Clinico-Demographic and Imaging Profile of Pediatric Patients with Abdominal Tuberculosis

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Abstract

Background: Abdominal tuberculosis (ATB) in children presents a diagnostic challenge due to its nonspecific clinical presentation and low microbiological yield. Imaging plays a crucial role in supporting diagnosis, particularly in resource-limited and high-burden settings.
Objective: To describe the clinico-demographic profile and imaging spectrum of pediatric abdominal tuberculosis and to evaluate imaging findings stratified by diagnostic categories.
Methods: This retrospective study included 50 pediatric patients (aged 1–14 years) diagnosed with abdominal tuberculosis at a tertiary care center over a one-year period. Cases were categorized as microbiologically confirmed, histopathology-confirmed, or probable tuberculosis based on predefined criteria. Clinical, laboratory, and imaging data were analyzed. Ultrasound and contrast-enhanced computed tomography findings were reviewed using standardized definitions. Imaging features were stratified according to diagnostic category, and exploratory statistical analysis was performed.
Results: The study included 28 males and 22 females, with a mean age of 8.2 ± 3.5 years. The most common clinical features were ascites (72%), abdominal pain (62%), and weight loss (40%). Diagnostic classification revealed 15 microbiologically confirmed, 25 histopathology-confirmed, and 10 probable cases. Ascites was the most frequent imaging finding on both ultrasound and CT. Other common findings included mesenteric lymphadenopathy, bowel wall thickening, and omental involvement. Stratified analysis demonstrated that ascites was prevalent across all diagnostic categories (80%, 72%, and 60%, respectively). Necrotic lymphadenopathy, bowel wall thickening, and omental thickening showed overlapping distributions among groups, with no statistically significant differences ($p > 0.05$). GeneXpert positivity was significantly associated with necrotic lymphadenopathy ($p < 0.05$).
Conclusion: Pediatric abdominal tuberculosis demonstrates a spectrum of overlapping imaging findings across diagnostic categories. While features such as ascites and necrotic lymphadenopathy are common, they are not specific to confirmed disease. Imaging plays an important supportive role, particularly in probable cases lacking microbiological confirmation. An integrated approach combining clinical, laboratory, and radiological findings is essential for timely diagnosis and management.

Keywords: Pediatric abdominal tuberculosis; ultrasound; Computed Tomography (CT); Extrapulmonary tuberculosis; Mesenteric lymphadenopathy

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Introduction

Abdominal tuberculosis (ATB) is an important form of extrapulmonary tuberculosis in children and poses significant diagnostic challenges, particularly in endemic regions. Although pulmonary tuberculosis is the most common manifestation in the pediatric population, abdominal tuberculosis accounts for approximately 0.3–4% of all childhood TB cases (1-3). The clinical presentation of abdominal TB is nonspecific and has a wide spectrum, ranging from mild abdominal pain with lymphadenopathy and ascites to severe complications like intestinal perforation, bleeding, and obstruction. The

diagnosis of abdominal TB remains challenging , and a high index of clinical suspicion is required. Histopathological observation of typical caseating granulomas has been reported in around 40% of abdominal TB, but more so in lymph node (LN) specimens only [4,5]. Isolation of acid-fast bacilli (AFB) by microscopy or culture in body fluids or tissue biopsies is the diagnostic gold standard, but the yield is low [6]. Ascitic adenosine deaminase (ADA) levels have been reported sensitivity and specificity of 93% and 96% respectively, but they can have false negatives in malignant ascites and HIV [7]. The Cartridge-Based Nucleic Acid Amplification Test (CBNAAT) is a real-time PCR assay designed to detect Mycobacterium tuberculosis and rifampicin resistance. It offers rapid results with high specificity, though its sensitivity can be variable [8]. Radiological imaging may reveal suggestive but non-pathognomonic findings. The search for rapid clinical and investigational diagnosis and management of abdominal TB, which is crucial but still a challenge, continues.

The present study aims to describe the clinico-demographic characteristics and standardized imaging spectrum of pediatric abdominal tuberculosis in a tertiary care center, while stratifying findings according to diagnostic certainty.

Methods

Study Design and Setting:

This retrospective study was conducted in the Departments of Radiodiagnosis and Pediatrics at Al-Falah School of Medical Science and Research centre, Faridabad, Haryana over a period of 1 year (May 2022 to May 2023 after getting approval from the Institutional Ethics Committee (IEC) **(Ref, No AFSMS&RC/ F-01/23/106).** Due to the retrospective design, a waiver of informed consent was granted, and all patient data were anonymized prior to analysis.

