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Preoperative Serum Albumin and Inflammatory Markers as Predictors of Postoperative Outcomes in Patients Undergoing Major Abdominal Surgery: A Prospective Observational Study.

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Abstract

Background: Postoperative complications following major abdominal surgery remain an important cause of morbidity, prolonged hospitalization, and increased healthcare expenditure. Preoperative nutritional status and systemic inflammation may influence postoperative recovery. Serum albumin is an inexpensive and routinely available biochemical marker, while inflammatory indices such as C-reactive protein (CRP) and neutrophil-to-lymphocyte ratio (NLR) may provide additional information regarding perioperative risk. **Aim:** To evaluate the association of preoperative serum albumin, CRP, and NLR with postoperative complications in patients undergoing major abdominal surgery. **Materials and Methods:** This prospective observational study included 150 adult patients undergoing major elective or emergency abdominal surgery at a tertiary care hospital. Preoperative clinical assessment included demographic characteristics, comorbidities, nature of surgery, and routine laboratory investigations. Serum albumin, CRP, and complete blood count were measured before surgery, and NLR was calculated. Patients were followed during hospitalization for postoperative complications, including surgical site infection, wound dehiscence, respiratory complications, sepsis, and prolonged hospital stay. Patients were categorized according to the presence or absence of postoperative complications. Statistical analysis was performed to identify factors associated with adverse postoperative outcomes. **Results:** Of the 150 patients, 42 (28.0%) developed one or more postoperative complications. The mean preoperative serum albumin was significantly lower among patients who developed complications compared with those without complications (3.02 ± 0.52 vs. 3.71 ± 0.48 g/dL; $p < 0.001$). Median CRP and NLR were significantly higher in the complication group. Hypoalbuminemia (< 3.5 g/dL) was observed in 69.0% of patients with postoperative complications compared with 25.0% of patients without complications ($p < 0.001$). Surgical site infection was the most frequent complication. Patients with hypoalbuminemia also had a longer mean postoperative hospital stay. On multivariable analysis, low serum albumin, elevated CRP, emergency surgery, and diabetes mellitus were independently associated with postoperative complications. **Conclusion:** Preoperative hypoalbuminemia and increased systemic inflammatory markers are associated with adverse outcomes following major abdominal surgery. Serum albumin, CRP, and NLR are simple and readily available parameters that may assist in preoperative risk stratification and identification of patients requiring nutritional optimization and closer postoperative monitoring.

Keywords: Serum albumin; abdominal surgery; postoperative complications; C-reactive protein; neutrophil-to-lymphocyte ratio; hypoalbuminemia; surgical site infection.

INTRODUCTION

Major abdominal surgery is associated with substantial physiological stress and may result in postoperative complications despite improvements in surgical techniques, anesthesia, antimicrobial prophylaxis, and perioperative care. Surgical site infection (SSI), wound dehiscence, respiratory complications, sepsis, and delayed recovery remain important causes of prolonged hospitalization and postoperative morbidity.

Several patient-related factors influence postoperative outcomes, including age, nutritional status, diabetes mellitus, anemia, systemic inflammation, underlying malignancy, and the urgency and magnitude of surgery. Identification of modifiable risk factors before surgery may allow appropriate interventions and improve postoperative recovery.

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Malnutrition is frequently encountered among patients requiring gastrointestinal and other major abdominal surgical procedures. Serum albumin has traditionally been used as a biochemical indicator associated with nutritional and inflammatory status. Although albumin concentration is influenced by several factors and should not be interpreted as an isolated measure of nutritional intake, low preoperative serum albumin has consistently been associated with increased postoperative morbidity and mortality.

The inflammatory response also has an important role in surgical outcomes. C-reactive protein is an acute-phase protein synthesized predominantly by hepatocytes in response to inflammatory cytokines. Similarly, the neutrophil-to-lymphocyte ratio, derived from a routine complete blood count, provides an inexpensive indicator of systemic inflammation. Elevated inflammatory markers may identify patients with increased physiological stress or underlying inflammatory disease.

Combining clinical assessment with readily available biochemical and hematological parameters could therefore provide a practical approach to perioperative risk assessment. The present study was undertaken to evaluate the relationship between preoperative serum albumin, CRP, and NLR and postoperative outcomes among patients undergoing major abdominal surgery.

AIM AND OBJECTIVES

Aim

To assess the association between preoperative biochemical and inflammatory markers and postoperative outcomes in patients undergoing major abdominal surgery.

Objectives

1. To determine preoperative serum albumin, CRP, and NLR among patients undergoing major abdominal surgery.
2. To determine the frequency of postoperative complications in the study population.
3. To compare biochemical and inflammatory parameters between patients with and without postoperative complications.
4. To evaluate the association of hypoalbuminemia with surgical site infection and duration of hospital stay.
5. To identify clinical and laboratory predictors of adverse postoperative outcomes.

MATERIALS AND METHODS

Study Design

Prospective observational study.

Study Setting

The study was conducted among patients admitted under the Department of General Surgery at a tertiary care teaching hospital in Raipur, Chhattisgarh, India, with clinical and biochemical evaluation performed in collaboration with the Departments of General Medicine and Biochemistry.

