public health problem and accounting for 22% of nosocomial infections. Globally surgical site infections (SSIs) lead to longer hospital stays and limiting the potential benefits of surgical interventions, increasing mortality risks and costs of patient.
Objective: To determine if preoperative total cholesterol and serum albumin levels are associated with increased risk of surgical site infections and mortality.
Materials and Methods: 100 Cases were selected from the patients who got admitted to department of General Surgery, V.S.S. Medical College and hospital (VIMSAR), Burla for major elective surgery between November 2020 to October 2022. The study is an observational cross sectional study.
Pre-operative serum albumin and serum cholesterol were estimated and any surgical site infection was noted following surgery. Association between serum albumin and serum cholesterol with SSI were evaluated by Chi-square test and independent sample T test using SPSS software.
Results: Out of 100 cases, 16 cases developed SSI. Most of the cases developing SSI had serum albumin level < 3.5 g/dl. The surgical site infections (SSIs) rate decreased as serum albumin levels increased. Association of SSI decreased in malignancy as serum albumin levels improved. SSI were more seen in cases having serum cholesterol levels ≤ 159 mg/dl.
Conclusion: Pre-operative evaluation of serum albumin and serum cholesterol should be done on a routine basis as nutritional assessment factors, so that SSI can be prevented by improving the albumin and cholesterol levels.

1. Introduction

Surgical site infection (SSI) is defined as infections that occur at or near surgical incision within 30 days of operation or after 1 year if an implant is placed, and the infection appears to be related to the operative procedure. [1]

The surgical wound encompasses the area of the body, internally and externally, that involves the entire operative site. Surgical site infections(SSI) is the 3^{rd} most commonly reported infection accounting for 14-16% of all health care associated infections among hospitalized patients. [2]

Malnutrition has links with serious complications, but as many as 50% of cases of pre-existing malnutrition are unrecognized in the hospital population, with a reasonable explanation being that observable signs of malnutrition appear only in extreme cases.

Cholesterol is an essential component of cell membranes, of brain, nerve cells, and of bile, which helps the body absorb fats and fat soluble vitamins. The levels of cholesterol, its fractions (high-density lipoprotein

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cholesterol [HDL-C] and low-density lipoprotein cholesterol [LDL-C]), and serum albumin reflect nutritional status and are related to onset of surgical site infection.

The serum albumin level is the most readily available and clinically useful parameter. A serum albumin level greater than 3.5 g/dl suggests adequate protein reserves and it offers a protective effect with decrease risk of morbidity and SSIs incidence.[3]

2. Aim

To determine if preoperative total cholesterol and serum albumin levels are associated with increased risk of surgical site infections and mortality.

3. Objective

To study the relationship between serum cholesterol and serum albumin with surgical site infection in patients undergoing elective surgery

4. Materials and Methods

4.1. Source of data

Patients admitted to department of General Surgery, V.S.S. Medical College and hospital, Burla for major elective surgery between November 2020 to October 2022.

The study is an observational cross sectional study.

Sample size = 100 (0ut of which Male = 54, and Female = 46).

4.2. Inclusion criteria

1. Patients who were admitted for any major elective surgery under the department of surgery in V.S.S. Medical college, Burla

4.3. Exclusion criteria

1. Children <12 years.
2. Patients who have icterus, severe anemia < 7gm/dl, diabetes mellitus, HTN, chronic renal disease, and patients on steroids.
3. Patients presenting with diffuse peritonitis.
4. Patients undergoing emergency procedures such as hollow viscous perforation, volvulous.

4.4. Method of collection of data

1. Details of cases was recorded including history, clinical examination, demographic profile and all routine investigation mainly serum protein and serum cholesterol profile.
2. The study design was approved by the Institutional Ethics Committee of VIMSAR, Sambalpur, Odisha constituted as per ICMR guidelines (IECo No - 120/2022)

Total serum Albumin were classified in 3 categories -
Hypoalbuminemia - < 3.5
Normal - 3.5 - <5.5
Hyperalbuminemia - >5.5

Total cholesterol levels were classified into three categories according (<159, 160-239, and >240 mg/dl).

