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Research Article

PLASMA PROCALCITONIN AS A DIAGNOSTIC MARKER FOR ACUTE COMPLICATED APPENDICITIS - A CLINICAL EVALUATION

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ABSTRACT

Objective: Acute appendicitis is a common abdominal emergency requiring timely diagnosis and management. Differentiating between uncomplicated and complicated appendicitis can be challenging using traditional clinical evaluations, imaging, and inflammatory markers. Plasma procalcitonin (PCT), a biomarker associated with bacterial infections, has emerged as a promising tool for identifying complicated appendicitis. This study aims to evaluate the diagnostic efficacy of PCT in distinguishing complicated from uncomplicated acute appendicitis.

Methods: This observational study included 120 adult patients diagnosed with acute appendicitis at a tertiary care hospital between March 2022 and December 2022. Plasma PCT levels were measured on admission using Enzyme-linked immunosorbent assay and intraoperative findings and histopathological examinations were used to confirm the severity of appendicitis. PCT levels >0.66 ng/mL were considered indicative of complicated appendicitis. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated to assess the diagnostic performance of PCT.

Results: Of the 120 patients, 76 (63.3%) were diagnosed with complicated appendicitis, whereas 44 (36.7%) had uncomplicated appendicitis. Elevated PCT levels (>0.66 ng/mL) were significantly associated with complicated cases, showing a sensitivity of 81.58% and specificity of 77.27%. The PPV was 82.1% while the NPV was 76.6%. The receiver operating characteristic analysis yielded an area under the curve of 0.84, indicating good diagnostic accuracy.

Conclusion: Plasma PCT is a valuable diagnostic tool for predicting complicated appendicitis, offering higher sensitivity and specificity compared to traditional markers such as C-reactive protein and white blood cell. Integrating PCT measurements into routine diagnostic protocols can improve clinical decision-making, enabling timely surgical intervention and better resource allocation. Future research should focus on standardizing PCT thresholds and validating its utility across diverse populations.

Keywords: Acute appendicitis, Procalcitonin, Complicated appendicitis, Biomarkers, Diagnostic accuracy, Plasma procalcitonin.

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INTRODUCTION

Acute appendicitis is one of the most common causes of acute abdominal pain and often requires surgical intervention. The timely differentiation between uncomplicated and complicated appendicitis is critical, as delayed diagnosis of complicated cases – such as perforated or gangrenous appendicitis – can lead to severe morbidity and mortality. Conventionally, clinical examination, laboratory tests, and imaging modalities such as ultrasonography or computed tomography (CT) have been used to assess appendicitis. However, these methods have their limitations, particularly in emergency settings where swift decision-making is crucial [1-3].

Plasma procalcitonin (PCT), a biomarker for bacterial infections and systemic inflammatory responses, has gained attention for its diagnostic value in identifying complicated infections. Elevated PCT levels have been associated with severe infections, making it a potential indicator for distinguishing between uncomplicated and complicated appendicitis. Early identification of complicated cases can guide surgeons toward timely operative management, reducing the risk of post-operative complications. This study aims to evaluate the diagnostic efficacy of plasma PCT in predicting complicated appendicitis in patients presenting with acute abdominal pain. By correlating PCT levels with intraoperative findings and histopathological examination (HPE) results, the study seeks to determine whether PCT can serve as a reliable marker for guiding clinical decisions. The findings from this study will contribute to enhancing the diagnostic process, enabling clinicians to better triage patients for conservative or surgical management based on disease severity [2,4,5].

In this paper, we explore the relationship between plasma PCT levels and the severity of acute appendicitis. We hypothesize that patients with elevated PCT levels are more likely to present with complicated appendicitis, and early detection through PCT measurements may facilitate optimal patient outcomes. This study presents a comprehensive analysis of clinical data to validate the use of PCT as a diagnostic tool to improve the management and prognosis of acute appendicitis [6,7].

Challenges in diagnosing acute appendicitis

Acute appendicitis remains one of the most common abdominal emergencies, but diagnosing it accurately poses significant challenges. Early and precise diagnosis is crucial to avoid complications such as perforation, peritonitis, and sepsis. However, symptoms of appendicitis are often non-specific, overlapping with other abdominal or gastrointestinal conditions, such as urinary tract infections, pelvic inflammatory disease, or gastroenteritis. This diagnostic ambiguity makes it challenging for physicians to distinguish uncomplicated appendicitis from more severe, complicated forms in time for effective intervention [8-10].

While clinical examination has traditionally served as the first step in diagnosis, it is limited by variability in patient presentation. Scoring systems such as the Alvarado score assist in assessing

the likelihood of appendicitis, but they have limited reliability in identifying complications. Imaging techniques, including ultrasound and CT scans, are frequently used to confirm the diagnosis. However, ultrasonography's accuracy depends heavily on the operator's expertise, whereas CT scans involve exposure to ionizing radiation and are not always available in resource-constrained settings. Laboratory markers such as white blood cell (WBC) counts and C-reactive protein (CRP) provide some insight into inflammation but offer little specificity in distinguishing uncomplicated from complicated cases, resulting in potential diagnostic delays or unnecessary surgical interventions. These challenges emphasize the need for more precise biomarkers to assess the severity of appendicitis accurately [2,11].

