

The Role of C - Reactive Protein and Procalcitonin in the Early Diagnosis of Intraabdominal Infections in a Patient with History of Gastrointestinal Surgery

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Received: 01-03-2026 / Revised: 15-04-2026 / Accepted: 21-05-2026

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Conflict of interest: Nil

Abstract

Background: Intraabdominal infections are most important postop complications following laparotomy for GI surgeries. This increases morbidity, and increase the hospital stay, and mortality. Early diagnosis may be nonspecific in the immediate postoperative period due to the post-operative pain, and pathology. Biomarkers such as C-reactive protein (CRP) and procalcitonin (PCT) have been studied for their role in the early detection of infective complications.

Aim: To evaluate the role of serum C-reactive protein and procalcitonin levels in the early diagnosis of intraabdominal infections in patients undergoing gastrointestinal surgery.

Materials and Methods: This was a prospective observational study conducted at Siddhartha Medical College & Hospital, Vijayawada, over a period of one year. Adult patients undergoing elective or emergency gastrointestinal surgery and requiring postoperative intensive care monitoring were included. Serum CRP and PCT levels were measured at first Hour, Day 1, 2 and 3rd day. Patients were monitored clinically and radiologically for the development of intraabdominal infections. Diagnostic accuracy of CRP and PCT was assessed.

Results: A significant proportion of patients developed postoperative intraabdominal infections. Both CRP and PCT levels were significantly higher in infected patients compared to non-infected patients, particularly at 2nd and 3rd day postoperatively. Procalcitonin demonstrated higher sensitivity and specificity than CRP at these time points, indicating superior predictive value for early diagnosis of intraabdominal infections.

Conclusion: Serial measurement of serum procalcitonin and C-reactive protein is valuable in the early detection of postoperative intraabdominal infections. Procalcitonin, especially at 2nd day and 3rd Day, is a more reliable biomarker than CRP and can aid clinicians in early diagnosis and timely intervention.

Keywords: C-reactive Protein, Procalcitonin, GI Surgery Intraabdominal Infection.

DOI: 10.25258/ijcpr.18.6.190

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Introduction

Postoperative complications after gastrointestinal surgery remain a significant challenge for both surgeons and critical care specialists. Intraabdominal infections, particularly anastomotic leaks and intraabdominal abscesses, contribute substantially to postoperative morbidity and mortality.

Timely identification of these complications is often challenging because the normal postoperative inflammatory response may obscure early signs of infection.

Traditional laboratory parameters, such as total leukocyte count, have limited specificity in distinguishing infectious complications from routine postoperative inflammation, creating a need for more accurate diagnostic biomarkers. C-reactive protein (CRP) is an acute-phase protein produced by the liver in response to inflammatory stimuli, whereas procalcitonin (PCT) is a biomarker that shows a marked increase in the presence of bacterial infections and sepsis.

This study was undertaken to assess and compare the effectiveness of CRP and PCT as early diagnostic

markers for detecting intraabdominal infections in patients undergoing gastrointestinal surgery.

Aim: To evaluate the role of serum C-reactive protein and procalcitonin levels in the early diagnosis of intraabdominal infections in patients undergoing gastrointestinal surgery.

Material and Methods: This was a prospective observational study conducted at Siddhartha Medical College & Hospital, Vijayawada, over a period of one year after obtaining institutional ethical committee approval.

Inclusion Criteria: Adult patients undergoing gastrointestinal surgery in emergency or elective and require postop ICU Stay.

Exclusion Criteria: Patients with pre-existing infections, and on long-term steroid or immunosuppressive therapy, with hepatic or renal dysfunction.

Methodology: Patient demographics, surgical procedures performed, and relevant clinical

information were systematically documented. Serum levels of C-reactive protein (CRP) and procalcitonin (PCT) were assessed at the 1st, 24th, 48th, and 72nd postoperative hours. Patients were closely observed for clinical indicators of infection, including fever, tachycardia, abdominal manifestations, and abnormal laboratory parameters. Radiological investigations were undertaken whenever clinical suspicion warranted further evaluation. The diagnosis of intraabdominal infection was established based on a combination of clinical assessment, imaging findings, and operative evidence.