Case Identification and Sampling:

Patients were identified through review of hospital medical records, pediatric TB clinic registers, and radiology databases. Consecutive patients meeting eligibility criteria during the study period were included.

Inclusion Criteria

- Patients in the age group of 1 year to 14 years
- Patients diagnosed with abdominal tuberculosis based on clinical and imaging features
- Availability of complete medical records

Exclusion Criteria

- Patients less than 1 year and more than 14 years

- Patients with incomplete records
- Cases where an alternative diagnosis (e.g., lymphoma, Crohn's disease) was established

Diagnostic Classification:

Cases were classified into the following predefined categories:

1. Confirmed TB: Microbiological confirmation by AFB smear, culture, or CBNAAT/GeneXpert positive from abdominal specimen including ascitic fluid, lymph node aspirate, bowel biopsy, or tissue sample).

2. Histopathology-Confirmed TB: Granulomatous inflammation with caseation consistent with tuberculosis on tissue sampling, with no alternative diagnosis.

3. Probable TB: Clinical features suggestive of TB with supportive epidemiology and imaging findings, negative microbiological/histopathological results, and documented clinical response to anti-tubercular therapy.

Imaging Evaluation:

Ultrasound and CT images were reviewed retrospectively from stored radiology records. Imaging had originally been interpreted by consultant radiologists as part of routine clinical care. For study purposes, reports were reviewed by two radiologists in consensus.

Ultrasound Technique:
Abdominal ultrasound was performed using high-frequency linear and curvilinear probes (3–12 MHz). Doppler assessment was performed where indicated.

CT Technique:
Contrast-enhanced CT (CECT) of the abdomen was performed in portal venous phase following intravenous contrast administration.

Imaging Definitions:
- Necrotic lymph node: Enlarged node with central low attenuation and peripheral rim enhancement on CECT.
- Bowel wall thickening: Circumferential wall thickness >3 mm in adequately distended small bowel.
- Omental thickening/caking: Diffuse or nodular soft tissue infiltration of omental fat.
- Ascites: Classified as free or loculated; internal echoes/septations noted on ultrasound.

Statistical Analysis :

Statistical analysis was exploratory in nature and limited by the sample size. Associations between imaging findings and diagnostic categories were assessed using chi-square or Fisher's exact test where appropriate.

Results

Of the 50 patients, 22 were female (44%), and 28 (56%) were male. The age range was 1 year to 14 years, with a mean of 8.2 ± 3.5 years. The duration of symptoms ranged from 10 days to 3 years (mean: 109 days). In 22 cases (44 %), there was a history of contact with an adult diagnosed with pulmonary tuberculosis.

Diagnostic Categories:

- Confirmed TB (microbiological): 15 patients
- Histopathology-confirmed TB: 25 patients
- Probable TB: 10 patients

The most common symptoms and signs were ascites, abdominal pain, abdominal distention, weight loss, and fever (Table 1)

Table 1. Signs and symptoms of the patients at the time of presentation.

Symptom	Number	Percentage
Ascites	36	72%
Abdominal Pain	31	62%
Abdominal distention	21	42%
Weight loss	20	40%
Fever	16	32%

Anemia was present in 72% of patients with elevated ESR in 80%, Positive Mantoux test in 68% and positive GeneXpert in 30 % cases (Table 2)

Table 2. Laboratory Findings

Parameter	Number	Percentage
Anemia	36	72%
Elevated ESR	40	80%
Positive Mantoux test	34	68%
Positive GeneXpert	15	30%

Chest X-rays of 20 patients were consistent with pulmonary tuberculosis. Forty-one patients were assessed by abdominal ultrasound, and the most frequent findings were ascites, mesenteric lymphadenopathy, hepatic enlargement, splenic enlargement, and thickening of the intestinal loops (Table 3).Twenty-two patients underwent Contrast-

enhanced CT (CECT). The most common findings on abdominal computed tomography (CECT) were ascites, mesenteric lymphadenopathy (Figure 1), mesenteric thickening, omental thickening (Figure 2), thickening of the intestinal loops (Figure 3), hepatic enlargement, splenic enlargement, intra-abdominal mass, and pelvic mass (Table 4).