Antibiotic prophylaxis of Inj. Ceftriaxone 1g i.v. was given half an hour before the skin incision and repeated after 6 hours and 12 hours. Strict aseptic precautions were taken during pre and post-operative period. Operative wounds were examined on the second, fifth and eighth postoperative days for signs of surgical site infections (any discharge, leak, dehiscence)

4.5. Statistical analysis

1. Data collected was entered as master chart into MS-Excel spread sheet. Categorical / Nominal variables were summarized as number.
2. Continuous variables were summarized as mean and standard deviation.
3. Chi-square test was used determine the association between variables and outcome (SSI).
4. Student T test was used to compare the means of the variables between the patients who developed SSI and the patients who didn't develop SSI.
5. A p value ≤0.05 was taken as statistically significant.
6. All statistical analysis was done using "SPSS" programme software

5. Results

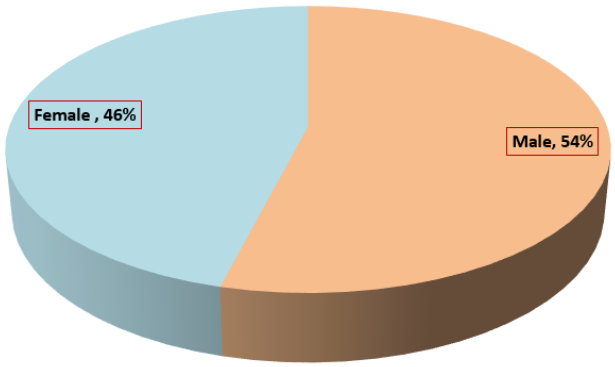

Figure 1: Sex distribution

Figure 1 Ratio of males to females - It comprises 54% males and 46% females. Out of the 100 patients 54 are males and 46 are females. Out of 100 patients 16 developed surgical site infection.

Table 1 shows - 28% of the patients were between 15 to 30 years, 35% were between 30-50 years, 32% were

Table 1: Age distribution of the study population

Age (years)	15-30	30-50	50-70	>70
SSI	5	**3**	7	1
No SSI	23	32	25	4
Total	28	35	32	5

Value - 049

between 50-70 years and 5% of the population were > than 70 years.

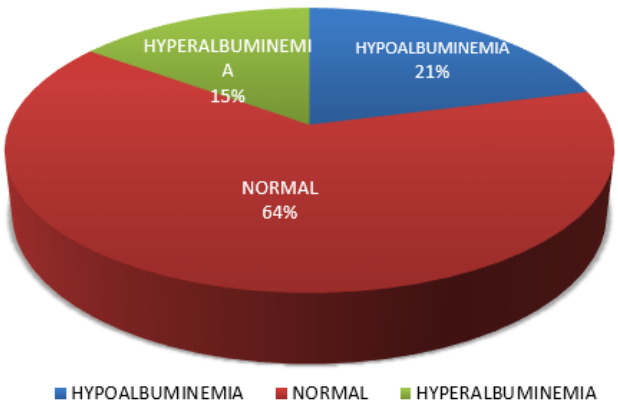

Figure 2: Serum albumin distribution in study population

Figure 2 Out of 100 patients - 15, 21, and 64 patients have hyperalbuminemia, hypoalbuminemia, and normal protein level respectively.

