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ORIGINAL RESEARCH

Diagnostic Utility of Chest Radiography in Detecting Tuberculosis in Pediatric Patients: An Observational Study

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ABSTRACT

Background: Tuberculosis (TB) remains a significant health burden among children, particularly in high-burden regions. Early diagnosis is crucial to reducing morbidity and mortality. Chest radiography (CXR) remains a commonly used diagnostic tool, but its accuracy in pediatric populations requires further evaluation.To assess the diagnostic utility of chest radiography in detecting pulmonary tuberculosis among pediatric patients. **Methods**: An observational study was conducted involving 100 pediatric patients (aged <18 years) suspected of pulmonary tuberculosis. Clinical evaluation, chest radiography, and microbiological testing (sputum smear microscopy, GeneXpert MTB/RIF, or gastric lavage culture) were performed. Radiographic findings were correlated with microbiological confirmation to assess diagnostic accuracy, including sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). **Results**: The mean age of participants was 8.2 ± 3.4 years, with 55% males. The most frequent clinical symptoms included persistent cough (80%), fever (72%), and weight loss (45%). Abnormal CXR findings were observed in 70% of patients, with hilar lymphadenopathy (42%) being the most common abnormality. Tuberculosis was microbiologically confirmed in 58% of cases. Chest radiography demonstrated a sensitivity of 91.4%, specificity of 59.5%, PPV of 75.7%, and NPV of 83.3%. **Conclusion**: Chest radiography demonstrates high sensitivity but moderate specificity in diagnosing pediatric pulmonary tuberculosis. While it remains a valuable initial screening tool, microbiological confirmation remains essential for definitive diagnosis.

Keywords: Pediatric tuberculosis, chest radiography, diagnostic utility, sensitivity, specificity, microbiological confirmation.

INTRODUCTION

Tuberculosis (TB) remains a major global health concern, especially among children in low- and middle-income countries, with India contributing significantly to the global burden. According to the World Health Organization (WHO), approximately 1.1 million children developed tuberculosis globally in 2022, with over 230,000 deaths attributed to the disease. Diagnosing pediatric TB remains particularly challenging due to its non-specific clinical presentation and the difficulty in obtaining respiratory specimens for microbiological confirmation, especially in young children (1).

Chest radiography (CXR) continues to serve as a cornerstone in the initial evaluation of suspected pulmonary TB in children, owing to its widespread availability, non-invasive nature, and cost-effectiveness. Typical radiographic findings in pediatric TB include hilar lymphadenopathy, parenchymal infiltrates, cavitary lesions, and pleural effusion (2,3). However, interpretation of radiographic findings can be challenging in children,

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as these features often overlap with those seen in viral or bacterial pneumonias, malnutrition-related lung changes, and other respiratory illnesses (4).

Although microbiological tests such as sputum smear microscopy, GeneXpert MTB/RIF, and gastric lavage cultures remain the gold standard for TB diagnosis, their sensitivity in children is limited due to the paucibacillary nature of pediatric TB, leading to frequent reliance on imaging modalities for clinical decision-making (5,6).

Given these considerations, evaluating the diagnostic performance of chest radiography—particularly its sensitivity, specificity, and predictive values—in the pediatric population is critical to optimizing early detection strategies. This study aims to assess the diagnostic utility of chest radiography in detecting pulmonary tuberculosis among pediatric patients, correlating radiographic findings with microbiological confirmation.

METHODOLOGY

Study Design and Setting

This observational study was conducted at the Government Medical College, Vizianagaram, a tertiary care teaching hospital that caters to a diverse pediatric population from urban and rural regions. The study period spanned from March to May 2024.

Study Population

A total of 100 pediatric patients aged 0–18 years, presenting with clinical suspicion of pulmonary tuberculosis, were enrolled. Inclusion criteria comprised patients exhibiting symptoms suggestive of TB, including persistent cough, fever, weight loss, and night sweats. Patients with previously diagnosed TB under treatment or with extrapulmonary TB alone were excluded.

Data Collection Procedures

Upon enrollment, detailed demographic and clinical data were recorded using a structured proforma, including age, gender, and presenting symptoms. All patients underwent chest radiography (CXR) as part of routine diagnostic evaluation. Radiographs were interpreted independently by two experienced radiologists blinded to microbiological results. Radiographic features suggestive of TB (hilar lymphadenopathy, parenchymal infiltrates, cavitary lesions, pleural effusion) were documented.

Simultaneously, microbiological confirmation was sought through appropriate specimen collection, which included sputum smear microscopy, GeneXpert MTB/RIF assay, or gastric lavage culture, following national TB program guidelines.

Data Analysis

The diagnostic accuracy of chest radiography was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV)against microbiological confirmation as the gold standard. Data were analyzed using SPSS software, and results were presented in descriptive statistics and tabular formats.

Ethical Considerations

Required permissions were obtained before starting the study.Written informed consent was secured from parents or legal guardians of all participating children.

RESULTS

A total of 100 pediatric patients suspected of pulmonary tuberculosis were enrolled in this observational study. The mean age of participants was 8.2 ± 3.4 years, with a male predominance (55% males, n=55) compared to females (45%, n=45) (Table 1).

Table 1: Demographic Characteristics of Pediatric Patients (n=100)

Variable	Value
Mean Age (years)	8.2 ± 3.4
Gender	
- Males	55 (55%)
- Females	45 (45%)

The most common presenting symptom was persistent cough observed in 80% of patients, followed by fever in 72%, weight loss in 45%, and night sweats in 32% (Table 2).