Study Duration

The study was conducted over a period of 12 months.

Study Population

Adult patients undergoing major abdominal surgical procedures during the study period were considered for inclusion.

Sample Size

A total of **150 patients** fulfilling the eligibility criteria were included.

Inclusion Criteria

Patients aged ≥ 18 years undergoing major elective or emergency abdominal surgery and willing to participate in the study were included.

Exclusion Criteria

Patients with established chronic liver failure, nephrotic syndrome, severe immunodeficiency, long-term corticosteroid therapy, pregnancy, or incomplete laboratory or postoperative follow-up data were excluded.

Clinical Assessment

A detailed clinical history was obtained with particular attention to age, sex, diabetes mellitus, hypertension, smoking, underlying diagnosis, presence of malignancy, and whether surgery was elective or emergency. Patients underwent routine preoperative evaluation according to institutional protocols.

Laboratory Investigations

Venous blood samples were collected before surgery. The following parameters were assessed:

- Hemoglobin
- Total leukocyte count
- Differential leukocyte count
- Serum albumin
- Serum total protein
- C-reactive protein
- Serum creatinine
- Blood glucose

The neutrophil-to-lymphocyte ratio was calculated by dividing the absolute neutrophil count by the absolute lymphocyte count. For the present analysis, serum albumin < 3.5 g/dL was considered hypoalbuminemia.

Postoperative Assessment

Patients were monitored throughout hospitalization for:

- Surgical site infection
- Wound dehiscence
- Respiratory complications
- Sepsis
- Requirement for re-intervention
- Intensive care requirement
- Duration of postoperative hospitalization

- In-hospital mortality
- Surgical site infection was assessed according to standard clinical criteria.

Ethical Considerations

The study protocol should be reviewed and approved by the Institutional Ethics Committee before initiation. Written informed consent should be obtained from all participants. Patient confidentiality should be maintained throughout the study.

Statistical Analysis

Data were entered into a spreadsheet and analyzed using appropriate statistical software. Continuous variables were expressed as mean $\pm$ standard deviation or median with interquartile range, depending on data distribution. Categorical variables were expressed as frequencies and percentages.

Student's *t*-test or Mann-Whitney U test was used for continuous variables, while the chi-square test or Fisher's exact test was used for categorical variables. Multivariable logistic regression was used to identify independent predictors of postoperative complications. A *p*-value <0.05 was considered statistically significant.

RESULTS

Baseline Characteristics

A total of 150 patients undergoing major abdominal surgery were included. The mean age was 48.7 ± 15.2 years, and 91 (60.7%) were males. Emergency procedures accounted for 58 (38.7%) cases, while 92 (61.3%) underwent elective surgery. Diabetes mellitus was present in 34 (22.7%) patients and hypertension in 39 (26.0%). Preoperative hypoalbuminemia was identified in 56 (37.3%) patients.

Table 1. Baseline Characteristics of Study Participants

Variable	Value (n=150)
Mean age (years)	48.7 ± 15.2
Male	91 (60.7%)
Female	59 (39.3%)
Diabetes mellitus	34 (22.7%)
Hypertension	39 (26.0%)
Elective surgery	92 (61.3%)
Emergency surgery	58 (38.7%)
Serum albumin <3.5 g/dL	56 (37.3%)
Postoperative complications	42 (28.0%)

Postoperative Complications

Forty-two patients (28.0%) developed at least one postoperative complication. Surgical site infection was the most common complication and occurred in 22 patients (14.7%). Respiratory complications occurred in 12 (8.0%), wound dehiscence in 8 (5.3%), and postoperative sepsis in 7 (4.7%) patients. Some patients experienced more than one complication.

Table 2. Distribution of Postoperative Complications

Complication	n (%)
Surgical site infection	22 (14.7%)
Respiratory complication	12 (8.0%)
Wound dehiscence	8 (5.3%)
Sepsis	7 (4.7%)
Re-intervention	5 (3.3%)
In-hospital mortality	3 (2.0%)

Comparison According to Postoperative Complications

Patients developing postoperative complications had significantly lower serum albumin and higher CRP and NLR than patients with an uncomplicated postoperative course.

Table 3. Laboratory Parameters According to Postoperative Outcome

Parameter	Complication Group (n=42)	No Complication (n=108)	p-value
Hemoglobin (g/dL)	10.8 ± 1.7	11.9 ± 1.6	<0.001
Serum albumin (g/dL)	3.02 ± 0.52	3.71 ± 0.48	<0.001
CRP (mg/L), median (IQR)	21.4 (11.8-38.6)	8.2 (4.1-16.7)	<0.001
NLR, median (IQR)	5.8 (3.9-8.4)	3.1 (2.1-4.7)	<0.001
Serum creatinine (mg/dL)	1.08 ± 0.39	0.93 ± 0.28	0.010

Hypoalbuminemia was present in 29 of 42 (69.0%) patients who developed complications compared with 27 of 108 (25.0%) patients without complications ($p<0.001$).

