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Correlation between Preoperative Serum Albumin and Postoperative Surgical Site Infection in Exploratory Laparotomy: A Retrospective Observational Study

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Conflicts of Interest: Nil

Abstract

Background: Preoperative serum albumin is a well-recognized marker that reflects both the nutritional reserve and systemic inflammatory state of a patient. Hypoalbuminemia is often indicative of poor nutritional status, chronic illness, or ongoing inflammation, all of which adversely affect tissue repair, immune function, and overall surgical resilience. In surgical practice, serum albumin has been shown to be an important predictor of postoperative morbidity and mortality, particularly in major abdominal surgeries. Exploratory laparotomy, a commonly performed emergency and elective abdominal procedure, carries a significant risk of postoperative complications such as surgical site infection (SSI), prolonged hospital stay, wound dehiscence, and mortality. Identifying reliable preoperative biochemical predictors of these complications can improve risk stratification and patient optimization before surgery.

Objective: This study aims to assess the correlation between preoperative serum albumin levels and postoperative SSI in patients undergoing exploratory laparotomy. The sample size of 53 was derived from prior literature, specifically the study by Hennessey et al. (2010), which demonstrated that preoperative hypoalbuminemia is an independent risk factor for surgical site infection following gastrointestinal surgery[1]. By applying similar clinical parameters in an Indian tertiary care setting, this study seeks to validate and contextualize those findings for the local population.

Methods: A retrospective observational study was conducted in the Department of General Surgery, ESIC PGIMSR and MH, Bengaluru, over a two-year period from October 2023 to October 2025. The study included 53 patients who underwent exploratory laparotomy for various elective and emergency abdominal conditions. Data were retrieved from medical records, operative notes, and postoperative follow-up documentation. Patients were divided into two groups based on preoperative serum albumin levels: Group A ($\geq$3.5 g/dL, normoalbuminemic) and Group B (<3.5 g/dL, hypoalbuminemic). Postoperative outcomes were analyzed in terms of surgical site infection as defined by CDC criteria. Sample size was calculated based on Hennessey et al. (2010), assuming SSI rates of approximately 9% in

normoalbuminemic and 50% in hypoalbuminemic patients, requiring a minimum of 23 patients per group (total n = 46) to achieve 90% power at a 5% significance level. The final sample size was increased to 53 patients to account for potential missing data.

Results: A total of 53 patients were included in the study. The mean preoperative serum albumin was significantly lower among patients who developed SSI compared to those without infection (3.15 g/dL vs. 3.75 g/dL; p = 0.00009). Patients with hypoalbuminemia (<3.5 g/dL) had a significantly higher incidence of SSI (74.1%) compared to those with normal albumin levels (42.3%). The association between albumin group and SSI was statistically significant (χ^2 = 6.07, df = 1, p = 0.0138). Logistic regression demonstrated that each 1 g/dL increase in serum albumin reduced the odds of developing SSI by approximately 55% (OR = 0.45; 95% CI: 0.27–0.75; p = 0.002).

Conclusion: Preoperative hypoalbuminemia is strongly associated with increased postoperative SSI in patients undergoing exploratory laparotomy. Serum albumin should be routinely evaluated and optimized before surgery to reduce postoperative complications and improve patient outcomes.

Keywords: Serum albumin, hypoalbuminemia, surgical site infection, exploratory laparotomy, postoperative complications, nutritional status

