

Original Research Article

A PROSPECTIVE STUDY OF SERUM C-REACTIVE PROTEIN AND D-LACTATE LEVELS FOR EARLY PREDICTION OF STRANGULATION IN INTESTINAL OBSTRUCTION

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ABSTRACT

Background: Intestinal obstruction is a common surgical emergency, and bowel strangulation is its most serious complication. Early diagnosis of strangulation remains difficult because clinical and radiological findings are often nonspecific. Delayed recognition may result in bowel ischemia, necrosis, perforation, sepsis, and increased mortality. Serum C-reactive protein (CRP) and D-lactate have emerged as potential biomarkers for the early detection of bowel strangulation. **Aims and Objectives:** 1. To estimate serum C-reactive protein and serum D-lactate levels in patients with acute intestinal obstruction. 2. To evaluate the role of serum C-reactive protein and D-lactate, individually and in combination, as markers of bowel strangulation.

Materials and Methods: This prospective observational study was conducted at a tertiary care centre, Ajmer, from July 2024 to December 2025. Sixty patients with acute intestinal obstruction who underwent exploratory laparotomy were included. Based on intraoperative findings, patients were categorized into Group A (obstruction with strangulation, n=27) and Group B (obstruction without strangulation, n=33). Serum CRP and D-lactate levels were measured preoperatively and correlated with operative findings.

Results: Among 60 patients, 27 (45%) had strangulated obstruction and 33 (55%) had non-strangulated obstruction. The mean age was 55.63 ± 19.35 years in Group A and 46.15 ± 19.94 years in Group B ($p=0.068$). Male predominance was significantly higher in Group A (77.78%) compared to Group B (42.42%) ($p=0.006$). Obstipation was significantly associated with strangulation ($p<0.001$). Mean serum CRP level was significantly higher in Group A than in Group B (93.96 ± 23.63 mg/L vs 42.48 ± 17.68 mg/L; $p<0.001$). CRP demonstrated a sensitivity of 88.89% and specificity of 78.79%. Mean serum D-lactate level was significantly elevated in Group A compared to Group B (5.26 ± 0.80 mmol/L vs 3.34 ± 1.09 mmol/L; $p<0.001$). D-lactate showed a sensitivity of 85.19% and specificity of 84.85%. Mean total leukocyte count was significantly higher in Group A (15607 ± 3689 cells/mm³) than in Group B (9836 ± 2744 cells/mm³).

Conclusion: Serum CRP and D-lactate are valuable biomarkers for the early prediction of bowel strangulation in patients with acute intestinal obstruction. Their combined assessment improves diagnostic accuracy and may facilitate timely surgical intervention, thereby reducing morbidity and mortality.

Keywords: Acute intestinal obstruction, Bowel strangulation, C-reactive protein, D-lactate, Intestinal ischemia.

INTRODUCTION

Acute intestinal obstruction is a common surgical emergency associated with significant morbidity and mortality, particularly when complicated by bowel strangulation.^[1-3] Strangulation leads to impaired blood supply, resulting in bowel ischemia, necrosis, perforation, and sepsis if not diagnosed and treated promptly.^[4-6] Early differentiation between strangulated and non-strangulated obstruction remains challenging because clinical signs and symptoms are often nonspecific. Although radiological investigations are useful, they may not reliably detect early bowel ischemia.^[7-8] Therefore, there is increasing interest in biochemical markers that can facilitate early diagnosis.^[9] C-reactive protein (CRP), an acute-phase reactant, increases in response to inflammation and tissue injury, while D-lactate, a product of anaerobic bacterial metabolism, rises in intestinal ischemia due to mucosal damage and increased intestinal permeability. Several studies have reported elevated CRP and D-lactate levels in patients with bowel strangulation. However, their diagnostic utility in predicting strangulation has not been conclusively established. Therefore, the present study was undertaken to evaluate the role of serum CRP and D-lactate levels in the early prediction of bowel strangulation in patients with acute intestinal obstruction.

MATERIALS AND METHODS

This prospective observational study was conducted at a tertiary care centre, Ajmer, from July 2024 to December 2025.

Study population

The study was performed on 60 patients admitted in Tertiary Care Center, Ajmer with diagnosis of acute intestinal obstruction and underwent exploratory laparotomy.

