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Evaluation of Procalcitonin and CRP in Diagnosing Acute Pelvic Inflammatory Disease

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Abstract

Acute pelvic inflammatory disease (PID) is a common gynecological emergency resulting from infection and inflammation of the upper genital tract. Early diagnosis is essential to prevent complications such as infertility, ectopic pregnancy, and chronic pelvic pain. However, clinical diagnosis of PID is often challenging due to nonspecific symptoms and overlap with other acute abdominal conditions. Inflammatory biomarkers, particularly C-reactive protein (CRP) and procalcitonin (PCT), have been investigated as adjunctive diagnostic tools. This study aimed to evaluate the diagnostic utility of serum PCT and CRP in women presenting with acute PID. A prospective cohort of 180 women aged 18–45 years with suspected PID was analyzed. Clinical evaluation, transvaginal ultrasonography, microbiological testing, and laboratory measurements of PCT and CRP were performed. Histopathological or laparoscopic confirmation served as the gold standard. The mean PCT level in confirmed PID cases was 1.28 ± 0.5 ng/mL compared to 0.23 ± 0.1 ng/mL in controls ($p < 0.001$), while mean CRP was 48.2 ± 12.6 mg/L versus 16.4 ± 6.7 mg/L ($p < 0.001$). PCT demonstrated higher specificity (91%) compared to CRP (75%), whereas CRP had higher sensitivity (88% vs 80%). Combined measurement increased diagnostic accuracy to 93%. These findings suggest that PCT and CRP complement each other in the diagnostic evaluation of acute PID, providing objective evidence that can support clinical and imaging assessments in ambiguous cases.

Keywords: pelvic inflammatory disease, procalcitonin, C-reactive protein, biomarkers, diagnosis

Introduction

Pelvic inflammatory disease (PID) is one of the most significant infectious conditions affecting women of reproductive age. It represents an ascending infection from the lower genital tract, involving the endometrium, fallopian tubes, and adjacent pelvic structures. The disease spectrum ranges from mild endometritis to severe tubo-ovarian abscesses and peritonitis. Globally, PID remains a major cause of preventable infertility and adverse reproductive health outcomes. Its impact is particularly high in regions with limited access to healthcare, inadequate sexual health education, and insufficient screening programs for sexually transmitted infections.1-5

Despite advances in gynecological diagnostics, PID remains a challenging condition to diagnose accurately. Clinical presentation is highly variable, with symptoms including lower abdominal pain, abnormal vaginal discharge, fever, dyspareunia, and menstrual irregularities. These features overlap significantly with other gynecological and gastrointestinal conditions, including ectopic pregnancy, appendicitis, ovarian torsion, and urinary tract infection. No single symptom, sign, or laboratory test offers definitive diagnostic accuracy, and as a result, clinical diagnosis often carries a risk of both overdiagnosis and underdiagnosis.6-7

Current diagnostic strategies rely on a combination of clinical evaluation, imaging studies, and laboratory investigations. Laparoscopy remains the gold standard, enabling direct visualization of inflamed pelvic organs. However, it is invasive, costly, and impractical for routine use in all suspected cases. Transvaginal ultrasonography is widely used but may miss subtle early-stage PID, especially in the absence of tubo-ovarian abscesses. Consequently, there has been growing interest in biochemical markers that may provide objective evidence to support diagnosis, stratify severity, and guide management.8-10

Among inflammatory biomarkers, C-reactive protein (CRP) has been extensively studied. CRP is an acute-phase reactant synthesized by the liver in response to interleukin-6, with levels rising rapidly in systemic infection and inflammation. Elevated CRP is commonly observed in women with acute PID and correlates with disease severity. However, CRP is nonspecific, as it may also rise in non-infective inflammatory conditions, limiting its discriminatory power.

Procalcitonin (PCT), a precursor of calcitonin, has gained recognition as a more specific marker of bacterial infection. Under normal physiological conditions, PCT is produced in negligible amounts by thyroid C-cells. During systemic bacterial infection, however, multiple tissues secrete PCT in response to pro-inflammatory cytokines and bacterial toxins, resulting in markedly elevated serum concentrations. PCT levels correlate with bacterial load and disease severity and have been shown to outperform CRP in distinguishing bacterial from viral infections. This makes it a potentially valuable marker in the evaluation of PID, particularly in differentiating bacterial etiology from other non-infectious gynecological conditions.

The clinical utility of combining PCT and CRP has been explored in other infectious diseases, including sepsis, pneumonia, and urinary tract infections, where it improves diagnostic accuracy and guides antibiotic stewardship. In the context of PID, such a combined approach may enhance diagnostic precision, allowing clinicians to initiate prompt treatment while avoiding unnecessary antibiotic exposure in non-infective cases.

The present study was designed to evaluate the diagnostic performance of serum PCT and CRP in women presenting with acute PID. By comparing biomarker levels with laparoscopic and histopathological findings, it aims to establish their individual and combined accuracy in differentiating true PID from other causes of lower abdominal pain. Such insights may inform more evidence-based diagnostic protocols and improve outcomes for women affected by this common but complex condition.