Biomarkers in acute appendicitis diagnosis

To address the limitations of imaging and inflammatory markers, recent studies have explored the use of biomarkers in diagnosing appendicitis. CRP and WBC counts remain standard in evaluating inflammatory processes, but they are limited by their low specificity. Elevated CRP levels are indicative of inflammation but can also result from various infections and non-infectious conditions. Similarly, WBC counts often rise in response to infections, including appendicitis, but do not effectively differentiate between uncomplicated and complicated cases. Given these limitations, there has been an increasing interest in identifying novel biomarkers that provide more accurate diagnostic insights [12-14].

PCT has emerged as a promising biomarker for bacterial infections and has been studied for its role in acute abdominal conditions, including appendicitis. Unlike CRP, which takes longer to rise, PCT levels increase rapidly in response to severe bacterial infections, potentially making it a more effective marker for identifying complicated appendicitis. The use of PCT could complement existing clinical assessments, facilitating timely surgical interventions and improving patient outcomes [15].

Role of Plasma PCT as a biomarker

PCT, a peptide precursor of the hormone calcitonin, is released in response to systemic bacterial infections and sepsis. In non-infectious conditions, PCT levels remain low, making it a relatively specific marker for bacterial infections. In cases of complicated appendicitis, where bacterial invasion into the peritoneal cavity occurs, PCT levels are often elevated, indicating a systemic inflammatory response. This characteristic has positioned PCT as a potential diagnostic tool to predict the severity of appendicitis [16,17].

Several studies have demonstrated the diagnostic value of PCT in acute appendicitis. Patients with elevated PCT levels were found to be at higher risk of developing complicated appendicitis, such as perforations or abscess formations, requiring prompt surgical intervention. Compared to traditional markers such as CRP and WBC, PCT offers quicker and more specific insights, improving the diagnostic process in time-sensitive clinical situations [6,17].

Correlation between PCT sevels and severity of appendicitis

The correlation between PCT levels and disease severity has been explored in several studies with consistent findings supporting its predictive value. Elevated PCT levels have been linked with intraoperative findings of gangrenous or perforated appendicitis and post-operative HPEs confirming abscesses or necrosis. This relationship underscores the potential of PCT as a real-time biomarker to assess the progression of appendicitis [17,18]. HPE remains the gold standard for diagnosing and classifying appendicitis. However, HPE results are only available after surgery, limiting their role in emergency decision-making. The ability to correlate elevated PCT levels with severe intraoperative findings suggests that PCT can serve as a valuable pre-operative marker, guiding surgeons in identifying high-risk patients who may benefit from early surgical intervention [9,10].

Diagnostic performance of PCT in clinical practice

The diagnostic accuracy of PCT in appendicitis has been evaluated through various studies with promising results. PCT has shown higher sensitivity and specificity than CRP and WBC in identifying complicated appendicitis. Some studies have reported sensitivities of over 80%, suggesting that PCT can reliably distinguish complicated cases from uncomplicated ones. This accuracy makes PCT a useful tool for emergency settings where rapid decisions are required [10,19].

However, the diagnostic performance of PCT varies depending on the threshold used to define elevated levels. While PCT levels above 0.5–0.66 ng/mL are often indicative of complicated appendicitis, variability in optimal cutoff values across different studies remains a challenge. Despite this limitation, PCT has shown significant potential when used alongside other clinical and imaging assessments [1,4].

Limitations of Plasma PCT in appendicitis diagnosis

Although plasma PCT offers significant advantages, it is not without limitations. One challenge lies in the variability of PCT levels due to the presence of other infections or inflammatory conditions, which may confound its interpretation. Patients with coexisting infections, such as urinary or respiratory tract infections, may also exhibit elevated PCT levels, reducing its specificity for appendicitis. In addition, the cost of PCT assays may limit their widespread adoption in some healthcare settings [16].

Another critical limitation is the lack of standardized cut-off values across studies. Differences in the methodology, population demographics, and clinical settings contribute to variations in reported thresholds, complicating the integration of PCT into routine practice. Further research is needed to establish uniform reference ranges and validate PCT's diagnostic utility across diverse patient populations.