Table 3. Abdominal ultrasound findings(% calculated out of patients who underwent USG n= 41)

Finding	Number	Percentage
Ascites	33	80.49%
Mesenteric Lymphadenopathy	12	29.3%
Hepatic enlargement	8	19.5%
Splenic enlargement	8	19.5%
Thickening of intestinal loops	7	17%

Table 4. Abdominal computed tomography findings(% calculated out of patients who underwent CT n= 22)

Finding	Number	Percentage
Ascites	11	50%
Mesenteric Lymphadenopathy	9	40.9%
Mesenteric thickening	5	22.7%
Omental thickening	4	18.2%
Thickening of intestinal loops	4	18.2%
Hepatic enlargement	3	13.6%
Splenic enlargement	2	9%
Abdominal mass	1	4.5%
Pelvic mass	1	4.5%

Imaging findings were further stratified according to diagnostic categories (Table 5). Ascites was the most common imaging finding across all groups, with slightly higher

prevalence in microbiologically and histopathology-confirmed cases compared to probable TB. Necrotic lymphadenopathy was observed across all groups, with a marginally higher proportion in probable cases. Bowel wall thickening and omental involvement were present in all diagnostic categories with overlapping distribution. However, no statistically significant association was found between imaging findings and diagnostic categories, likely due to the limited sample size. The analysis was exploratory in nature.

Pathological examination of specimens obtained during ultrasound-guided fine needle aspiration, biopsy (n=16) , laparotomy (n=6) and laparoscopy (n=3) revealed chronic granulomatous inflammation. Exploratory analysis showed GeneXpert positivity was associated with necrotic lymphadenopathy ($p < 0.05$). Other associations were not statistically significant.

Table 5 : Stratification of key Imaging findings by diagnostic category

Imaging Finding	**Microbiologically Confirmed TB(n=15)**	**Histopathology Confirmed TB (n=25)**	**Probable TB (n=10)**	**p-value**
Ascites	12(80%)	18(72%)	6(60%)	0.45
Necrotic lymph nodes	3(20%)	6(24%)	3(30%)	0.82
Bowel wall thickening	3(20%)	5(20%)	1(10%)	0.78
Omental thickening	2(13.3%)	2(8%)	0(0%)	0.52

Note: Stratified analysis presented to reduce interpretative bias. Statistical analysis is exploratory due to limited sample size.