Methodology

This prospective observational study was conducted in the Department of Obstetrics & Gynaecology, Foundation University Medical College, Islamabad. A total of 180 women aged 18–45 years who presented with suspected acute PID were enrolled. Inclusion criteria included lower abdominal pain, adnexal tenderness on examination, cervical motion tenderness, and fever ≥38°C. Exclusion criteria were confirmed pregnancy, history of recent pelvic surgery, chronic pelvic pain of non-infective origin, or concurrent systemic infections.

All participants underwent detailed history-taking, physical examination, laboratory investigations, and imaging studies. Blood samples were collected at presentation to measure CRP and PCT levels. CRP was measured using immunoturbidimetric assay (mg/L), while PCT was determined using electrochemiluminescence immunoassay (ng/mL). Transvaginal ultrasonography was performed to detect adnexal masses, fluid collection, or tubo-ovarian abscess. Laparoscopy or endometrial biopsy with histopathology was conducted in cases where diagnosis remained uncertain and served as the gold standard for confirmation.

Data were analyzed using SPSS version 27. Mean and standard deviation were calculated for continuous variables, and diagnostic performance (sensitivity, specificity, positive predictive value, negative predictive value, and accuracy) was determined using receiver operating characteristic (ROC) analysis. A p-value <0.05 was considered statistically significant. Ethical approval was obtained, and informed consent was secured from all participants.

Results

Table 1. Baseline Characteristics of Study Population

Variable	Value (n=180)
Mean age (years)	29.7 ± 6.4
Mean CRP (mg/L)	36.8 ± 15.3
Mean PCT (ng/mL)	0.94 ± 0.6
Confirmed PID cases (%)	65%

Table 2. Biomarker Levels in Confirmed PID vs Non-PID Cases

Marker	PID (n=117)	Non-PID (n=63)	p-value
CRP (mg/L)	48.2 ± 12.6	16.4 ± 6.7	<0.001
PCT (ng/mL)	1.28 ± 0.5	0.23 ± 0.1	<0.001

Table 3. Diagnostic Performance of CRP and PCT

Marker	Sensitivity (%)	Specificity (%)	Accuracy (%)
CRP	88	75	83
PCT	80	91	86
CRP + PCT	92	94	93

Commentary: Both biomarkers were significantly elevated in PID, with PCT showing higher specificity and CRP higher sensitivity. Combined measurement yielded the best diagnostic accuracy.

Discussion

This study highlights the diagnostic utility of CRP and PCT in acute PID, demonstrating that both markers significantly differentiate confirmed PID from non-PID cases. Elevated CRP levels were observed in the majority of PID patients, consistent with its role as a nonspecific inflammatory marker. However, its lower specificity underscores the risk of false positives in other inflammatory conditions.11-13

PCT, by contrast, demonstrated superior specificity, reflecting its more selective rise in systemic bacterial infections. This aligns with findings from studies in sepsis and pneumonia, where PCT has outperformed CRP in discriminating bacterial from viral etiologies. In the present cohort, PCT elevation was strongly associated with laparoscopically confirmed PID, supporting its role as a reliable biomarker.14-16

The complementary strengths of CRP and PCT were evident in combined analysis, which achieved the highest diagnostic accuracy of 93%. This suggests that integrating both markers into diagnostic algorithms could reduce misclassification, particularly in ambiguous cases where imaging and clinical findings are inconclusive. Such an approach is especially valuable in emergency settings where rapid and accurate decision-making is crucial.17-18

The practical implications of these findings are significant. Early initiation of appropriate antibiotic therapy is critical in PID to prevent long-term sequelae such as infertility and ectopic pregnancy. However, overtreatment with antibiotics in non-infective conditions contributes to antimicrobial

resistance and exposes patients to unnecessary risks. By improving diagnostic confidence, CRP and PCT measurements can guide more judicious use of antibiotics.19-20

It is noteworthy that biomarker testing should not replace, but rather complement, clinical evaluation and imaging. Symptoms such as pelvic pain and adnexal tenderness remain essential diagnostic triggers, while transvaginal ultrasound provides structural insights that biomarkers cannot. The strength of CRP and PCT lies in their ability to provide biochemical confirmation of suspected infection, thereby enhancing overall diagnostic precision.

The study has certain limitations. The sample size, though adequate, was confined to a single tertiary care center, which may limit generalizability. Additionally, serial measurements of biomarkers were not performed, which could have provided insights into disease progression and treatment response. Future research with larger multicenter cohorts and dynamic monitoring of biomarkers is warranted.

Overall, this study affirms the role of CRP and PCT as valuable adjuncts in the diagnosis of acute PID. Their combined use improves accuracy, supports timely initiation of therapy, and contributes to evidence-based patient care in gynecology.

Conclusion

Serum procalcitonin and CRP are significantly elevated in women with acute PID. PCT offers higher specificity, while CRP provides greater sensitivity. Combined use enhances diagnostic accuracy and should be considered in routine evaluation of suspected PID.

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