Future directions and clinical implications

Given the growing evidence supporting the use of plasma PCT in appendicitis diagnosis, several future directions for research and clinical practice emerge. Standardizing PCT thresholds for predicting complicated appendicitis is essential to ensure consistent diagnostic accuracy [1,11,20]. In addition, integrating PCT measurements into existing diagnostic protocols can provide a more comprehensive approach to managing acute appendicitis, especially in emergency departments where time is of the essence. PCT has the potential to enhance clinical decision-making by guiding surgeons in prioritizing patients for early surgery, thereby reducing post-operative complications. Its use can also minimize unnecessary surgeries by helping identify patients with uncomplicated appendicitis who may benefit from conservative management. As research progresses, further validation of PCT's performance in larger, multi-center studies will be critical for establishing its role as a reliable diagnostic tool. Ultimately, incorporating PCT into standard clinical practice could significantly improve outcomes in patients with acute appendicitis [21,22].

METHODS

This study employed an observational design to evaluate the diagnostic utility of plasma PCT in predicting complicated acute appendicitis. The investigation was conducted at a tertiary care hospital, Sri Ramachandra Medical College and Research Institute, over a period from March 2022 to December 2022. The primary objective was to correlate plasma PCT levels with intraoperative findings and post-operative HPE, aiming to determine the biomarker's effectiveness in distinguishing complicated from uncomplicated appendicitis.

Study population and sample size

The study included 120 adult patients who presented with symptoms suggestive of acute appendicitis and were subsequently admitted for further evaluation and treatment. The inclusion criteria required participants to be over the age of 18 years with clinical and radiological evidence suggestive of appendicitis. Patients below 18 years of age were excluded from the study to maintain homogeneity in the sample and eliminate confounding factors associated with pediatric appendicitis. In addition, patients with coexisting infections or inflammatory conditions that could influence PCT levels were excluded to ensure that the results specifically reflected the association between PCT and appendicitis severity.

Data collection procedures

On admission, all patients underwent standard diagnostic procedures, including clinical evaluation, laboratory testing, and imaging studies such as ultrasonography or CT scans. Plasma PCT levels were measured at the time of admission using enzyme-linked immunosorbent assay methods. These PCT measurements were recorded and later compared against intraoperative and histopathological findings to determine their diagnostic value. Intraoperative findings were documented during surgery, noting the presence of gangrene, perforation, or abscess, which were classified as indicators of complicated appendicitis. Specimens collected during surgery were sent for HPE to confirm the diagnosis and assess disease severity.

Outcome measures

The primary outcome of interest was the ability of plasma PCT levels to predict complicated appendicitis. Cases with intraoperative findings of gangrene, perforation, or abscess formation were categorized as complicated appendicitis, whereas those without these findings were classified as uncomplicated. The plasma PCT threshold for identifying complicated appendicitis was set at >0.66 ng/mL, based on previously published literature and preliminary clinical observations. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated to assess the diagnostic performance of PCT in predicting disease severity.

Statistical analysis

The collected data were analyzed using appropriate statistical tools. Descriptive statistics were used to summarize demographic variables, clinical symptoms, and PCT levels. Sensitivity, specificity, PPV, and NPV were computed to evaluate the diagnostic accuracy of PCT in identifying complicated appendicitis. A receiver operating characteristic (ROC) curve analysis was performed to determine the optimal PCT cutoff value, maximizing sensitivity and specificity. In addition, Chi-square tests were used to assess the statistical significance of the association between PCT levels and intraoperative findings. A $p<0.05$ was considered statistically significant.

Ethical considerations

The study was conducted in accordance with the ethical guidelines outlined by the institutional ethics committee. Informed consent was obtained from all participants after explaining the purpose, risks, and benefits of the study. Confidentiality of patient data was maintained throughout the research process, and the collected data were used solely for academic and clinical purposes. Patients diagnosed with complicated appendicitis received immediate surgical intervention based on standard clinical protocols, ensuring that participation in the study did not delay or alter their treatment.

Limitations

The study was limited by its single-center design, which may affect the generalizability of the findings. In addition, the exclusion of patients with coexisting infections could limit the applicability of the results to real-world clinical scenarios where such conditions frequently coexist. Further research involving larger, multi-center cohorts would be necessary to validate the findings and establish plasma PCT as a standard diagnostic marker in appendicitis management.

In summary, this observational study aimed to determine the diagnostic value of plasma PCT in differentiating complicated from uncomplicated acute appendicitis. Through systematic data collection, intraoperative findings, and statistical analysis, the study provides insights into the potential role of PCT as a biomarker for timely clinical decision-making and improved patient outcomes.

RESULTS

Demographic and clinical characteristics of the study population

The study included a total of 120 patients diagnosed with acute appendicitis. The majority of patients fell within the age range of 21–30 years (33.3%), reflecting a higher prevalence of appendicitis in younger adults. A slight male predominance was observed, with 55.8% of the participants being male and 44.2% female. All participants reported abdominal pain as their primary symptom, with 90.8% specifically identifying right iliac fossa pain. Additionally, 76.7% of the patients experienced nausea or vomiting, while 20% presented with fever. The analysis of the age distribution among the study participants reveals several important insights. The mean age of the participants is approximately 33.44 years, indicating that the sample is skewed toward young to middle-aged adults. This is further supported by the observation that a large proportion of participants fall within the 21–30 years (33.3%) and >40 years (33.3%) age groups.