Inclusion Criteria

- All patients aged 13-90 years with suspicion of acute intestinal obstruction and underwent exploratory Laparotomy in the emergency operation at Tertiary Care Center, Ajmer

Exclusion Criteria

- Patients with coexisting medical illnesses, such as chronic kidney disease, any cardiac disease, diabetes mellitus, coagulopathy, liver disorder and COPD.
- Patients with any intra-operative finding apart from simple or strangulated bowel obstruction.
- Short bowel Syndrome.

Data collection

Based on the various intra-operative finding causing acute intestinal obstruction all patients divided into two groups-

- A. Obstruction with strangulation.
- B. Obstruction without strangulation.

Blood investigation were send for serum C-reactive protein (CRP) and serum D-lactate.

Measurement of serum CRP levels

- Quantitative assessment of serum CRP was done using human CRP kit based on the principle of solid-phase enzyme-linked immunosorbent assay.
- For calculation of sensitivity and specificity cut-off value of CRP was used 60mg/L

Measurement of serum D-lactate levels

- D-lactate was estimated by using the D-lactate assay kit based on the principle of proportionate color generation as a result of oxidation of D-lactate by D-lactate dehydrogenase.
- For calculation of sensitivity and specificity cut-off value of D-lactate was used 4.5mmol/L.

Statistical Analysis

- All data were analyzed on EPI-info statistical software.
- Qualitative data was expressed in the form of proportion.
- Quantitative data was expressed in mean $\pm$ SD
- Qualitative data was compared by Chi-square test
- Unpaired t-test was used to infer the difference in means.
- For significance, following at the level of "p" value was taken

P>0.05 - Not significant

P=0.05 - Just significant

P<0.05 - Significant

P<0.001 - Highly significant.

RESULTS

Age Incidence

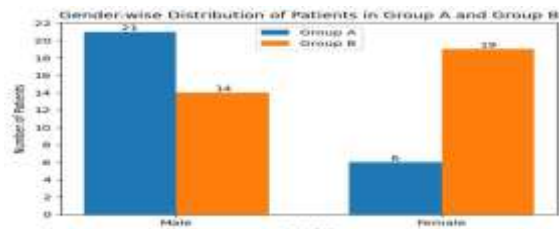
The present study demonstrated that the mean age of patients in Group A (intestinal obstruction with strangulation) was 55.63 ± 19.35 years, while in Group B (intestinal obstruction without strangulation) it was 46.15 ± 19.94 years. The difference in mean age between the two groups was not statistically significant.

Gender Wise Distribution

In Group A, 21 patients (77.78%) were males and 6 patients (22.22%) were females. In Group B, 14 patients (42.42%) were males and 19 patients (57.58%) were females. The difference in gender distribution between the two groups was found to be statistically significant. [Table 1, Graph 1]

Table 1: Gender Wise Distribution

Gender	Group A (Intestinal obstruction with strangulation)		Group B (Intestinal obstruction without strangulation)		Total
	No. of patients	Percentage	No. of patients	Percentage	
Male	21	77.78	14	42.42	35
female	6	22.22	19	57.58	25
total	27	100.00	33	100.00	60
P-value	0.006				



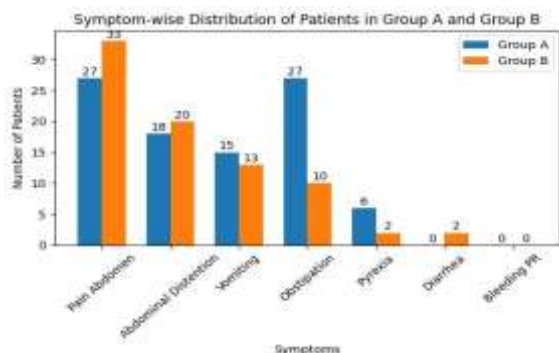
Graph 1: Gender Wise Distribution

Symptoms of Patients

The occurrence of obstipation was significantly higher in patients with strangulation compared to those without strangulation ($p < 0.001$). Other symptoms including abdominal distention, vomiting, pyrexia, and diarrhoea did not show statistically significant differences between the two groups. [Table 2, Graph 2]