Statistical Analysis: Data were subjected to appropriate statistical evaluation. The diagnostic performance of CRP and PCT was assessed by calculating sensitivity, specificity, and receiver operating characteristic (ROC) curve parameters. A p-value of less than 0.05 was considered indicative of statistical significance.

Results

Table 1: Demographic and Clinical Characteristics

Variable	Total Cases	With IAI	Without IAI	P Value
Mean Age (years)	57.1 ± 11.8	59.0 ± 10.1	56.6 ± 12.2	0.58
Gender (M)	39/21	8/4	31/17	0.89
ASA I & II	45 (75.0%)	8 (66.7%)	37 (77.1%)	0.49
ASA III & IV	15 (25.0%)	4 (33.3%)	11 (22.9%)	0.49
Elective Surgery	43 (71.7%)	7 (58.3%)	36 (75.0%)	0.28
Emergency Surgery	17 (28.3%)	5 (41.7%)	12 (25.0%)	0.28

Table 2: Surgeries Performed

Surgery Type	Total Cases	With IAI	Without IAI
Colorectal Procedures	21 (35.0%)	4 (19.0%)	17 (81.0%)
Small Intestinal Resections	27 (45.0%)	3 (11.1%)	24 (88.9%)
Gastric Procedures	12 (20.0%)	5 (41.7%)	7 (58.3%)

Table 3: Postoperative CRP and Procalcitonin Levels

Postoperative Day	Mean CRP (mg/L)			Mean PCT (ng/mL)		
	No IAI	IAI	P Value	No IAI	IAI	P Value
POD 1	70	95	0.07	0.45	1.25	0.012
POD 2	108	152	0.03	0.40	1.01	0.018
POD 3	90	202	<0.001	0.28	1.15	<0.001

Table 4: Diagnostic Performance of CRP and Procalcitonin On Pod 3

Biomarker	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
CRP	68.4	89.6	63.2	92.8
Procalcitonin	90.5	81.3	57.1	96.9

Among the 60 study participants, 12 (20%) developed postoperative intraabdominal infections. Baseline demographic characteristics, ASA status, and type of surgical procedure were comparable between infected and non-infected groups, with no statistically significant differences.

Patients who developed intraabdominal infections demonstrated consistently higher postoperative CRP

and procalcitonin levels. The difference became statistically significant from postoperative day 2 onward and was most pronounced on postoperative day 3. Mean CRP levels on POD 3 were 202 mg/L in infected patients compared with 90 mg/L in non-infected patients ($p < 0.001$). Similarly, mean procalcitonin levels on POD 3 were 1.15 ng/mL versus 0.28 ng/mL, respectively ($p < 0.001$).

Procalcitonin exhibited superior diagnostic performance compared with CRP, with a sensitivity of 90.5% and specificity of 81.3%. CRP showed a sensitivity of 68.4% and specificity of 89.6%. The negative predictive value was high for both markers but was greatest for procalcitonin (96.9%). These findings indicate that postoperative procalcitonin is a more reliable early biomarker than CRP for predicting intraabdominal infectious complications following gastrointestinal surgery.

Discussion:

The present study demonstrates that gastrointestinal surgery is associated with a significant postoperative inflammatory response, resulting in elevated serum levels of both C-reactive protein (CRP) and procalcitonin (PCT). Among the 60 patients included in the study, 12 (20%) developed postoperative intraabdominal infections (IAI). Baseline demographic characteristics, ASA status, and type of surgical procedure were comparable between patients with and without IAI, indicating that postoperative biomarker trends were more useful predictors of infection than preoperative clinical variables.

Patients who developed intraabdominal infections exhibited consistently higher CRP and PCT levels throughout the postoperative period. Although CRP levels were elevated in all patients following surgery, significant differences between infected and non-infected patients became evident from postoperative day (POD) 2 onwards and were most pronounced on POD 3. Mean CRP levels on POD 3 were 202 mg/L in patients with IAI compared to 90 mg/L in those without infection ($p < 0.001$). These findings support the role of CRP as a useful marker of postoperative infectious complications, particularly when elevated levels persist beyond the expected postoperative inflammatory response.