The calculated standard deviation (SD) of 9.82 years suggests a moderate spread around the mean, indicating a relatively diverse age range among participants. While the lowest age group (18–20 years) accounts for only 12.5%, the higher representation in the >40 years group suggests inclusion of older adults, likely increasing variability in the dataset. Mean±SD=33.44±9.82. Table 1 shows the age distribution among study participants, and Table 2 shows the demographic and clinical characteristics of the study population.

Distribution of Plasma PCT levels

Plasma PCT levels varied considerably among the study population. A total of 72 patients (60%) exhibited PCT levels above 0.6 ng/mL, indicating a heightened inflammatory response suggestive of complicated appendicitis. In contrast, 48 patients (40%) had PCT levels at or below 0.5 ng/mL. Elevated PCT levels were predominantly observed in patients with severe intraoperative findings, including abscess formation, perforation, or gangrenous appendicitis. Fig. 1 shows the distribution of plasma PCT levels in study participants.

Intraoperative and histopathological findings

Among the 120 patients, 76 (63.3%) were found to have complicated appendicitis based on intraoperative findings, whereas 44 (36.7%) were diagnosed with uncomplicated appendicitis. Complicated cases were characterized by gangrene (32%), perforation (21%), and abscess formation (10.3%). These findings were confirmed through HPE, which served as the gold standard for final diagnosis. Table 3 shows the intraoperative and histopathological findings in the study population.

Table 1: Age distribution among the study participants

Age group (years)	Midpoint (x)	Frequency (f) (%)
18–20	19.0	15 (12.5)
21–30	25.5	40 (33.3)
31–40	35.5	25 (20.8)
>40 (assumed 41–50)	45.5	40 (33.3)
Total	Mean: 33.44	120

Table 2: Demographic and clinical characteristics of the study population

Gender (%)	
Male	67 (55.8)
Female	53 (44.2)
Symptoms (%)	
Right iliac fossa pain	109 (90.8)
Nausea/vomiting	92 (76.7)
Fever	24 (20)

Table 3: Intraoperative and histopathological findings

Type of appendicitis	Frequency (%)
Uncomplicated	44 (36.7)
Complicated	76 (63.3)
Gangrene	38 (32)
Perforation	25 (21)
Abscess	13 (10.3)

Comparison of PCT levels with intraoperative findings

A significant association was observed between plasma PCT levels and intraoperative findings. Among the patients with PCT levels >0.66 ng/mL, 85% (61 out of 72) presented with complicated appendicitis. Conversely, 37 out of 48 patients (78%) with PCT levels ≤0.5 ng/mL were found to have uncomplicated appendicitis. This relationship underscores the potential of PCT as a biomarker for preoperatively identifying severe appendicitis cases. Table 4 shows the comparison of PCT levels with the intraoperative findings.

Diagnostic performance of Plasma PCT

The diagnostic performance of plasma PCT was assessed using sensitivity, specificity, PPV, and NPV at a cutoff threshold of 0.66 ng/mL. The sensitivity of PCT in predicting complicated appendicitis was 81.58%, indicating its ability to identify most patients with severe disease. The specificity was 77.27%, reflecting its capacity to rule out uncomplicated cases. The PPV was 82.1%, suggesting a high likelihood of complicated appendicitis when PCT levels were elevated. The NPV was 76.6%, indicating that low PCT levels were predictive of uncomplicated appendicitis. Table 5 shows the Diagnostic performance of Plasma PCT.

A ROC curve was generated to further evaluate the diagnostic power of PCT. The area under the curve (AUC) was 0.84, demonstrating good predictive ability. Fig. 2 depicts the ROC curve for plasma PCT in predicting complicated appendicitis.

Findings from results

This study demonstrates that plasma PCT is a valuable biomarker for predicting the severity of acute appendicitis. Elevated PCT levels were significantly associated with complicated appendicitis, as confirmed by intraoperative findings and HPE. The high sensitivity and specificity observed suggest that PCT can serve as a reliable diagnostic tool, complementing clinical assessments and imaging studies in emergency settings. These results support the integration of PCT measurement into routine diagnostic workflows for acute appendicitis, helping to guide timely surgical intervention and improve patient outcomes.

DISCUSSION

This study demonstrates the diagnostic utility of plasma PCT in distinguishing between complicated and uncomplicated appendicitis. The findings align with existing literature, emphasizing the potential of PCT as a valuable biomarker to complement traditional diagnostic methods in emergency settings. Elevated PCT levels correlated significantly with severe intraoperative findings, such as gangrene, perforation, and abscess formation, supporting its role as a reliable predictor of complicated appendicitis. This section discusses the clinical implications, limitations, and future research directions for the use of PCT in appendicitis diagnosis.

