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Abdominal Tuberculosis: Correlation Between Clinical, Radiologic and Pathological Findings

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Abstract

Background: Abdominal tuberculosis (ATB) presents with nonspecific clinical manifestations and overlapping radiological and pathological features, making diagnosis challenging. This study evaluated the correlation between clinical, radiological, pathological, and molecular findings and assessed their diagnostic performance in patients with suspected ATB.

Methods: In this cross-sectional diagnostic accuracy study, 220 adults with suspected ATB were evaluated. Patients were classified using a composite reference standard incorporating histopathology, microbiological confirmation, and clinicoradiological response where appropriate. Clinical features, contrast - enhanced computed tomography (CT), histopathology and tissue polymerase chain reaction (PCR) findings were analyzed using diagnostic accuracy measures, chi-square testing, and multivariable logistic regression.

Results: Of 220 participants, 132 were diagnosed with ATB. Weight loss, as cites, bowel-wall thickening, necrotic lymphadenopathy and peritoneal thickening were significantly associated with ATB. A CT composite incorporating ≥2 characteristic imaging features demonstrated 85.6% sensitivity, 89.2% specificity, and 86.8% diagnostic accuracy.

Histopathology showed 83.6% sensitivity and the highest specificity (93.2%) among tissue - based investigations, whereas tissue PCR demonstrated high

specificity (94.6%) but relatively low sensitivity (55.5%). Multivariable analysis identified bowel - wall thickening, as cites, necrotic lymphadenopathy, and weight loss as independent predictors of ATB.

Conclusion: Clinical assessment, CT imaging, histopathology, and tissue PCR provide complementary diagnostic information in abdominal tuberculosis. Histopathology remains the most reliable confirmatory investigation, while tissue PCR serves as a highly specific adjunctive test. A multimodal diagnostic approach improves diagnostic confidence and may facilitate earlier diagnosis of abdominal tuberculosis.

Keywords: Abdominal Tuberculosis, Computed Tomography, Histopathology, Tissue Polymerase Chain Reaction, Diagnostic Accuracy, Multimodal Diagnosis.

Introduction

Abdominal tuberculosis (ATB) is one of the most common forms of extra pulmonary tuberculosis in countries where tuberculosis remains endemic[1,2].It can involve the gastrointestinal tract, peritoneum, mesenteric lymph nodes, and solid abdominal organs either in isolation or in combination[1].Despite advances in diagnostic techniques, ATB continues to pose a major diagnostic challenge because of its nonspecific clinical presentation and its ability to mimic a wide spectrum of inflammatory and neo plastic disorders, including Crohn's disease, gastrointestinal malignancies, peritoneal carcinomatosis, and lymphoma[3,4].Early and accurate diagnosis is essential, as delayed treatment may result in bowel obstruction, perforation, fistula formation, or disseminated disease [2].

Patients with ATB commonly present with constitutional symptoms such as fever, weight loss, anorexia, and abdominal pain, accompanied by laboratory evidence of systemic inflammation or anemia[5]. However, these manifestations lack sufficient specificity to establish a definitive diagnosis. Consequently, clinicians rely on a combination of clinical assessment, imaging studies, microbiological investigations, and pathological examination to differentiate ATB from other abdominal diseases[3]. No single diagnostic modality provides adequate sensitivity and specificity across the diverse spectrum of disease presentations.

Contrast-enhanced computed tomography (CT) has become the imaging modality of choice for evaluating suspected ATB because it provides comprehensive assessment of bowel involvement, peritoneal disease, lymphadenopathy, and associated complications[6]. Characteristic CT findings - including as cites, smooth or nodular peritoneal thickening, necrotic mesenteric lymphadenopathy, ileocecal involvement, and bowel - wall thickening - can strongly suggest the diagnosis and guide tissue sampling[4,6]. Nevertheless, considerable overlap with malignant and inflammatory conditions limits the diagnostic specificity of imaging when interpreted in isolation[4,7].

Histopathological examination remains the cornerstone for confirmation of ATB, particularly when tissue biopsy demonstrates epithelioid Granulomas, caseous necrosis, or acid-fast bacilli [8].

However, classical pathological features are not uniformly present, especially in early disease or Immunocompromised patients, and granulomatous inflammation may also occur in several infectious and noninfectious disorders [7,8]. Molecular techniques such as polymerase chain reaction (PCR) provide rapid detection of Mycobacterium tuberculosis DNA and offer high diagnostic specificity, although their sensitivity varies depending on specimen quality, bacterial burden, and laboratory methodology[9,10]. Therefore, molecular tests

are best interpreted alongside clinical, radiological, and Histopathological findings rather than as stand-alone investigations[2,9]. Recent national and international recommendations advocate a multimodal diagnostic approach that integrates clinical features, radiological findings, micro biological evidence, and pathological examination to improve diagnostic confidence and reduce treatment delays [2,3].