Procalcitonin demonstrated an earlier and more marked rise in patients who subsequently developed intraabdominal infections. Mean PCT levels were significantly higher in the infected group from POD 1 onwards, reaching 1.15 ng/mL on POD 3 compared with 0.28 ng/mL in non-infected patients ($p < 0.001$). This suggests that PCT may identify infective complications earlier than CRP and may therefore facilitate prompt intervention.

The diagnostic performance analysis further highlighted the superiority of PCT over CRP. On POD 3, procalcitonin demonstrated a sensitivity of 90.5% and a negative predictive value (NPV) of 96.9%, compared with 68.4% and 92.8%, respectively, for CRP. Although CRP showed slightly higher specificity (89.6% vs. 81.3%), the higher sensitivity and NPV of PCT make it a more reliable biomarker for ruling out postoperative intraabdominal infection. The low positive

predictive values observed for both biomarkers suggest that they should be interpreted alongside clinical and radiological findings rather than used in isolation.

Our findings are consistent with previous studies that have reported significant postoperative elevations of both CRP and PCT after gastrointestinal surgery. Several investigators have demonstrated that persistent elevation of CRP beyond the second or third postoperative day is associated with an increased risk of anastomotic leakage and intraabdominal sepsis. Similarly, previous studies have shown that PCT possesses superior diagnostic accuracy for detecting postoperative infectious complications because of its greater specificity for bacterial infections and sepsis.

Ortega-Deballon et al. prospectively studied 133 patients undergoing elective colorectal surgery and found that C-reactive protein (CRP) was an effective early predictor of postoperative septic complications and anastomotic leaks. A CRP level >125 mg/L on postoperative day 4 showed 81.8% sensitivity and 95.8% negative predictive value, supporting its use in guiding safe hospital discharge. [1]

Warschkow et al. retrospectively analyzed 1,187 patients undergoing colorectal cancer surgery to assess the diagnostic value of CRP and white blood cell counts for detecting postoperative inflammatory complications. CRP on postoperative day 4 showed the highest accuracy (AUC 0.76), while WBC counts were less useful. The authors recommended CRP as a screening tool for early postoperative inflammatory complications. [2]

Reith et al. conducted a prospective study involving 70 patients undergoing elective colorectal or aortic surgery to evaluate the role of procalcitonin (PCT) in the early detection of postoperative complications. Laboratory and cytokine measurements were obtained preoperatively and during the postoperative period. The study found that patients who developed postoperative complications had significantly elevated PCT levels as early as the first postoperative day. In contrast, interleukin-6 and C-reactive protein (CRP) levels increased after surgery but did not effectively distinguish patients with complications from those without. The authors concluded that PCT is a reliable and reproducible biomarker for the early prediction of postoperative infective complications and sepsis. [3]

Watkins and Lemonovich reviewed the role of procalcitonin (PCT) in the diagnosis and management of intra-abdominal infections (IAIs). They found that PCT levels rise significantly in bacterial and fungal infections and may be particularly useful in detecting postoperative

infections and necrotizing pancreatitis. The authors concluded that PCT is a valuable adjunctive biomarker for diagnosing IAIs and guiding antibiotic therapy. [4]

McKay et al. assessed the usefulness of C-reactive protein (CRP) in predicting postoperative infective complications after elective colorectal cancer surgery. The prospective study included 150 patients following exclusion of 10 cases with incomplete data. Infective complications occurred in 21% of patients, with an overall complication rate of 29%. CRP levels measured on postoperative day 4 were significantly associated with infection. A CRP value >145 mg/L had a positive predictive value of 61%, while a value <145 mg/L had a negative predictive value of 96%. The authors concluded that CRP is a reliable marker for early detection of postoperative infective complications. [5]