Table 4: Comparison of PCT Levels with intraoperative findings

PCT levels (ng/mL)	Complicated (%)	Uncomplicated (%)
≤0.5 ng/mL	11 (22)	37 (78)
>0.66 ng/mL	61 (85)	11 (15)

PCT: Procalcitonin

Table 5: Diagnostic performance of plasma procalcitonin

Metric	Value (%)
Sensitivity	81.58
Specificity	77.27
Positive predictive value	82.1
Negative predictive value	76.6

Diagnostic accuracy and clinical implications

The study observed a sensitivity of 81.58% and a specificity of 77.27% for PCT levels above 0.66 ng/mL, indicating that PCT is highly effective in identifying patients with complicated appendicitis. These diagnostic metrics suggest that PCT offers higher precision than traditional inflammatory markers such as CRP and WBC counts, which often fail to differentiate between uncomplicated and complicated cases. The AUC from the ROC analysis was 0.84, further validating the strength of PCT as a diagnostic tool.

In clinical practice, PCT can assist in early decision-making, particularly in cases where imaging results are inconclusive or when access to advanced imaging modalities is limited. Early identification of complicated appendicitis allows surgeons to prioritize high-risk patients for urgent surgical intervention, potentially reducing the risk of adverse outcomes such as sepsis or delayed treatment. Incorporating PCT measurements into routine diagnostic workflows could also improve resource allocation by minimizing unnecessary surgeries and ensuring that patients with uncomplicated appendicitis receive appropriate conservative management.

Comparison with existing biomarkers

Traditional biomarkers such as CRP and WBC counts are widely used to support clinical diagnoses, but their limitations are well-documented.

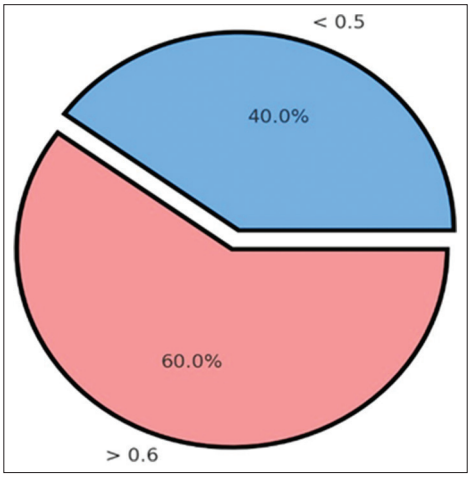

Fig. 1: Distribution of plasma procalcitonin levels in study participants

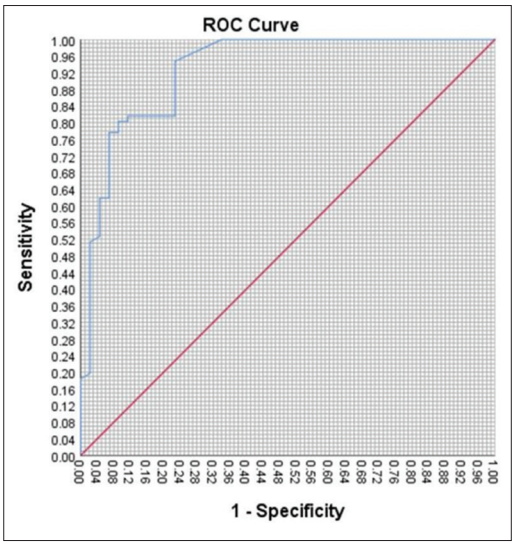

Fig. 2: Receiver operating characteristic curve for plasma procalcitonin in predicting complicated appendicitis

CRP and WBC elevations indicate the presence of inflammation but lack specificity, as they can rise in response to various infections and non-infectious conditions. This non-specificity can lead to diagnostic ambiguity, resulting in unnecessary surgeries or delayed interventions. In contrast, PCT rises rapidly and specifically in response to bacterial infections, making it a more reliable indicator of disease severity in appendicitis. The findings of this study reinforce the growing body of evidence that PCT provides superior diagnostic accuracy compared to CRP and WBC, particularly in distinguishing complicated appendicitis cases.

Correlation with intraoperative and histopathological findings

The correlation between elevated PCT levels and intraoperative findings of gangrene, abscess formation, and perforation underscores the clinical relevance of PCT as a pre-operative marker. Among patients with PCT levels exceeding 0.66 ng/mL, 85% were confirmed to have complicated appendicitis through intraoperative and histopathological assessments. This strong association suggests that PCT can serve as an early warning signal, guiding surgeons in identifying patients at risk for severe disease and ensuring timely surgical intervention. HPE remains the gold standard for diagnosing and categorizing appendicitis, but its utility is limited to post-operative confirmation. In contrast, PCT offers real-time diagnostic insights, enhancing the clinician's ability to predict disease severity before surgery. This predictive capability is particularly valuable in emergency departments, where rapid decision-making is essential to optimize patient outcomes.