Table 2: Symptoms of Patients

Symptoms	Group A (Intestinal obstruction with strangulation)		Group B (Intestinal obstruction without strangulation)		P-value
	No. of patients	Percentage	No. of patients	Percentage	
Pain abdomen	27	100.00	33	100.00	NA
Abdominal distention	18	66.66	20	60.60	0.63
Vomiting	15	55.55	13	39.39	0.22
Obstipation	27	100.00	10	30.30	<0.001
Pyrexia	6	22.22	2	6.06	0.11
Diarrhoea	0	0.00	2	6.06	0.19
Bleeding per rectum	0	0.00	0	0	NA



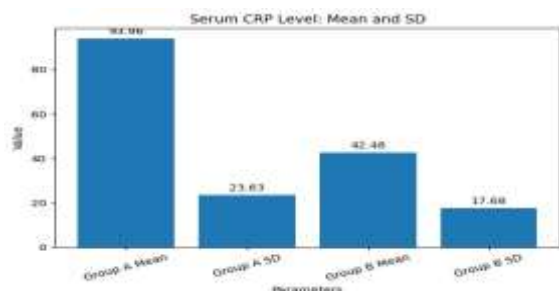
Graph 2: Symptoms of Patients

Serum C- Reactive Protein Level

The mean serum CRP level in Group A (intestinal obstruction with strangulation) was 93.96 ± 23.63 mg/L, whereas in Group B (intestinal obstruction without strangulation) it was 42.48 ± 17.68 mg/L. On applying the independent sample t-test, the difference in mean CRP levels between the two groups was found to be highly statistically significant. [Table 3, Graph 3]

Table 3: Serum C- Reactive Protein Level

	Group A (Intestinal obstruction with strangulation)		Group B (Intestinal obstruction without strangulation)	
	Mean	SD	Mean	SD
CRP level	93.96	23.63	42.48	17.68
P-value	<0.001			



Graph 3: Serum C- Reactive Protein Level

SENSITIVITY AND SPECIFICITY FOR ELEVATED SERUM C- REACTIVE PROTEIN LEVEL

In the present study, elevated serum CRP demonstrated a sensitivity of 88.89% and a specificity of 78.79% for predicting strangulation in intestinal obstruction. The positive predictive value was 77.42%, while the negative predictive value was 89.66%. On applying the Chi-square test, the association between elevated CRP levels and

strangulation was found to be highly statistically significant. [Table 4, Graph 4]

Table 4: Sensitivity and specificity for elevated serum c- reactive protein level

CRP level	Group A (Intestinal obstruction with strangulation)	Group B (Intestinal obstruction without strangulation)
Increased	24	7
Normal	3	26
Total	27	33

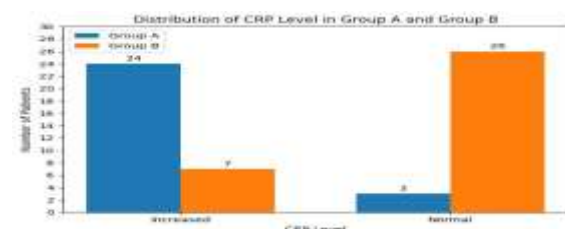
p-Value < 0.001

Sensitivity = 88.89%

Specificity = 78.79%

Positive predictive value = 77.42%

Negative predictive value = 89.66%



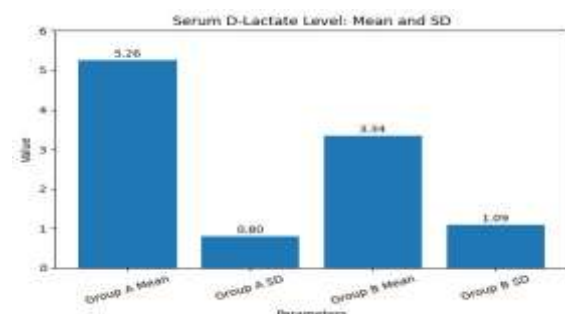
Graph 4: Sensitivity and specificity for elevated serum c-reactive protein level

Serum D- Lactate Level

The mean serum D-lactate level was significantly higher in patients with intestinal obstruction complicated by strangulation (5.26 ± 0.80) compared to those without strangulation (3.34 ± 1.09). The difference between the two groups was statistically highly. [Table 5, Graph 5]

Table 5: Serum D- Lactate Level

	Group A (Intestinal obstruction with strangulation)		Group B (Intestinal obstruction without strangulation)	
	Mean	SD	Mean	SD
Lactate level	5.26	0.80	3.34	1.09
p-value	<0.001			