Nevertheless, there remains limited evidence directly comparing the relative contribution of these diagnostic modalities within a single cohort using standardized diagnostic accuracy measures and multivariable statistical analysis, particularly in resource - constrained settings where advanced diagnostic facilities may not always be available.

The present study was undertaken to evaluate the correlation between clinical manifestations, contrast-enhanced CT findings, Histopathological features, and tissue PCR results in patients with suspected abdominal tuberculosis. In addition, we assessed the diagnostic performance of individual and composite diagnostic approaches and identified independent predictors of abdominal tuberculosis using multivariable logistic regression, with the aim of providing practical evidence to support an integrated diagnostic strategy.

Materials and Methods

Study Design and Setting

This cross-sectional diagnostic accuracy study included 220 consecutive adult patients evaluated for suspected abdominal tuberculosis (ATB). The study was designed to assess the diagnostic performance of clinical features, contrast-enhanced computed tomography (CECT), Histopathological examination, and tissue polymerase chain reaction (PCR), as well as the correlation among these diagnostic modalities.

Study Population

Adult patients (≥ 18 years) with clinical suspicion of abdominal tuberculosis who underwent clinical evaluation, abdominal CECT, Histopathological examination of tissue biopsy, and/or tissue PCR were included. Patients with incomplete diagnostic data, inadequate tissue specimens, or previously confirmed alternative diagnoses that fully explained the clinical presentation were excluded.

Using a predefined composite reference standard[3,9], participants were classified into two groups:

- **Abdominal tuberculosis (ATB) group:** n = 132
- **Non-abdominal tuberculosis (non-ATB) group:** n = 88

The composite reference standard incorporated compatible Histopathological findings, microbiological confirmation where available, and clinicoradiological response to antitubercular therapy when microbiological confirmation was unavailable[3].

Clinical Evaluation

Demographic characteristics and clinical variables were recorded, including age, sex, fever, abdominal pain, weight loss, anemia, and serum C-reactive protein (CRP) levels. Clinical findings were compared between the ATB and non-ATB groups.

Radiological Assessment

All patients underwent contrast-enhanced computed tomography (CECT) of the abdomen. The following predefined radiological variables were evaluated:

- As cites
- Necrotic mesenteric lymphadenopathy
- Ileocecal involvement
- Peritoneal thickening
- Bowel-wall thickening

A CT composite score was defined as the presence of two or more characteristic imaging features, and its diagnostic performance for abdominal tuberculosis was evaluated [4].

Histopathological Examination

Tissue biopsy specimens obtained from involved abdominal sites were routinely processed and stained with hematoxylin and eosin. Histopathological evaluation included assessment for

- Epithelioid granulomas
- Caseous necrosis
- Acid-fast bacilli (AFB), where Ziehl–Neelsen staining was performed Histopathological findings were interpreted in conjunction with clinical and radiological information[8].

Tissue Polymerase Chain Reaction

Tissue specimens were subjected to polymerase chain reaction (PCR) for detection of Mycobacterium tuberculosis DNA according to institutional laboratory protocols[10]. PCR results were analyzed independently and compared with the composite reference standard.

Outcome Measures

The primary outcome was the diagnostic accuracy of clinical assessment, CECT, histopathology, and tissue PCR for diagnosing abdominal tuberculosis.

Secondary outcomes included:

1. Correlation between clinical, radiological, pathological, and molecular findings;
2. Comparison of diagnostic performance among different modalities; and
3. Identification of independent predictors of abdominal tuberculosis.

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were summarized as frequencies and percentages. Group comparisons were performed using the independent-samples t-test for continuous variables and Pearson's chi-square test for categorical variables.

Diagnostic performance of the clinical composite, CT composite, histopathology, and tissue PCR was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy using the composite reference standard as the reference diagnosis.

Variables demonstrating clinical relevance were entered into a multivariable logistic regression model to identify independent predictors of abdominal tuberculosis. Predictor variables included fever, weight loss, anemia, as cites, necrotic lymphadenopathy, ileocecal involvement, peritoneal thickening, and bowel-wall thickening. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. Statistical significance was defined as a two-tailed p value <0.05.

Results

The cohort comprised 132 participants with ATB and 88 without ATB. Mean age was 43.0 ± 13.5 years in the ATB group and 37.9 ± 13.6 years in the non-ATB group. Men represented 56.4% of the cohort.