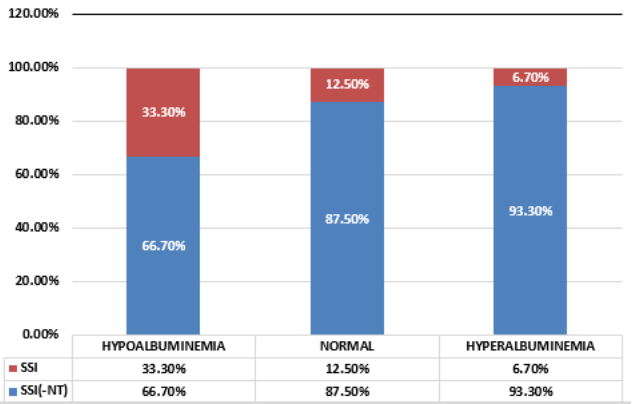

Figure 3: Serum albumin – Comparison of SSI vs No SSI

Table 5 shows out of the 31 patients with hypocholesterolemia, 32.3% developed SSI sparing 67.7%. Out of the 52 patients with normal cholesterol levels only 7.7% developed SSI and rest 92.3% had no SSI. Out of the 17 cases with cholesterol levels ≥ 240, 11.8% developed SSI sparing 88.2%. Percentage of cases having SSI is more in hypocholesterolemia group. Chi-square test

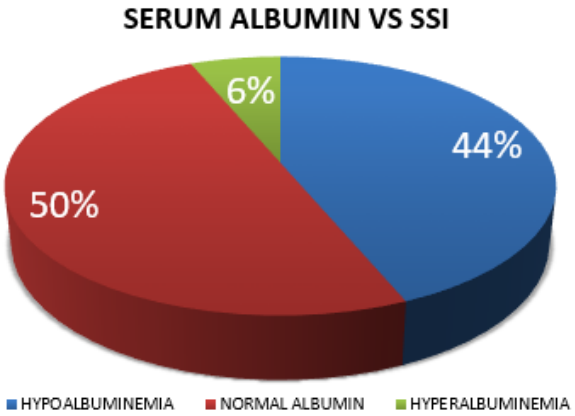

Figure 4: Serum albumin vs SSI

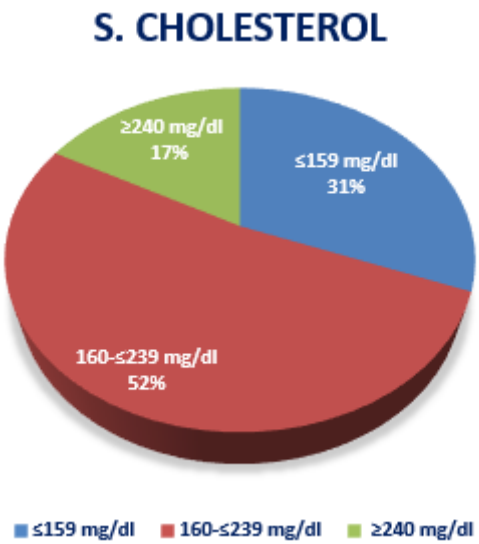

Figure 5: Serum cholesterol distribution in study population

of independence was done to test the association between serum cholesterol levels and SSI and the test was found to be significant. (p value - .011) suggesting different levels of serum cholesterol have relation with outcome.

Table 2, Figures 3 and 4 21% had hypoalbuminemia, 64% had albumin within normal limits and rest 15% had hyperalbuminemia.16 patients developed SSI and out of them 43.8% had hypoalbuminemia, 50 % of them had albumin within normal limits and rest 6.3% had albumin more than 5.5. 84 patients didn't develop SSI and out of them 16.7 % had hypoalbuminemia, 66.7% had albumin within normal limits and the rest 16.7% had albumin more than 5.5 mg/dl·Out of the 21 patients with hypoalbuminemia, 33.33 % of them developed SSI sparing 67.3%. Out of the 64 patients having normal range of albumin, only 12.5% suffered from SSI. Out of the 15

Table 2: SSI in relation to serum albumin

Serum albumin	SSI(+ve)	SSI(-ve)	Total
Hypoalbuminemia (< 3.5 G/DL)	7 (33.3%)	14(66.7%)	21
NORMAL (3.5 - < 5.5 G/DL)	8 (12.5%)	56(87.5%)	64
Hyperalbuminemia (≥5.5 G/DL)	1(6.7%)	14(93.3%)	15
Total	16	84	100

Table 3: Independent sample t test for the mean albumin in both group

SSI	N	MEAN ± S.D (of albumin)	T test for equality of means
Present	16	3.069 ± 1.19	T Value - 3.145
Absent	84	4.074 ± 1.16	Df - 98
Total	100		P Value- .002