Limitations and challenges in implementation

Despite its advantages, the use of PCT as a diagnostic marker is not without limitations. One of the primary challenges lies in the variability of PCT levels due to coexisting infections or inflammatory conditions, which can lead to false-positive results. Patients with concurrent urinary or respiratory tract infections, for example, may exhibit elevated PCT levels, complicating the interpretation of test results. This variability highlights the need for clinicians to consider PCT levels in conjunction with clinical findings and imaging studies to ensure accurate diagnosis.

In addition, the lack of standardized PCT thresholds across studies presents another challenge. While this study used a cut-off value of 0.66 ng/mL, other studies have reported different thresholds, leading to variability in diagnostic performance. Establishing uniform reference values for PCT would be essential to facilitate its integration into routine clinical practice. Furthermore, the cost of PCT assays may limit their widespread use, especially in resource-limited healthcare settings. Cost-effectiveness analyses are needed to evaluate the long-term benefits of using PCT in appendicitis diagnosis compared to traditional diagnostic approaches.

Future research directions

The promising results from this study pave the way for further research to validate the clinical utility of PCT in diagnosing complicated appendicitis. Future studies should focus on multi-center trials involving diverse patient populations to establish standardized PCT thresholds and assess the biomarker's diagnostic performance across different clinical settings. In addition, research should explore the cost-effectiveness of incorporating PCT into diagnostic workflows, particularly in emergency departments where rapid and accurate decision-making is critical. Further investigation is also needed to evaluate the use of PCT in conjunction with other diagnostic modalities, such as ultrasound or CT scans, to develop a comprehensive diagnostic algorithm for appendicitis. Exploring the potential of combining PCT with other biomarkers may enhance diagnostic accuracy and reduce the likelihood of false-positive or false-negative results. Integrating PCT with artificial intelligence-based tools and predictive models could further optimize patient management by providing clinicians with real-time decision support [2,20].

Comparison with other studies

The findings of this study align with previous research, supporting the use of PCT as a reliable predictor of complicated appendicitis. In a study conducted by Gavela *et al*. (2012), elevated PCT levels were associated with severe bacterial infections, and the biomarker showed higher diagnostic accuracy than CRP in distinguishing between uncomplicated and complicated cases. Similarly, our study found that a PCT threshold of >0.66 ng/mL provided a sensitivity of 81.58% and a specificity of 77.27%, comparable to other studies reporting similar diagnostic metrics [23].

Previous studies have also demonstrated that PCT outperforms CRP and WBC counts in predicting the severity of appendicitis. According to Assicot *et al*. (1993), PCT levels rise earlier and more specifically in response to bacterial infections, making it a more reliable indicator of disease severity. Our findings support this conclusion, as patients with elevated PCT levels were more likely to present with intraoperative findings of gangrene or perforation compared to those with normal levels. Furthermore, this study adds to the growing body of evidence suggesting that PCT can guide clinical decision-making by helping clinicians identify patients at risk of complicated disease [14].

Similar to findings reported by Borschitz *et al.* (2010), our study demonstrated that PCT levels correlate well with HPE results, which confirmed the presence of severe inflammation or necrosis in complicated cases. Both studies highlight the importance of biomarkers in providing real-time insights into disease severity, particularly when imaging results are inconclusive. However, the variability in PCT thresholds reported across studies, including this one, underscores the need for further research to establish standardized reference values [15].

Our study's ROC curve analysis, which revealed an AUC of 0.84, is consistent with prior research showing similar diagnostic performance. Studies by Simon *et al*. (2004) and Muenzer and Atkinson (2006) reported AUC values above 0.8, reinforcing the utility of PCT in diagnosing severe infections and guiding early surgical interventions. The slight variations in sensitivity and specificity observed across studies may result from differences in study populations, sample sizes, and diagnostic protocols, highlighting the need for multi-center trials to validate PCT's diagnostic role in appendicitis [24].

Diagnostic accuracy continues to be a challenge, especially in low-resource settings. Singh *et al*. (2024) evaluated the predictive value of biochemical markers such as CRP and WBC counts in combination with the RIPASA score. Although the combined method demonstrated moderate specificity (74.1%), the overall diagnostic accuracy was only 42.7%, indicating a need for better clinical tools, especially in early-stage or atypical presentations [25].

Surgical management remains essential in complicated or perforated cases. A retrospective study by Yadav *et al.* (2022) evaluated the outcomes of laparoscopic appendectomy in a tertiary care hospital and found that it remains a safe and effective approach, even in patients with complicated appendicitis. Their findings support laparoscopic surgery as the gold standard where expertise and equipment are available [26].

Perforated appendicitis presents a more severe clinical scenario. A study by Nivedita *et al*. (2023) provided insights into the clinicopathological profile of patients with appendicular perforation, highlighting key inflammatory markers and clinical signs that correlate with disease severity. These data can aid clinicians in early recognition and triaging of patients at higher risk [27].