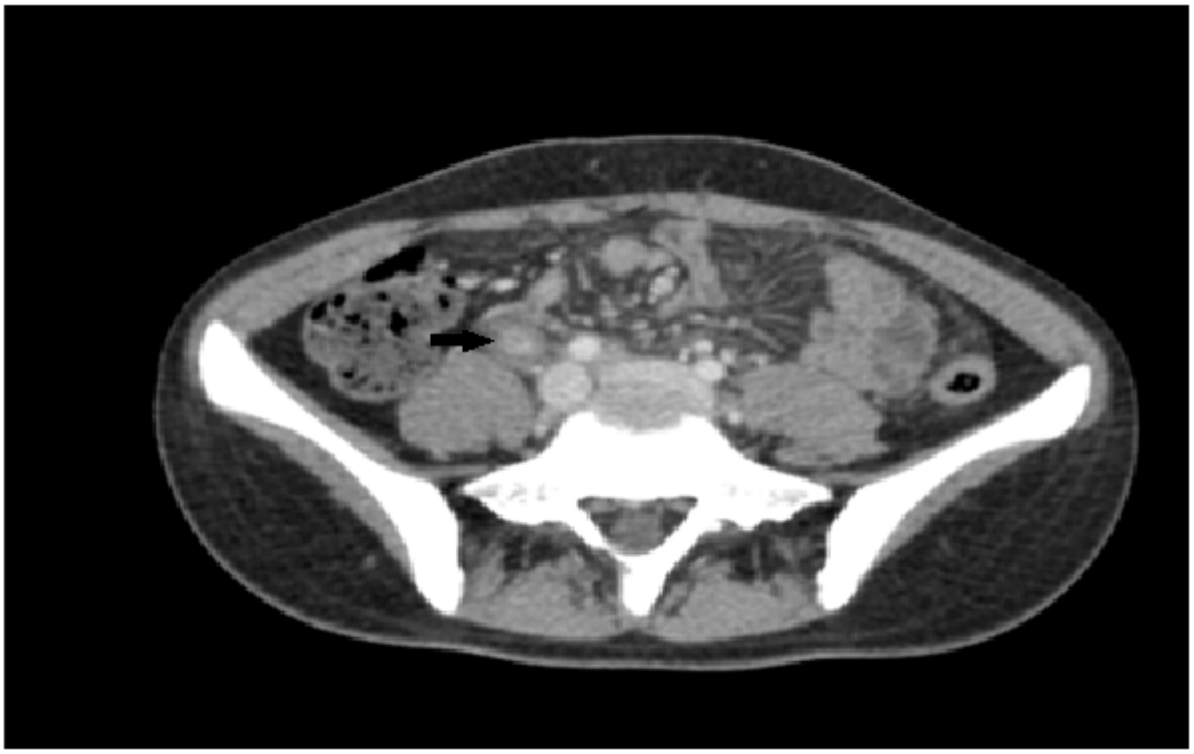

Figure 1 : Axial Contrast enhanced CT (Portal venous phase)of Abdomen in a 13 year old patient demonstrating an enlarged right common iliac lymph node (black arrow) located anteromedial to right common iliac vessels with a few non-enhancing necrotic areas within.

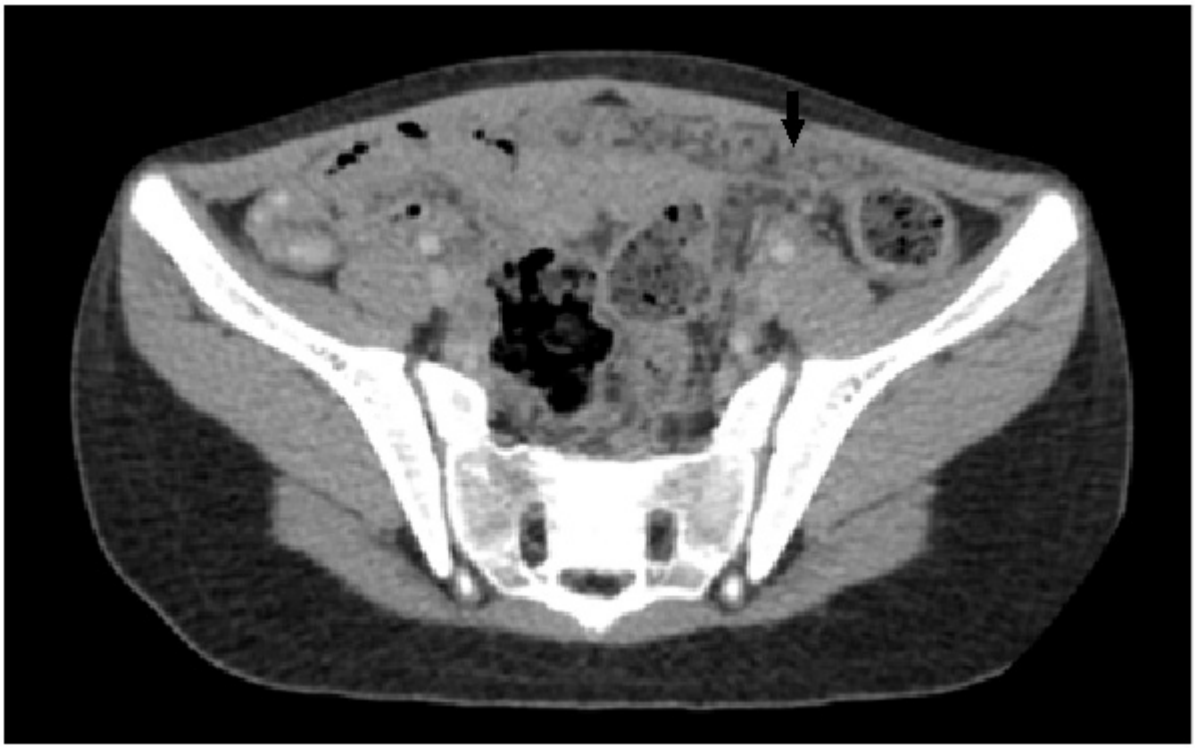

Figure 2: Axial Contrast enhanced CT(Portal venous phase) of abdomen in a 13 year old patient demonstrating omental thickening with nodular soft tissue infiltration “Omental Caking” (black arrow)