Table 4: SSI vs serum albumin vs Malignant and non-malignant cases

D isease	Serum albumin(g/dl)	SSI	SSI (-NT)	Total
	<3.5 g/dl	4(40%)	6(60%)	10
Malignant	3.5 - <5.5 g/dl	1(5.8%)	16(94.2%)	17
	≥ 5.5 g/dl	NIL	1(100%)	1
	<3.5 g/dl	3(27.28%)	8(72.72%)	11
Non-malignant	3.5 - <5.5 g/dl	7(14.8%)	40(85.2%)	47
	≥ 5.5 g/dl	1(7.1%)	13(92.9%)	14
Total		16	84	100

Table 5: Serum cholesterol relation to SSI

Serum Cholesterol (mg/dl)	SSI (+VE)	SSI (-VE)	Total	Chi – square
Hypocholesterolemia (≤159 mg/dl)	10(32.3%)	21(67.7%)	31	(X^2) - 8.994
Normal cholesterol (160 mg/dl - ≤239 mg/dl)	4(7.7%)	48(92.3%)	52	Df = 2
Hypercholesterolemia (≥240 mg/dl)	2(11.8%)	15(88.2%)	17	P value = .011
Total	16	84	100	

Table 6: Independent sample t test for the mean cholesterol in both groups.

SSI	N	Mean ± S.D (of cholesterol)	T test for equality of means
Present	16	139.87 ± 49.48	T Value- 3.729
Absent	84	181.95 ± 39.7	P Value- .001
Total	100		

Table 7: SSI vs serum cholesterol vs Malignant and Non-malignant cases

Disease	Serum cholesterol (mg/dl)	SSI	SSI (-NT)	Total
	≤ 159 mg/dl	4(44.4%)	5(55.6%)	9
Malignant	160 - ≤ 239 mg/dl	1(7.7%)	12(92.3%)	13
	≥ 240 mg/dl	NIL	6(100%)	6
	≤ 159 mg/dl	6(27.28%)	16(72.72%)	22
Non-malignant	160 - ≤ 239 mg/dl	3(7.7%)	36(92.3%)	39
	≥ 240 mg/dl	2(18.1%)	9(81.9%)	11
Total		16	84	100

patients having albumin more than or equal to 5.5 mg/dl, only a mere 6.7 % of them had SSI.

Table 3 shows Mean value of serum albumin in patients suffering from SSI is found to be (M = 3.069) and standard deviation is (S.D = 1.19). Mean value of serum albumin in patients who had no surgical site complications was found to be (M = 4.074) and standard deviation was (S.D = 1.16). From these above statistics we can say that the mean value of serum albumin for SSI was on a lower side as compared to mean of serum albumin in patients having no SSI. Mean difference between both the groups is 1.005 and to test the statistical significance of the difference, independent sample t test was done. "t" value was 3.145 and "p" value was .002. In our study we have taken CI as 95% and "p" as 0.05. As the "p" value is < .05 implying the difference in means to be statistically significant.

Table 4 shows a comparison was done between the malignant and non-malignant (hernia, hydrocele, cholelithiasis) cases with different serum albumin levels and their association with SSI. Out of 28 malignant cases, 10 cases had serum albumin <3.5g/dl and out of them 40% developed SSI. 17 cases had normal serum albumin levels and out of them 15.8% developed SSI. And 1 case had serum albumin ≥5.5g/dl with no record of any SSI. The SSI rate declined significantly as there was increase in serum albumin. This was found to be significant between the cases developing SSI below 3.5g/dl and >3.5 g/dl. (p value-.022). It implies that in malignant cases as the serum albumin level increases the SSI rate decreases.

In non-malignant cases, 11 cases had serum albumin <3.5g/dl and out of them 27.28% developed SSI. 47 cases had normal serum albumin levels, 14.8% developed SSI.14 cases have albumin levels ≥5.5 g/dl, and only 7.1% developed SSI. SSI rate decreased as the serum albumin levels increased.