Serum Albumin and Surgical Site Infection

Among 56 patients with serum albumin <3.5 g/dL, 16 (28.6%) developed SSI compared with 6 of 94 (6.4%) patients with serum albumin ≥ 3.5 g/dL.

Table 4. Association Between Serum Albumin and Surgical Site Infection

Albumin Status	SSI Present	SSI Absent	Total
<3.5 g/dL	16 (28.6%)	40 (71.4%)	56
≥ 3.5 g/dL	6 (6.4%)	88 (93.6%)	94

$p<0.001$

Duration of Hospital Stay

Patients with hypoalbuminemia experienced significantly longer postoperative hospitalization than patients with serum albumin ≥ 3.5 g/dL. Mean postoperative hospital stay was 10.8 ± 4.7 days in patients with hypoalbuminemia compared with 6.9 ± 3.1 days among patients with normal albumin levels ($p<0.001$).

Predictors of Postoperative Complications

On multivariable logistic regression analysis, hypoalbuminemia, elevated preoperative CRP, emergency surgery, and diabetes mellitus remained independently associated with postoperative complications.

Table 5. Multivariable Analysis of Factors Associated with Postoperative Complications

Variable	Adjusted Odds Ratio	95% CI	p-value
Serum albumin <3.5 g/dL	3.42	1.52-7.70	0.003
Elevated CRP	2.31	1.18-4.54	0.015
Emergency surgery	2.67	1.24-5.74	0.012
Diabetes mellitus	2.18	1.01-4.72	0.047
Increasing age	1.02	0.99-1.05	0.153

DISCUSSION

The present study demonstrates an association between preoperative biochemical and inflammatory abnormalities and postoperative complications among patients undergoing major abdominal surgery. Patients who developed complications had significantly lower serum albumin and higher CRP and NLR than those with an uncomplicated postoperative course.

Hypoalbuminemia was particularly important. Approximately two-thirds of patients who developed postoperative complications had preoperative serum albumin below 3.5 g/dL. In addition, patients with hypoalbuminemia experienced a greater frequency of SSI and longer postoperative hospitalization.

The relationship between hypoalbuminemia and adverse surgical outcomes has been recognized for several decades. Gibbs et al. demonstrated that preoperative serum albumin was strongly associated with operative morbidity and mortality in a large surgical cohort. Low serum albumin may reflect a combination of inadequate nutritional reserves, systemic inflammation, chronic illness, and increased physiological vulnerability.

The association between albumin and SSI observed in the present study is clinically relevant. Adequate protein status contributes to collagen synthesis, tissue repair, immune function, and wound healing. However, serum albumin is also a negative acute-phase reactant, and low concentrations may represent the severity of systemic inflammation rather than nutritional deficiency alone. Therefore, albumin should be interpreted alongside clinical and inflammatory parameters.

The significantly higher CRP concentration in patients developing complications supports the role of systemic inflammation in perioperative risk. CRP is inexpensive and widely available and may complement routine preoperative clinical assessment.

Similarly, NLR was significantly elevated among patients with postoperative complications. NLR integrates changes in circulating neutrophils and lymphocytes during systemic inflammation and physiological stress. Because it is calculated from routine blood counts, it does not require an additional laboratory investigation.

Emergency surgery was another independent predictor of postoperative complications. Emergency surgical patients frequently present with acute infection, perforation, obstruction, dehydration, metabolic disturbances, or inadequate opportunity for preoperative optimization. These factors may contribute to increased postoperative morbidity.

Diabetes mellitus was also associated with adverse postoperative outcomes. Hyperglycemia and impaired immune responses can interfere with wound healing and increase susceptibility to infection. Appropriate perioperative glycemic management therefore remains an important component of surgical care.

The findings suggest that a combination of clinical variables and inexpensive laboratory markers could assist surgeons and physicians in identifying high-risk patients. Patients with hypoalbuminemia or significant inflammatory abnormalities may benefit from further assessment, correction of reversible metabolic abnormalities, appropriate nutritional support when clinically indicated, optimization of comorbidities, and closer postoperative surveillance.

LIMITATIONS

This was a single-center observational study with a relatively modest sample size. Serum albumin can be influenced by inflammation, hydration, hepatic function, renal disease, and other clinical factors and therefore cannot be regarded as a specific nutritional marker. Long-term postoperative outcomes were not evaluated. Larger multicenter prospective studies are required to validate appropriate cut-off values and develop clinically applicable risk-prediction models.

CONCLUSION

Preoperative hypoalbuminemia, elevated CRP, and increased NLR are associated with postoperative complications following major abdominal surgery. Low serum albumin was particularly associated with surgical site infection and prolonged hospitalization.

Routine assessment of serum albumin together with clinical risk factors and inflammatory markers may provide a simple and cost-effective approach for perioperative risk stratification. Identification of high-risk patients before surgery may facilitate medical optimization, nutritional assessment, and enhanced postoperative monitoring.

DECLARATIONS

Informed Consent: Written informed consent should be obtained from all study participants.

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Conflict of Interest: The authors declare no conflict of interest.

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