Introduction

Exploratory laparotomy remains a cornerstone procedure in the diagnosis and management of intra-abdominal pathologies, ranging from traumatic injuries to acute inflammatory and neoplastic conditions. Despite significant advances in anesthesia, asepsis, and perioperative care, postoperative morbidity and mortality following laparotomy continue to pose a substantial clinical challenge, particularly in developing countries where late presentation and malnutrition are common. Among the various prognostic indicators evaluated for surgical risk, serum albumin has consistently emerged as one of the most reliable and cost-effective biochemical markers. Albumin, synthesized in the liver, reflects both the nutritional status and systemic inflammatory response of a patient. Hypoalbuminemia (<3.5 g/dL) often indicates poor nutritional reserve, ongoing infection, or hepatic dysfunction, all of which compromise tissue oxygenation, wound healing, and immune competence[2,3]. Consequently, low serum albumin has been associated with delayed recovery, increased incidence of surgical site infection (SSI), prolonged hospital stay, and higher mortality rates[4,5]. Multiple studies across surgical disciplines have established the prognostic value of albumin. Notably, Hennessey et al. (2010) demonstrated that preoperative hypoalbuminemia is an independent risk factor for the development of SSI in patients undergoing gastrointestinal surgery[1]. However, there remains a paucity of data focusing specifically on the Indian population, where nutritional deficiencies and delayed surgical interventions may amplify the impact of low serum albumin on postoperative outcomes.

Therefore, this study aims to evaluate the correlation between preoperative serum albumin levels and postoperative SSI in patients undergoing exploratory laparotomy at a tertiary care center in Bengaluru, India. By establishing this correlation, the study seeks to reinforce the role of serum albumin as a simple yet powerful prognostic indicator to guide preoperative optimization and improve patient outcomes.

Materials and Methods

Study Design and Setting

This retrospective observational study was conducted in the Department of General Surgery, ESIC PGIMSR and

MH, Bengaluru, over a two-year period from October 2023 to October 2025. The study protocol was approved by the Institutional Ethics Committee, and patient confidentiality was maintained throughout the study.

Study Population

The study included 53 patients who underwent exploratory laparotomy for a wide range of abdominal conditions, encompassing both elective and emergency indications such as perforation peritonitis, intestinal obstruction, blunt or penetrating abdominal trauma, and intra-abdominal sepsis.

Data Collection

Clinical data were collected from the hospital's electronic medical records, operative notes, and postoperative follow-up charts maintained in the surgical department's registry. Preoperative serum albumin levels, measured within one week before surgery, were documented for all patients. Demographic variables such as age, sex, comorbidities (e.g., diabetes mellitus, hypertension), and indication for surgery were also recorded to account for potential confounding factors.

Patient Stratification Based on preoperative serum albumin levels, the study population was stratified into two groups:

Group A (Normoalbuminemic): Serum albumin ≥3.5 g/dL

Group B (Hypoalbuminemic): Serum albumin <3.5 g/Dl

Outcome Measures

Postoperative outcomes were carefully recorded, with the primary outcome being surgical site infection (SSI) as defined by the Centers for Disease Control and Prevention (CDC) criteria[6]. All patient data were anonymized to ensure confidentiality.

Sample Size Calculation

The sample size was calculated based on data from Hennessey et al. (2010), who reported preoperative hypoalbuminemia as an independent risk factor for SSI in gastrointestinal surgery with a relative risk (RR) of 5.68[1]. Using these proportions and assuming SSI rates of approximately 9% in normoalbuminemic and 50% in hypoalbuminemic patients, a minimum of 23 patients per group (total n = 46) was required to achieve 90% power at a 5% significance level (two-sided test). To compensate for potential missing or incomplete data, the final sample size was increased to 53 patients.

Statistical Analysis

Descriptive statistics were calculated for demographic and clinical variables. Continuous variables were expressed as mean ± standard deviation, and categorical variables were expressed as frequencies and percentages. The chi-square test was used to assess the association between albumin groups and SSI. Logistic regression analysis was performed to evaluate the independent effect of serum albumin on the odds of developing SSI. A p-value of <0.05 was considered statistically significant. All statistical analyses were performed using appropriate statistical software.

Results Demographic Characteristics

A total of 53 patients were included in the study. The mean age of the patients was 44.8 ± 13.6 years, ranging from 19 to 72 years. There was a male predominance (64.1%), with 34 males and 19 females included in the study. The distribution of age and gender between the normal albumin (≥3.5 g/dL) group and the hypoalbuminemia (<3.5 g/dL) group did not show any statistically significant difference (p > 0.05), indicating that both groups were demographically comparable.