Figure 5 out of 100 patients - 17, 31, and 52 patients have hypercholesterolemia, hypocholesterolemia, and normal cholesterol level respectively.

16 patients developed SSI. Out of them 10(32.3%) have hypocholesterolemia, 4(7.7%) of them have cholesterol within normal limits and rest 2(11.8%) have hypercholesterolemia.

Table 6 shows Mean value of serum cholesterol in patients suffering from SSI is found to be (M = 139.87) and standard deviation is (S.D = 49.48). Mean value of serum cholesterol in patients who had no surgical site complications was found to be (M = 181.95) and standard deviation was (S.D = 39.7). From these above statistics we can say that the mean value of serum cholesterol for SSI was on a lower side as compared to mean of serum cholesterol in patients having no SSI. Mean difference between both the groups is 42.08 and to test the statistical significance of the difference, independent sample t test was done. "t" value was 3.729 and "p" value was .001. In our study we have taken CI as 95% and "p" as 0.05. As the "p" value is < .05 implying the result to be statistically significant for the patients with hypocholesterolemia.

Table 7 shows a comparison was done between the malignant and non-malignant (hernia, hydrocele, cholelithiasis) cases with different serum cholesterol levels and their association with SSI. Out of 28 malignant cases, 9 cases had serum cholesterol ≤ 159 mg/dl and out of them 44.4% developed SSI. 13 cases had normal serum cholesterol levels and out of them 7.7% developed SSI. And 6 cases had serum cholesterol 160 - ≤ 239(mg/dl) with no record of any SSI. The SSI rate was significantly more with serum cholesterol ≤ 159 mg/dl. This was found to be significant between the cases developing SSI below ≤ 159 mg/dl and > 159 mg/dl. (p value-.011) in malignant cases.

In non-malignant cases, 22 cases had serum cholesterol ≤ 159 mg/dl and out of them 27.28% developed SSI. 39 cases had normal serum cholesterol levels, 7.7%% developed SSI.11 cases have cholesterol levels ≥ 240 mg/dl, and only 18.1% developed SSI. The relation between serum cholesterol and SSI in non-malignant cases was found to be insignificant. (p value - .06).

6. Discussion

Surgical site infections are the third most common complication noted in the postoperative period.[4] The overall incidence of SSI in present observation study was 16%, which not similar to Kumar A et al. in 2017 (12.5% SSI rate) and Tang M D et al. (3% SSI rate).[4–6] The higher SSI rates observed in our study could be attributed to the poor preoperative nutritional status of patients thereby increasing the morbidity and risk of postoperative complications.

The mean age of patients who developed SSI in present study was 44.12 years, with 44% patients belonging to the 50-70 years age group? Among the patients who developed SSI, 50% were males and 50%were females. The major proportion of patients enrolled in the study also belong to male group. Increasing age has been observed as a risk factor for the development of SSI by several studies.[7] Male gender has been recorded as an independent risk factor for SSI in patients undergoing gastrointestinal and general surgical procedures.[8]

The observed results of gender relationship with SSI however were variable in different types of surgeries, with female preponderance being noted in some.[9] The gender differences noted in the development of SSI in previous studies may be partly due to the gender-related risk factors contributing to the same.[10] In present study, chi-square test confirmed no significant association between SSI and various age groups and gender.

Preoperative hypoalbuminemia (Serum Albumin level) is significantly associated with development of SSIs and post-operative complications according to Gibbs et al" (< 2.1 g/dl), Foley et al" (< 2.5 g/dl) , Baghetto et al" (< 3.5 g/dl) ,

Lohsiriwat V et al" & Hennessey DB et al" (< 3.5 g/dl), Lin MYet al" (< 3.2 g/dl).[11–18]

In present study, 21% of the total study population had serum albumin levels < 3.5 g/dl. Chi-square test of independence showed significant association between serum albumin levels and SSI (p value - .044) at CI 95%. Mean albumin of patients suffering from SSI was 3.069 ± 1.19 and the mean albumin of patients who had no SSI was 4.074 ± 1.16. Clearly, mean albumin level is on a lower side in cases of SSI. To test the significance of the means, independent sample t test was done, and found to be significant. (p value- .002). So, hypoalbuminemia has significant association with SSI.