Table 1: Clinical characteristics

Variable	ATB (n=132)	Non-ATB (n=88)	p value
Age, mean ± SD (years)	43.0 ± 13.5	37.9 ± 13.6	0.006
Male sex	75 (56.8%)	49 (55.7%)	0.879
Fever	95 (72.0%)	26 (29.5%)	<0.001

Abdominal pain	103 (78.0%)	51 (58.0%)	0.002
Weight loss	82 (62.1%)	19 (21.6%)	<0.001
Anemia	77 (58.3%)	22 (25.0%)	<0.001
CRP, mean ± SD (mg/L)	74.1 ± 30.0	39.2 ± 22.0	<0.001

Table 2: CT findings

Finding	ATB n (%)	Non-ATB n (%)	p value
As cites	77 (58.3%)	16 (18.2%)	<0.001
Necrotic lymphadenopathy	73 (55.3%)	14 (15.9%)	<0.001
Ileocecal involvement	63 (47.7%)	11 (12.5%)	<0.001
Peritoneal thickening	73 (55.3%)	9 (10.2%)	<0.001
Bowel-wall thickening	66 (50.0%)	16 (18.2%)	<0.001
At least 2 CT signature findings	125 (94.7%)	8 (9.1%)	<0.001

Table 3: Pathological and molecular findings

Finding	ATB n (%)	Non-ATB n (%)	p value
Epithelioid granulomas	95 (72.0%)	7 (8.0%)	<0.001
Caseous necrosis	63 (47.7%)	1 (1.1%)	<0.001
AFB identified	32 (24.2%)	1 (1.1%)	<0.001
Tissue PCR positive	81 (61.4%)	4 (4.5%)	<0.001

Table 4: Diagnostic performance

Method	TP	TN	FP	FN	Sensitivity	Specificity	PPV	NPV	Accuracy
Clinical composite	106	61	13	40	72.6%	82.4%	89.1%	60.4%	75.9%
CT composite	125	66	8	21	85.6%	89.2%	94.0%	75.9%	86.8%
Histopathology	122	69	5	24	83.6%	93.2%	96.1%	74.2%	86.8%
Tissue PCR	81	70	4	65	55.5%	94.6%	95.3%	51.9%	68.6%

Table 5: Multivariable logistic regression

Predictor	OR	95% CI	p value
Fever	3.31	1.16–9.40	0.025
Weight loss	9.16	2.80–29.93	<0.001
Anemia	3.54	1.23–10.24	0.020
As cites	11.94	3.47–41.13	<0.001
Necrotic lymphadenopathy	7.47	2.20–25.38	0.001
Ileocecal involvement	7.46	2.32–24.04	0.001
Peritoneal thickening	6.49	2.01–20.93	0.002
Bowel-wall thickening	17.88	4.44–71.91	<0.001

The CT composite was strongly associated with ATB ($\chi^2 = 111.84$, $p < 0.001$). In adjusted analysis, bowel-wall thickening and ascites demonstrated the largest associations. Histopathology showed the best specificity among tissue-based approaches, whereas PCR was highly specific but less sensitive.

Discussion

Abdominal tuberculosis (ATB) remains a significant diagnostic challenge because of its diverse clinical manifestations and its considerable overlap with inflammatory, infectious, and malignant gastrointestinal disorders[3,7].

The present study evaluated the relationship between clinical presentation, contrast - enhanced computed tomography (CECT), Histopathological findings, and tissue polymerase chain reaction (PCR), while also comparing the diagnostic performance of these complementary modalities. Our findings demonstrate that no single investigation is sufficient for establishing the diagnosis in all patients; rather, integration of clinical, radiological, pathological, and molecular information provides the highest diagnostic confidence [2,3].

Constitutional symptoms, particularly fever and weight loss, were significantly more common in patients with ATB than in the non-ATB group. Although these findings are consistent with the chronic inflammatory nature of tuberculosis, they are inherently nonspecific and overlap with several infectious, inflammatory, and malignant abdominal diseases[5]. Consequently, clinical features should be regarded as indicators of diagnostic suspicion rather than definitive evidence of disease. In the present study, weight loss remained an independent predictor of ATB on multivariable analysis, supporting previous reports that constitutional symptoms continue to have important diagnostic value when interpreted alongside objective investigations [5,12].

Among the radiological variables evaluated, as cites, necrotic lymphadenopathy, ileocecal involvement, peritoneal thickening, and bowel-wall thickening were all significantly associated with abdominal tuberculosis. These imaging findings correspond closely to the established Patho physiological spectrum of abdominal tuberculosis, which includes peritoneal inflammation, granulomatous lymphadenitis, and transmural intestinal involvement[1,6]. Importantly, the CT composite requiring the presence of two or more characteristic imaging features demonstrated high diagnostic performance, highlighting the value of recognizing combinations of radiological findings rather than relying on isolated abnormalities[4]. This observation supports current diagnostic recommendations emphasizing pattern recognition in abdominal imaging rather than single imaging signs [3,4].