Indications for Laparotomy

The most common indication for laparotomy was perforation peritonitis (41.5%), followed by intestinal obstruction (26.4%), abdominal trauma (18.9%), and malignant or infectious pathology (13.2%).

Albumin Level Distribution

Among the 53 patients, 27 patients (50.9%) had low albumin levels (<3.5 g/dL), while 26 patients (49.1%) had normal albumin levels (≥3.5 g/dL), demonstrating a nearly equal distribution between the two groups.

Albumin Level Distribution Among Patients
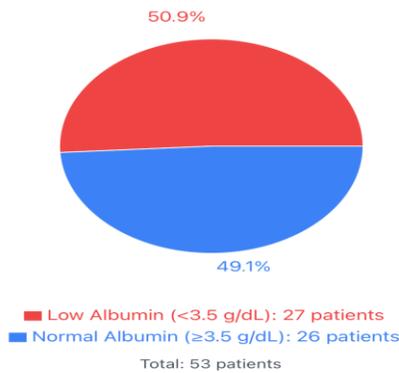
Preoperative Serum Albumin and SSI

The mean preoperative serum albumin was significantly lower among patients who developed SSI compared to those without infection (3.15 g/dL vs. 3.75 g/dL; p = 0.00009). This highly significant difference underscores the association between lower albumin levels and increased risk of postoperative infection.
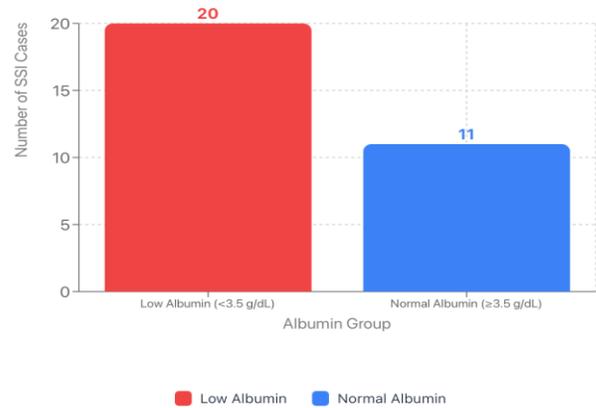
SSI Rate by Albumin Group (%)
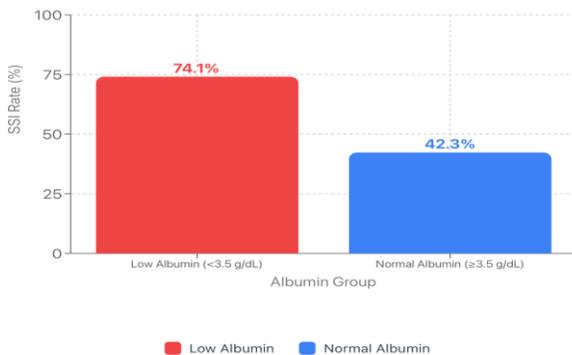
Incidence of SSI by Albumin Group

Patients with hypoalbuminemia (<3.5 g/dL) had a significantly higher incidence of SSI (74.1%, 20 out of 27 patients) compared to those with normal albumin levels (42.3%, 11 out of 26 patients). The association between albumin group and SSI was statistically significant (χ^2 = 6.07, df = 1, p = 0.0138).

SSI Count by Albumin Group

Logistic Regression Analysis

Logistic regression demonstrated that each 1 g/dL increase in serum albumin reduced the odds of developing SSI by approximately 55% (OR = 0.45; 95% CI: 0.27–0.75; p = 0.002). This finding confirms that preoperative serum albumin is an independent predictor of SSI following exploratory laparotomy.

Correlation Analysis

A point-biserial correlation analysis revealed a negative correlation between serum albumin levels and the occurrence of SSI (r = -0.34), further supporting the inverse relationship between albumin levels and postoperative infectious complications.