Considering the malignant diseases, as the serum albumin level increases the complication rate decreases which was statistically significant. Mean value of serum albumin in malignant cases was 3.34 ± 1.34, whose association was statistically significant (p value - .001). Significant association was also found in cases of non-malignant cases.

Preoperative Serum total cholesterol level is significantly associated with development of SSIs according to Morimoto M et al" (< 160 mg/dl), & Delgado-Rodriquez et al" (< 102 mg/dl and > 290 mg/dl).[19,20]

Low total serum cholesterol may contribute to the development of infections. There are a number of different potential mechanisms by which increased lipid levels could be beneficial. First, an increase in serum lipid levels may result in enhanced delivery of lipids to cells that are activated during the immune response and for the cells involved in tissue repair. Second, due to all classes of lipoproteins bind to endotoxins**.** Moreover, this binding could protect from the toxic effects of lipopolysaccharide.[21–23] Third, lipoproteins also bind a variety of viruses blocking their cytopathic effects.[24,25] Fourth, specifically high density lipoprotein induce the lysis of the parasite Trypanosoma bruceii.[26] Fifth, circulating cholesterol-rich lipoproteins and triglyceride-rich lipoproteins have the capacity to bind and detoxify bacterial lipopolysaccharide (LPS).[27] HDL has been shown to compete with LPS binding protein (LBP) for binding to LPS. The LPS-LBP complex attaches to the CD-14 receptor on cells, which, in turn, stimulates TNF production.[28] Sixth, in vitro and in vivo models of endotoxemia in rodents have shown that lipoproteins, such as LDLs, VLDLs, HDLs, lipoprotein, triglycerides, and chylomicrons, can modulate the bioactivity of LPS.[27,29] Lastly, cholesterol is the precursor of five major classes of steroid hormones. Cholesterol affects gluconeogenesis and immune function; its transport forms, the lipoproteins, also serve as vehicles for fat-soluble vitamins, antioxidants, drugs, and toxins. The steroidogenic tissues (e.g. adrenal, gonad) are unique in that they require cholesterol not only for membrane biogenesis, maintenance of membrane fluidity, and cell signaling but also as the starting material for the biosynthesis of steroid hormones.[30,31] This explains, hypocholesterolemia as a risk factor for nosocomial infections ,especially SSI.

In present study, 31% of the study population had hypocholesterolemia, 52% have cholesterol within normal limits and remaining 17% above 240 mg/dl levels. Out of the 31% of patients having cholesterol levels below 159 mg/dl, 32.3% suffered from SSI. Out of the 52%, only 7.7% suffered from SSI. More percentage of patients suffering from SSI have hypocholesterolemia. Chi-square test for relation between cholesterol levels and SSI was significant. [p value - .011]. Mean cholesterol level for patients suffering from SSI was 139.87± 49.48 and mean cholesterol for patients having no SSI was 181.95 ± 39.7. The difference between these means found to be significant using independent sample T test.[P value - .001]. So, hypocholesterolemia has significant association with SSI.

No, significant association was observed between serum cholesterol levels and malignant and non-malignant diseases. [P value - .7].

7. Conclusion

Hypoalbuminemia is associated with more cases of SSI and the relation is proved to be significant. Same is the scenario for serum albumin in case of malignant and non-malignant cases, serum albumin proving to be a decisive factor for SSI in both these cases. Pre-operative assessment of serum albumin can be beneficial in order to prevent SSI.

The correlation between serum cholesterol levels and SSI was statistically significant and hypocholesterolemia is associated with increased risk of SSI. Pre-operative evaluation of serum cholesterol can lead to significant decrease in SSI, especially in a malnourished population

8. Ethical Approval

Taken from Institutional Ethical Commettee, VIMSAR.

Sambalpur (IECo No. - 120/2022/I-S-T/108/Dated 17.05.2022).

9. Source of Funding

None.

10. Conflict of Interest

None.

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