Graph 5: Derum d- lactate level

SENSITIVITY AND SPECIFICITY FOR ELEVATED SERUM D-LACTATE LEVEL

The sensitivity and specificity of elevated serum D-lactate level in detecting intestinal obstruction with strangulation were 85.19% and 84.85%, respectively. The positive predictive value was 82.14%, and the negative predictive value was 87.50%. Statistical analysis using the Chi-square test demonstrated a highly significant association between elevated serum D-lactate levels and strangulation. [Table 6, Graph 6]

Table 6: Sensitivity and specificity for elevated serum d-lactate level

D-lactate level	Group A (Intestinal obstruction with strangulation)	Group B (Intestinal obstruction without strangulation)
Increased	23	5
Normal	4	28
Total	27	33

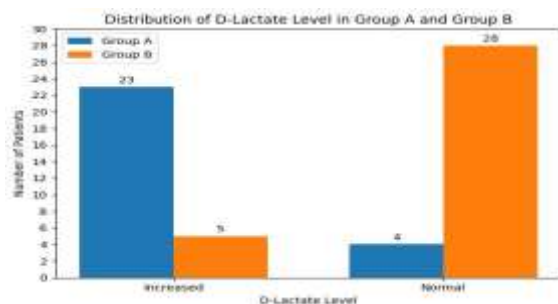
p-value < 0.001

Sensitivity = 85.19%

Specificity = 84.85%

Positive predictive value = 82.14%

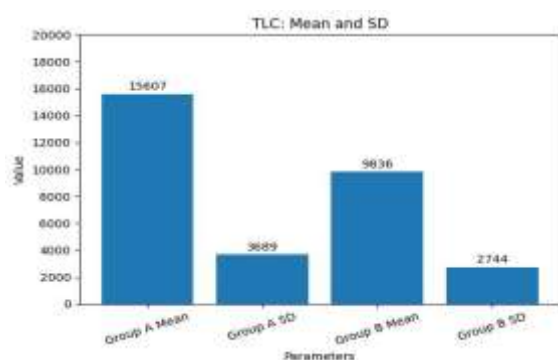
Negative predictive value = 87.50%



Graph 6: Sensitivity and specificity for elevated serum d- lactate level

Table 7: Total leukocyte count

	Group A (Intestinal obstruction with strangulation)		Group B (Intestinal obstruction without strangulation)	
	Mean	SD	Mean	SD
TLC	15607	3689	9836	2744
p-value	<0.001			



Graph 7: Total Leukocyte Count

Total Leukocyte Count

The mean Total Leukocyte Count (TLC) was markedly elevated in patients with intestinal obstruction complicated by strangulation (15607 ± 3689) compared to those without strangulation (9836 ± 2744). The observed difference between the two groups was statistically highly significant ($p < 0.001$), indicating a strong association between leukocytosis and the presence of bowel strangulation. [Table 7, Graph 7]

SENSITIVITY AND SPECIFICITY FOR ELEVATED TOTAL LEUKOCYTE COUNT LEVEL

The sensitivity and specificity of elevated Total Leukocyte Count in detecting intestinal obstruction with strangulation were 81.48% and 81.82%, respectively. The positive predictive value was 78.57%, while the negative predictive value was 84.38%. Statistical analysis using the Chi-square test demonstrated a highly significant association between elevated Total Leukocyte Count levels and strangulation. [Table 8, Graph 8]

Table 8: Sensitivity and specificity for elevated total leukocyte count level

TLC	Group A (Intestinal obstruction with strangulation)	Group B (Intestinal obstruction without strangulation)
Increased	22	6
Normal	5	27
Total	27	33

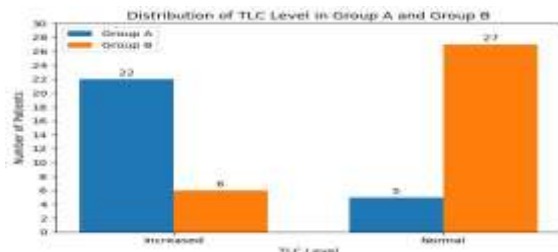
p-value < 0.001

Sensitivity = 81.48%

Specificity = 81.82%

Positive predictive value = 78.57%

Negative predictive value = 84.38%



Graph 8: Sensitivity and specificity for elevated total leukocyte count level

DISCUSSION

Early identification of bowel strangulation remains one of the most challenging aspects in the management of acute intestinal obstruction. Delayed

diagnosis may result in bowel ischemia, gangrene, perforation, sepsis, and increased mortality.^[4-6] Therefore, reliable biomarkers capable of predicting strangulation at an early stage are of considerable clinical importance.