Discussion

This study demonstrates that preoperative hypoalbuminemia is a significant predictor of postoperative morbidity in patients undergoing exploratory laparotomy. Patients with serum albumin levels below 3.5 g/dL had a markedly higher incidence of

surgical site infection (SSI) compared to those with normal albumin levels (74.1% vs. 42.3%). This association was statistically significant (χ^2 = 6.07, p = 0.0138), reinforcing the role of serum albumin as a clinically meaningful risk factor. The mean preoperative albumin level was also significantly lower in patients who developed SSI (3.15 g/dL) compared to those without infection (3.75 g/dL), with a highly significant difference (p = 0.00009). Logistic regression analysis further confirmed that each 1 g/dL increase in albumin reduced the odds of SSI by 55% (OR = 0.45, p = 0.002). These findings highlight albumin as an independent and measurable predictor of adverse postoperative outcomes.

Biological Rationale

The biological rationale behind this association is well established. Albumin reflects a combination of nutritional status, hepatic protein synthesis, and inflammatory activity. Hypoalbuminemia leads to impaired collagen formation, decreased fibroblast activity, reduced oxygen delivery to tissues, and altered immune responsiveness[7,8]. Additionally, reduced oncotic pressure in hypoalbuminemic patients promotes tissue edema, compromising microcirculation and impairing wound healing[9]. These mechanisms collectively increase susceptibility to infection and wound-related complications, consistent with the strong negative point-biserial correlation observed between albumin and SSI in this study (r = -0.34).

Comparison with Previous Literature

The present findings align with previous literature. Hennessey et al. (2010) identified hypoalbuminemia as an independent predictor of SSI in gastrointestinal surgery[1]. Similarly, Gibbs et al. (1999) and Kudsk et al. (2003) demonstrated a clear association between low albumin levels and increased postoperative morbidity, infectious complications, and prolonged recovery[2,3]. Bohl et al.

(2016) reported that hypoalbuminemia independently predicts surgical site infection, pneumonia, and mortality after major surgery[4]. The consistency between studies across diverse surgical populations underscores the reliability of albumin as a prognostic marker.

Clinical Implications

The clinical implications of these findings are substantial. Serum albumin is an inexpensive, readily available, and objective biomarker that should form an integral part of preoperative risk assessment. Correction of hypoalbuminemia through nutritional optimization, high-protein supplementation, or targeted perioperative nutritional therapy has been shown to improve postoperative outcomes[10,11]. Early identification and optimization may therefore reduce SSI rates and improve the overall prognosis of patients undergoing major abdominal surgery.

Limitations

While this study provides valuable insights, certain limitations must be acknowledged. The retrospective design may introduce selection bias and limit the ability to control for all confounding variables. Hospital stay data and mortality rates were not fully captured in the present dataset, preventing direct correlation analysis for these outcomes. Additionally, the study was conducted at a single tertiary care center, which may limit the generalizability of the findings to other healthcare settings or populations.

Future Directions

Future studies with larger, multicentric cohorts and prospective designs are warranted to further validate these findings and to establish evidence-based perioperative albumin correction protocols aimed at improving surgical outcomes and reducing morbidity. Randomized controlled trials evaluating the efficacy of preoperative nutritional interventions in hypoalbuminemic patients

would provide higher-level evidence for clinical practice guidelines.

Conclusion

Preoperative hypoalbuminemia has emerged as a strong and independent predictor of adverse postoperative outcomes in patients undergoing exploratory laparotomy. The present study demonstrates that low serum albumin levels are significantly associated with a higher incidence of surgical site infection (SSI). These findings reinforce the role of serum albumin as a simple, cost-effective, and reliable biochemical marker for preoperative risk stratification. Given its prognostic importance, routine preoperative assessment of serum albumin levels should be incorporated into the standard surgical evaluation of all patients scheduled for major abdominal procedures. Early identification of hypoalbuminemia provides an opportunity for targeted nutritional and metabolic optimization, which may improve wound healing, reduce postoperative complications, and shorten recovery time. Future studies with larger, multicentric cohorts and prospective designs are warranted to further validate these findings and to establish evidence-based perioperative albumin correction protocols aimed at improving surgical outcomes and reducing morbidity in patients undergoing exploratory laparotomy.

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