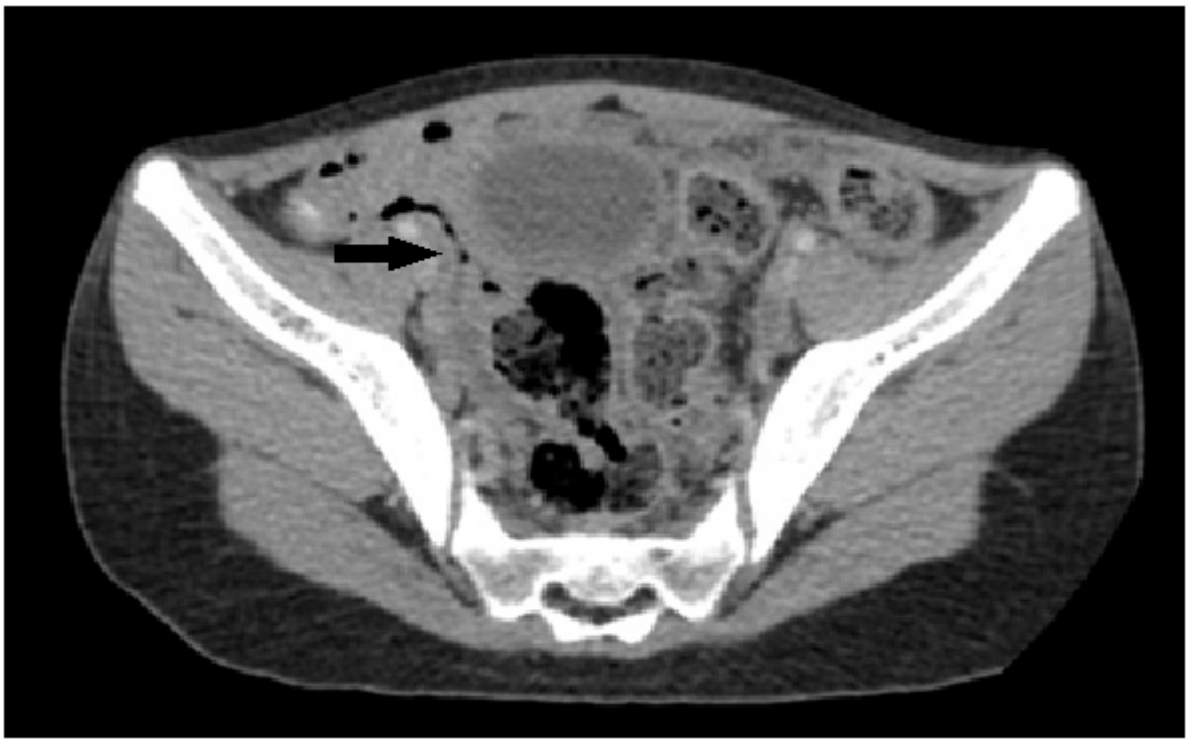

Figure 3 : Axial Contrast enhanced CT(Portal venous Phase) of pelvis in a 14 year old patient demonstrating circumferential wall thickening of terminal ileum(black arrow) with surrounding inflammatory changes.

Discussion

Abdominal tuberculosis (ATB) remains an important cause of chronic abdominal morbidity in children in endemic regions such as India, where delayed diagnosis continues to contribute to significant disease burden. The present study highlights the clinico-demographic profile and imaging spectrum of pediatric abdominal tuberculosis, emphasizing the role of radiologic evaluation in early diagnosis and disease characterization.

In the present cohort, peritoneal tuberculosis was the most common form, followed by intestinal involvement. This distribution is consistent with previous studies from endemic regions that report peritoneal involvement as the predominant manifestation in pediatric abdominal TB [4,9,10]. The nonspecific clinical presentation observed in this study—including abdominal pain, ascites, fever, and weight loss (Table 1)—closely mirrors earlier reports and contributes to frequent diagnostic delays due to overlap with inflammatory bowel disease, lymphoma, and other chronic intra-abdominal conditions [11].

Differential Diagnosis:
- Crohn's disease: Skip lesions, comb sign, absence of necrotic lymph nodes.
- Lymphoma: Bulky homogeneous lymphadenopathy without central necrosis.
- Peritoneal carcinomatosis: Irregular peritoneal nodularity without necrotic nodes.

Ultrasonography was the initial imaging modality in the majority of patients and demonstrated ascites and mesenteric lymphadenopathy as the most frequent findings (Table 3). These sonographic features, although not pathognomonic, are well-recognized indicators of abdominal tuberculosis when present in combination, particularly in endemic settings [12,13]. Additional findings such as bowel wall thickening and hepatosplenomegaly further supported the diagnosis in appropriate clinical contexts.