In the present study, patients with strangulated intestinal obstruction were relatively older than those without strangulation (55.63 ± 19.35 years vs 46.15 ± 19.94 years), although the difference was not statistically significant. A significant male predominance was observed among patients with strangulation. Similar demographic trends have been reported by Dhoon et al,^[10] and Demirkan et al,^[17] suggesting that older age and male gender may be associated with an increased risk of bowel ischemia. Among the clinical parameters evaluated, obstipation was significantly associated with bowel strangulation, whereas abdominal pain, distension, vomiting, and pyrexia were comparable between the two groups. These findings highlight the limited diagnostic value of clinical symptoms alone and

emphasize the need for objective laboratory markers to identify patients at risk of strangulation.

The most important finding of the present study was the significant elevation of serum CRP levels in patients with strangulated obstruction. Mean CRP levels were more than two-fold higher in the strangulated group compared with the non-strangulated group (93.96 ± 23.63 mg/L vs 42.48 ± 17.68 mg/L; $p < 0.001$). Furthermore, CRP demonstrated a sensitivity of 88.89% and specificity of 78.79% for predicting bowel strangulation. Elevated CRP reflects the intense inflammatory response triggered by bowel ischemia and tissue necrosis. Similar observations have been reported by Dhoon et al,^[10] Pal et al,^[11] and Sahoo et al,^[12] all of whom demonstrated a strong association between elevated CRP levels and bowel gangrene or ischemic bowel injury. The association between inflammatory markers and bowel ischemia has also been highlighted by Poeze et al,^[13] and Pepys et al.^[14]

Serum D-lactate also emerged as a valuable predictor of strangulation. Patients with bowel strangulation had significantly higher D-lactate levels than those without strangulation (5.26 ± 0.80 mmol/L vs 3.34 ± 1.09 mmol/L; $p < 0.001$). D-lactate achieved a sensitivity of 85.19% and specificity of 84.85%, indicating good diagnostic performance. The elevation of D-lactate can be explained by mucosal injury and increased intestinal permeability during ischemia, allowing bacterial metabolites to enter the systemic circulation. These findings are consistent with previous studies by Dhoon et al,^[10] Pal et al,^[11] Sahoo et al,^[12] and Evennett et al,^[15] and Kologlu et al,^[16] which identified D-lactate as a useful biochemical marker of intestinal ischemia.

Total leukocyte count was also significantly higher in the strangulated group, reflecting the inflammatory and ischemic processes associated with bowel compromise. However, TLC alone demonstrated lower diagnostic performance compared with CRP and D-lactate, suggesting that it should be interpreted as an adjunctive rather than a standalone marker.^[17]

Overall, the combined assessment of CRP, D-lactate, and TLC provides better diagnostic accuracy than clinical or radiological parameters alone and may help reduce delays in operative management, thereby improving patient outcomes.

CONCLUSION

The present study demonstrated that serum C-reactive protein and D-lactate levels were significantly elevated in patients with strangulated intestinal obstruction compared to non-strangulated obstruction. Both biomarkers showed good sensitivity and specificity for predicting bowel strangulation, with CRP demonstrating higher sensitivity and D-lactate showing better specificity.

Total leukocyte count was also significantly associated with bowel strangulation.

Clinical features and plain radiographic findings alone were insufficient to reliably differentiate strangulated from non-strangulated obstruction. The combined assessment of serum CRP, D-lactate, and TLC improved diagnostic accuracy and facilitated early identification of bowel ischemia.

Therefore, serum CRP and D-lactate may serve as useful adjunctive biomarkers in the routine evaluation of patients with acute intestinal obstruction. Their use may assist in timely surgical decision-making, reduce delays in intervention, and potentially decrease morbidity and mortality associated with bowel strangulation.

Declarations

Funding: None

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

Ethical Approval: Obtained from the Institutional Ethics Committee.

Informed Consent: Written informed consent was obtained from all participants.

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