Lindberg et al. studied the postoperative kinetics of procalcitonin (PCT) and C-reactive protein (CRP) in 47 patients who underwent major abdominal surgery and had an uncomplicated recovery. They found that PCT levels peaked on the first postoperative day and declined rapidly, reaching approximately half of the initial value by the second day. In contrast, CRP levels continued to rise during the first 48 hours, peaked later, and decreased more slowly, reaching half of the peak value by the fifth postoperative day. The study established reference intervals for both biomarkers, aiding the interpretation of postoperative inflammatory and infectious responses. [6]

García-Granero et al. conducted a prospective observational study involving 205 patients who underwent elective colorectal surgery to evaluate the role of procalcitonin (PCT) and C-reactive protein (CRP) as early predictors of anastomotic leak. Clinical variables, vital signs, and laboratory parameters, including PCT and CRP, were assessed daily during the first five postoperative days. Anastomotic leak occurred in 17 patients (8.3%), of whom 11 (5.4%) developed major leaks requiring drainage or reoperation.

The study found that neither PCT nor CRP was sufficiently reliable for detecting all anastomotic leaks when both minor and major leaks were considered. However, for major anastomotic leaks, both biomarkers showed good predictive accuracy between postoperative days 3 and 5, with area under the curve values exceeding 0.80. Procalcitonin demonstrated superior performance, particularly on postoperative day 5, where a cutoff value of 0.31 ng/mL achieved 100% sensitivity, 72% specificity, and 100% negative predictive value. The authors concluded that both CRP and PCT are useful predictors of major anastomotic leaks, with PCT being the more accurate biomarker. [7] Jebali et al. conducted a prospective study involving 100

patients undergoing elective cardiac surgery with cardiopulmonary bypass to assess the accuracy of procalcitonin (PCT) in diagnosing postoperative infections. Blood samples were collected before surgery and daily for seven postoperative days to measure PCT, C-reactive protein (CRP), white blood cell count, and interleukins 6 and 8. Postoperative infection was diagnosed in 16 patients. PCT levels were significantly higher in infected patients, with peak concentrations observed on the third postoperative day. PCT demonstrated superior diagnostic accuracy (AUC 0.88) compared to CRP and other inflammatory markers. A PCT value greater than 1.5 ng/mL after the second postoperative day predicted infection with 93% sensitivity and 80% specificity. The study concluded that PCT is a valuable and reliable biomarker for early detection of postoperative bacterial infections. An important observation in the present study is that serial monitoring of biomarker levels provides greater clinical value than isolated measurements. Trends showing persistently rising or non-declining CRP and PCT levels were more strongly associated with postoperative infection than single postoperative values. Therefore, routine serial assessment of these biomarkers may improve early identification of patients at risk of developing intraabdominal infections. [8]

Falcoz et al. conducted a prospective study of 157 patients undergoing thoracic surgery to evaluate the usefulness of procalcitonin (PCT) in detecting postoperative infections and compare it with C-reactive protein (CRP). PCT and CRP levels were measured preoperatively and during the first five postoperative days. Postoperative infection developed in 25 patients. In non-infected patients, PCT peaked on postoperative day 1, whereas CRP peaked on day 2. Patients with infection had significantly higher PCT levels than non-infected patients. PCT demonstrated superior diagnostic accuracy compared to CRP (AUC 0.92 vs. 0.66). The authors concluded that PCT is a reliable early marker for detecting and monitoring postoperative infectious complications. [9]

Madhusudhana et al. demonstrated that serial postoperative measurement of procalcitonin (PCT) and C-reactive protein (CRP) aids in the early detection of intraabdominal infections following gastrointestinal surgery. Elevated PCT and CRP levels at 48–72 hours were significantly associated with infective complications, with PCT showing superior sensitivity and specificity compared to CRP. [10]

Conclusion:

Both C-reactive protein and procalcitonin are useful biomarkers for the early detection of postoperative intraabdominal infections following gastrointestinal surgery. However, procalcitonin demonstrated

superior diagnostic performance, with higher sensitivity and negative predictive value compared to CRP. Elevated and persistent postoperative PCT levels, particularly during the first three postoperative days, are strongly associated with the development of intraabdominal infections. Serial measurement of these biomarkers, especially procalcitonin, can aid in early diagnosis, timely intervention, and improved postoperative outcomes.

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