Clinical implications

The results of this study highlight the potential of PCT to enhance clinical workflows in diagnosing acute appendicitis. The biomarker's high sensitivity and specificity for complicated cases allow clinicians to prioritize patients for urgent surgical intervention, reducing the risk of adverse outcomes such as sepsis or peritonitis. Furthermore, incorporating PCT measurements into diagnostic protocols can

help avoid unnecessary surgeries in patients with uncomplicated appendicitis, improving resource allocation and patient outcomes.

In practice, PCT could complement imaging studies, particularly in settings where radiological resources are limited or where imaging results are inconclusive. In emergency departments, where rapid decision-making is critical, PCT provides valuable insights into disease severity, helping clinicians determine whether conservative management or immediate surgery is required. The ability to predict complicated appendicitis before surgery ensures better preparedness and reduces the likelihood of post-operative complications.

Limitations and challenges

Despite the promising results, the study also highlights some limitations associated with the use of PCT as a diagnostic tool. One major challenge lies in the variability of PCT levels due to coexisting infections or inflammatory conditions, which may lead to false-positive results. For instance, patients with concurrent urinary tract or respiratory infections may exhibit elevated PCT levels, complicating the interpretation of results. Clinicians must therefore use PCT measurements alongside clinical assessments and imaging studies to make accurate diagnoses. Another limitation is the lack of standardized PCT thresholds across different studies, including this one. While this study identified 0.66 ng/mL as an optimal cutoff for predicting complicated appendicitis, other studies have reported slightly different values, leading to variability in diagnostic performance. The absence of uniform reference values limits the generalizability of findings and emphasizes the need for further research to establish consistent thresholds applicable across diverse populations and healthcare settings. Cost considerations also present a potential barrier to the widespread adoption of PCT testing. While PCT assays offer valuable diagnostic insights, their cost may limit their accessibility in resource-constrained settings. Future studies should explore the cost-effectiveness of incorporating PCT into diagnostic workflows for appendicitis and assess whether the benefits of early diagnosis and optimized resource allocation justify the additional expense.

CONCLUSION

This study provides robust evidence supporting the use of plasma PCT as a valuable diagnostic biomarker for predicting complicated appendicitis. The results align with findings from other studies, demonstrating that PCT offers superior diagnostic accuracy compared to traditional inflammatory markers. Despite some challenges, such as variability in thresholds and coexisting infections, PCT holds significant promise in improving clinical decision-making and optimizing patient outcomes.

Incorporating PCT measurements into diagnostic protocols for acute appendicitis could help clinicians accurately stratify patients, prioritize surgical interventions, and avoid unnecessary procedures. As further research validates the biomarker's utility, PCT has the potential to become an integral component of the diagnostic toolkit for appendicitis, enhancing the quality of care in emergency settings.

AUTHOR CONTRIBUTION

I, Dr. Kumaresh Pandian conceptualized and designed the study. Dr. Muthu helped in collecting the data and performed the statistical analysis. Prof. Raja Senthil V guided us throughout the research. All authors read and approved the final manuscript.

Ethical Committte Approval Number: CSP-MED/22/MAR/75/77

CONFLICT OF INTEREST

No conflict of interest.