Contrast-enhanced computed tomography (CT) provided superior anatomical delineation and comprehensive disease mapping. In this study, CT most commonly demonstrated ascites, necrotic mesenteric lymphadenopathy, mesenteric and omental thickening, and bowel loop involvement (Table 4). These imaging features have been consistently described as characteristic of abdominal tuberculosis and are helpful in differentiating it from Crohn's disease and intra-abdominal malignancies [14–16]. The coexistence of multiple CT findings significantly increased diagnostic confidence and aided in identifying optimal sites for image-guided biopsy or aspiration.

Despite advances in microbiological diagnostics, bacteriological confirmation remains challenging in pediatric abdominal tuberculosis due to the paucibacillary nature of the disease. In the present study, GeneXpert positivity was limited (Table 2), consistent with previously reported variable sensitivities in extrapulmonary tuberculosis [8]. Histopathological demonstration of granulomatous inflammation, although not universally present, remains an important diagnostic adjunct. Consequently, imaging assumes a central role in establishing the diagnosis when microbiological and histopathological results are inconclusive.

Based on the findings of this study and existing literature, a stepwise imaging-based diagnostic approach is advocated. Ultrasonography should be employed as the first-line imaging modality in suspected cases, followed by contrast-enhanced CT for detailed assessment of disease extent, complications, and guidance for tissue sampling. In patients with strong clinical suspicion and characteristic imaging findings, empirical anti-tubercular therapy may be justified even in the absence of microbiological confirmation, with close clinical and radiologic follow-up, as supported by current recommendations [17].

Correlation of imaging findings with clinical and laboratory parameters further underscores the diagnostic value of radiology. Ascites, the most common presenting feature (Table 1), corresponded with its high prevalence on ultrasonography and CT

(Tables 3 and 4). Mesenteric lymphadenopathy and bowel wall thickening showed close association with laboratory abnormalities such as anemia, elevated erythrocyte sedimentation rate, and positive Mantoux test (Table 2), although these laboratory parameters remained nonspecific. The integration of imaging with clinical and laboratory findings enabled diagnosis in both microbiologically confirmed and empirically treated cases.

The stratified imaging analysis (Table 5) demonstrated overlapping radiological features across diagnostic categories, underscoring the supportive role of imaging in abdominal tuberculosis. Although certain findings such as necrotic lymphadenopathy showed variation between groups, these differences were not statistically significant, highlighting the need for combined clinical, laboratory, and imaging correlation.

Pediatric-Specific Considerations:
Children more commonly demonstrate prominent lymphadenopathy, disseminated involvement, and nonspecific symptoms. Ultrasound remains preferred first-line imaging due to radiation considerations.
The limitations of this study include its retrospective design and relatively small sample size. Additionally, not all patients underwent both ultrasonography and CT, which may have limited direct comparison between modalities. Nevertheless, the study reinforces the indispensable role of imaging in the diagnostic evaluation of pediatric abdominal tuberculosis.

Conclusion

Pediatric abdominal tuberculosis continues to pose significant diagnostic challenges due to its nonspecific clinical presentation and low microbiological yield. In endemic regions, imaging plays an important role in early diagnosis and disease characterization. Ultrasonography serves as an effective first-line modality for detecting ascites, lymphadenopathy, and bowel involvement, while contrast-enhanced computed tomography provides comprehensive assessment of disease extent, identifies characteristic features such as necrotic lymph nodes, mesenteric and omental thickening, and guides image-directed tissue sampling.

In the appropriate clinical and epidemiological setting, a constellation of imaging findings can strongly suggest abdominal tuberculosis even in the absence of microbiological confirmation. An imaging-driven diagnostic approach, integrated with clinical and laboratory parameters, facilitates timely initiation of therapy, reduces diagnostic delays, and minimizes the need for invasive procedures in children.

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Declarations

Consent for publication: The author clarifies that written informed consent was obtained and the anonymity of the patient was ensured. This study submitted to Swiss J. Rad. Nucl. Med. has been conducted in accordance with the Declaration of Helsinki and according to requirements of all applicable local and international standards. All authors contributed to the conception and design of the manuscript, participated in drafting and revising the content critically for important intellectual input, and approved the final version for publication. Each author agrees to be accountable for all aspects of the work, ensuring its accuracy and integrity.

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