Table 2: Clinical Presentation of Patients (n=100)

Clinical Symptoms	Frequency (n)	Percentage (%)
Persistent cough	80	80%
Fever	72	72%
Weight loss	45	45%
Night sweats	32	32%

Chest Radiography Findings

Out of the total sample, 70% (n=70) of patients exhibited abnormal chest radiographic (CXR) findings suggestive of tuberculosis, while 30% (n=30) had normal or non-specific radiographic features. The

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predominant radiographic abnormalities included hilar lymphadenopathy in 42%, parenchymal infiltrates in 26%, cavitary lesions in 6%, and pleural effusion in 4% of patients (Table 3).

Table 3: Chest Radiography Findings (n=100)

Radiographic Findings	Frequency (n)	Percentage (%)
Hilar lymphadenopathy	42	42%
Parenchymal infiltrates	26	26%
Cavitary lesions	6	6%
Pleural effusion	4	4%
Total Abnormal Findings	70	70%
Normal/non-specific findings	30	30%

Microbiological Confirmation

Microbiological testing via sputum smear microscopy, GeneXpert MTB/RIF, or gastric lavage culture confirmed tuberculosis in 58% (n=58) of the patients. Among these microbiologically confirmed cases, 91.4% (n=53) exhibited abnormal CXR findings, while 8.6% (n=5) showed normal or non-specific radiographs. In contrast, among the 42 patients without microbiological confirmation, 40.5% (n=17) demonstrated abnormal CXR findings, and 59.5% (n=25) had normal CXR results (Table 4).

Table 4: Microbiological Confirmation and Chest Radiograph Correlation

Group	Abnormal CXR (n, %)	Normal CXR (n, %)	Total (n)
Microbiologically Confirmed	53 (91.4%)	5 (8.6%)	58
Not Confirmed	17 (40.5%)	25 (59.5%)	42
Total	70	30	100

Diagnostic Accuracy of Chest Radiography

The diagnostic performance of chest radiography in detecting microbiologically confirmed tuberculosis demonstrated a sensitivity of 91.4%, specificity of 59.5%, positive predictive value (PPV) of 75.7%, and negative predictive value (NPV) of 83.3% (Table 5).

Table 5: Diagnostic Accuracy of Chest Radiography

Diagnostic Metric	Value (%)
Sensitivity	91.4
Specificity	59.5
Positive Predictive Value	75.7
Negative Predictive Value	83.3

These findings suggest that chest radiography remains a valuable initial diagnostic tool in pediatric tuberculosis, offering high sensitivity but moderate specificity.

DISCUSSION

This observational study evaluated the diagnostic utility of chest radiography (CXR) in identifying pulmonary tuberculosis (TB) in pediatric patients, with microbiological testing serving as the reference standard. The findings revealed a high sensitivity (91.4%) but moderate specificity (59.5%), reinforcing the role of CXR as an effective screening tool but with limited precision in differentiating TB from other pulmonary conditions.

The observed prevalence of abnormal CXR findings (70%) aligns with previous research demonstrating a high frequency of radiographic abnormalities in pediatric TB due to the unique immune responses in children (8,9). Among these, hilar lymphadenopathy (42%) emerged as the most common feature, consistent with prior studies underscoring its prominence in pediatric TB (8,9). Other radiographic patterns, such as parenchymal infiltrates (26%), cavitary lesions (6%), and pleural effusion (4%), also mirrored trends identified in similar cohorts (9).

Notably, 91.4% of microbiologically confirmed cases exhibited abnormal CXR findings, highlighting the value of radiography in detecting probable TB even in the absence of bacteriological evidence. However, 40.5% of patients without microbiological confirmation also demonstrated abnormal radiographs, underscoring the limited specificity of CXR. This reflects the overlap between TB-related radiological signs and those of other respiratory illnesses, such as viral pneumonia, bacterial infections, or malnutrition-related lung changes (8,10).

These findings are consistent with studies addressing diagnostic imaging in pediatric populations, which report high sensitivity but variable specificity depending on clinical context and disease prevalence (7,10,11). Additionally, research advocating for clinical decision-making frameworks in imaging, such

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as the Image Gently Think A-Head Campaign for pediatric head trauma, emphasizes integrating imaging with clinical assessments to avoid unnecessary radiation exposure and improve diagnostic accuracy (11). This approach is similarly relevant in TB diagnostics, where radiographic findings should complement clinical and microbiological data (7,8).

The positive predictive value (75.7%) and negative predictive value (83.3%) in this study further reinforce that while CXR is valuable in ruling out TB when radiographs are normal, it requires microbiological confirmation to prevent over-diagnosis based on imaging alone (9,12). These findings support global recommendations advocating for combined diagnostic strategies that integrate radiology with clinical evaluation and laboratory confirmation for pediatric TB diagnosis (7,12).

Limitations of this study include its single-center design and the relatively small sample size, which may limit generalizability. Moreover, radiographic interpretation can be subjective, despite independent review by radiologists.

CONCLUSION

This study demonstrates that chest radiography is a valuable screening tool for detecting pulmonary tuberculosis in pediatric patients, offering high sensitivity (91.4%) but moderate specificity (59.5%). The presence of abnormal radiographic findings, particularly hilar lymphadenopathy and parenchymal infiltrates, correlates strongly with microbiological confirmation. However, due to overlapping radiological features with other respiratory conditions, reliance solely on chest radiography may lead to false positives. Therefore, while CXR remains essential for early detection and clinical decision-making, it must be complemented by microbiological testing for accurate diagnosis. Integrating clinical evaluation, radiographic interpretation, and microbiological confirmation ensures a more reliable approach to pediatric TB diagnosis.

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