Multivariable logistic regression further demonstrated that bowel-wall thickening and as cites exhibited the strongest independent associations with abdominal tuberculosis, followed by necrotic lymphadenopathy and ileocecal involvement.

These findings suggest that imaging features reflecting active intestinal and peritoneal disease provide greater diagnostic discrimination than constitutional symptoms alone[4,12]. Such predictors may assist clinicians in prioritizing tissue biopsy in patients presenting with nonspecific abdominal complaints, particularly in tuberculosis-endemic regions where timely diagnosis is essential [3].

Histopathological examination continues to represent the diagnostic cornerstone for abdominal tuberculosis [8]. In this study, histopathology demonstrated excellent

specificity together with high overall diagnostic accuracy. The identification of epithelioid granulomas and caseous necrosis remains highly supportive of tuberculosis in the appropriate clinical setting, although neither finding is universally present[7,8]. Furthermore, granulomatous inflammation may occur in several alternative conditions, including Crohn's disease, fungal infections, sarcoidosis, and foreign-body reactions[13-15]. Therefore, pathological interpretation should always incorporate clinical history, radiological findings, microbiological investigations, and relevant differential diagnoses [7, 15].

Tissue PCR demonstrated very high specificity but comparatively lower sensitivity than Histopathological examination. This pattern is biologically plausible because PCR performance depends on bacterial load, tissue preservation, DNA extraction efficiency, and sampling adequacy[9, 10, 16]. Consequently, a positive PCR result strongly supports the diagnosis of abdominal tuberculosis, whereas a negative result should not exclude disease when characteristic clinical, radiological, and pathological features are present[9, 11]. These findings reinforce the complementary role of molecular testing as an adjunct rather than a replacement for conventional Histopathological evaluation [2, 10].

The present findings are consistent with contemporary literature demonstrating that abdominal tuberculosis is best diagnosed using a multimodal approach [2,3]. Previous studies have similarly shown that characteristic CECT findings substantially improve pre-biopsy diagnostic suspicion [4,6], while histopathology remains the principal confirmatory investigation [8]. Molecular techniques have further enhanced diagnostic specificity but continue to exhibit variable sensitivity depending on disease burden and specimen quality[9,10].

Collectively, these observations support current international recommendations advocating integration of clinical, radiological, microbiological, and pathological evidence when evaluating patients with suspected abdominal tuberculosis [2,3,16].

The clinical implications of this study are particularly relevant for healthcare systems in tuberculosis-endemic and resource-constrained settings[1,3]. Recognition of characteristic combinations of clinical symptoms and CT findings may facilitate earlier identification of patients requiring tissue diagnosis, thereby reducing diagnostic delay and avoiding unnecessary surgical intervention or empirical treatment for alternative diseases[3,13]. Similarly, understanding the complementary strengths and limitations of histopathology and tissue PCR can help clinicians interpret discordant results more appropriately and improve multidisciplinary decision-making.

The strengths of the present study include simultaneous evaluation of four major diagnostic domains, comparison of their individual diagnostic performance using standard diagnostic accuracy measures, and assessment of independent predictors using multivariable logistic regression. This integrated analytical approach reflects routine clinical practice more closely than studies evaluating individual diagnostic tests in isolation.

Several limitations should be acknowledged. The study was cross-sectional and therefore does not provide longitudinal information regarding treatment response or long-term clinical outcomes. Imaging interpretation was not evaluated for inter observer variability, which may influence the reproducibility of CT findings. Additionally, microbiological culture and advanced molecular techniques such as Gene Xpert MTB/RIF Ultra were not included in the comparative analysis.

Future prospective multicenter studies incorporating standardized imaging protocols, comprehensive microbiological evaluation, and long-term follow-up are warranted to validate these findings and further optimize diagnostic algorithms for abdominal tuberculosis.

Conclusion

Abdominal tuberculosis remains a diagnostic challenge because of its nonspecific clinical presentation and overlap with several inflammatory and malignant abdominal disorders. Our findings support a multimodal diagnostic strategy in which clinical assessment, characteristic CECT findings, Histopathological examination, and tissue PCR are interpreted collectively to maximize diagnostic accuracy. Histopathology remains the cornerstone for diagnostic confirmation, whereas tissue PCR provides a highly specific adjunctive tool despite its lower sensitivity. Recognition of characteristic imaging patterns and their integration with pathological and molecular findings can improve diagnostic confidence, facilitate timely treatment, and reduce diagnostic delay, particularly in tuberculosis-endemic and resource-limited settings. Prospective multicenter validation using standardized diagnostic criteria is required before these findings can be broadly generalized.

Ethics Approval

The study protocol was approved by the Institutional Ethics Committee. The study was conducted in accordance with the applicable institutional guidelines. Written informed consent was obtained from all participants or was waived by the Institutional Ethics Committee for retrospective analysis, as applicable.

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