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REFERENCES

1. Oiak D, Yamini D, Udani VM, Lewis RJ, Arnell T, Vargas H, *et al*. Initial nonoperative management for periappendiceal abscess. Dis Colon Rectum. 2001;44:936-41.
2. Andersson M, Andersson RE. The appendicitis inflammatory response score: A tool for the diagnosis of acute appendicitis that outperforms the Alvarado score. World J Surg. 2008;32:1843-9.
3. Jones MW, Lopez RA, Deppen JG. Appendicitis. In: StatPearls. Treasure Island, FL: StatPearls Publishing; 2022.
4. Imran JB, Madni TD, Minshall CT, Mokdad AA, Subramanian M, Clark AT, *et al*. Predictors of a histopathologic diagnosis of complicated appendicitis. J Surg Res. 2017;214:197-202.
5. Swenson DW, Ayyala RS, Sams C, Lee EY. Practical imaging strategies for acute appendicitis in children. AJR Am J Roentgenol. 2018;211(4):901-9.
6. Eng KA, Abadeh A, Ligocki C, Lee YK, Moineddin R, Adams-Webber T, *et al*. Acute appendicitis: A meta-analysis of the diagnostic accuracy of US, CT, and MRI as second-line imaging tests after an initial US. Radiology. 2018;288(3):717-27.
7. Riva MA, Ceresoli M. 1522-2022: Considerations on the first description of the caecal appendix by Berengario da Carpi in its 500th anniversary. World J Surg. 2022;46:2554-8.
8. Styrud J, Eriksson S, Nilsson I, Ahlberg G, Haapaniemi S, Neovius G, *et al*. Appendectomy versus antibiotic treatment in acute appendicitis: A prospective multicenter randomized controlled trial. World J Surg. 2006;30:1033-7.
9. Markar SR, Karthikesalingam A, Cunningham J, Burd C, Bond-Smith G, Kurzawinski TR. Increased use of pre-operative imaging and laparoscopy has no impact on clinical outcomes in patients undergoing appendicectomy. Ann R Coll Surg Engl. 2011;93:620-3.
10. Martin AE, Vollman D, Adler B, Caniano DA. CT scans may not reduce the negative appendectomy rate in children. J Pediatr Surg. 2004;39:886-90.
11. Alvarado A. A practical score for the early diagnosis of acute appendicitis. Ann Emerg Med. 1986;15:557-64.
12. Grönroos JM, Grönroos P. Leucocyte count and C-reactive protein in the diagnosis of acute appendicitis. Br J Surg. 1999;86:501-4.
13. Simon L, Gauvin F, Amre DK, Saint-Louis P, Lacroix J. Serum procalcitonin and C-reactive protein levels as markers of bacterial infection: A systematic review and meta-analysis. Clin Infect Dis. 2004;39(2):206-17.
14. Assicot M, Gendrel D, Carsin H, Raymond J, Guilbaud J, Bohuon C. High serum procalcitonin concentrations in patients with sepsis and infection. Lancet. 1993;341:515-8.
15. Borschitz T, Gückel C, Stocker U, Müller C, Vögele-Kadletz M, Von Stebut E. The diagnostic value of plasma procalcitonin for distinguishing complicated fromuncomplicated acute appendicitis. J Pediatr Surg. 2010;45(8):1496-503.
16. Yamashita H, Yuasa N, Takeuchi E, Goto Y, Miyake H, Miyata K, *et al*. Diagnostic value of procalcitonin for acute complicated appendicitis. Nagoya J Med Sci. 2016;78(1):79-88.
17. Yu CW, Juan LI, Wu MH, Shen CJ, Wu JY, Lee CC. Systematic review and meta-analysis of the diagnostic accuracy of procalcitonin, C-reactive protein and white blood cell count for suspected acute appendicitis. Br J Surg. 2013;100:322-9.
18. Sand M, Bechara FG, Holland-Letz T, Sand D, Mehnert G, Mann B. Diagnostic value of hyperbilirubinemia as a predictive factor for appendiceal perforation in acute appendicitis. Am J Surg. 2009;198:193-8.
19. Gignoux B, Blanchet MC, Lanz T, Vulliez A, Saffarini M, Bothorel H, *et al*. Should ambulatory appendectomy become the standard treatment for acute appendicitis? World J Emerg Surg. 2018;13:28.
20. Sand M, Trullen XV, Bechara FG, Pala XF, Sand D, Landgrafe G, *et al*. A prospective bicenter study investigating the diagnostic value of procalcitonin in patients with acute appendicitis. Eur Surg Res. 2009;43(3):291-7.
21. Haghi AR, Kasraianfard A, Monsef A, Kazemi AS, Rahimi S, Javadi SM. The diagnostic values of procalcitonin and interleukin 6 in acute appendicitis. Turk J Surg. 2019;35(1):19-22.
22. Vaziri M, Ehsanipour F, Pazouki A, Tamannaie Z, Taghavi R, Pishgahroudsari M, *et al*. Evaluation of procalcitonin as a biomarker of diagnosis, severity and postoperative complications in adult patients with acute appendicitis. Med J Islam Repub Iran. 2014;28(1):50.
23. Gavela T, Cabeza B, Serrano A, Casado-Flores J. C-reactive protein and procalcitonin are predictors of the severity of acute appendicitis in children. Pediatr Emerg Care. 2012;28(5):416-9.

24. Muenzer JT, Atkinson TP. Meropenem vs. Ceftriaxone effectiveness for acute abdominal infections. Pediatrics. 2006;54:123-35.
25. Singh H, Johri V, Saran TS. A comparative study to evaluate the positive predictive value of biochemical markers with clinical RIPASA score in acute appendicitis: An *in vivo* study. Asian J Pharm Clin Res. 2024;17(2):58-61. doi: 10.22159/ajpcr.2024.v17i2.48290
26. Yadav AK, Yadav SK, Sinha PK, Dwivedi MK, Singh SK, Ranjan R. Assessment of laparoscopic appendectomy in patients of complicated appendicitis in tertiary care teaching hospital of central India. Asian J Pharm Clin Res. 2022;15(3):164-166. doi: 10.22159/ajpcr.2022.v15i3.45925
27. Nivedita K, Viqhas KM, Alam MN, Shrikanth M. A study of clinicopathological profile in patients of appendicular perforation. Asian J Pharm Clin Res. 2023;16(11):86-8. doi: 10.22159/ajpcr.2023.v16i5.49523