



Original Article

Role of Thoracoscopy in Establishing Diagnosis of Tuberculosis as a Cause of Pleural Effusion in a TB Endemic Area

Shivam Mohan Pandey¹; Ashwini Kumar Mishra²

¹Assistant Professor, Department of Pulmonary Medicine, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh, India.

²Associate Professor, Department of Pulmonary Medicine, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh, India.

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Corresponding Author:

Dr. Shivam Mohan Pandey

Assistant Professor, Department of Pulmonary Medicine, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh, India

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ABSTRACT

Tuberculosis (TB) remains one of the leading causes of pleural effusion in developing countries, particularly in TB-endemic regions such as India. Conventional diagnostic methods, including pleural fluid analysis and closed pleural biopsy, often yield inconclusive results due to the paucibacillary nature of tuberculous pleural effusion (TPE). This prospective observational study was conducted in the Department of Pulmonary Medicine, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh, over a one-year period from September 2024 to August 2025, to evaluate the diagnostic role of medical thoracoscopy in establishing tuberculosis as the cause of pleural effusion. A total of 60 patients with undiagnosed exudative pleural effusion were included. Medical thoracoscopy was performed under local anesthesia and conscious sedation, allowing direct visualization and targeted biopsy of abnormal pleural areas. Histopathological examination demonstrated granulomatous inflammation with caseation necrosis in 42 patients (70%), while microbiological confirmation by AFB smear, culture, or CBNAAT was obtained in 33 patients (55%). The overall diagnostic yield for tuberculosis was 85%. Common thoracoscopic findings included nodular pleura (45%) and diffuse pleural thickening (30%). Only minor complications such as mild chest pain (10%) and transient air leak (5%) were observed, with no major adverse events. These findings demonstrate that medical thoracoscopy is a safe, minimally invasive, and highly accurate diagnostic tool for identifying tuberculosis as a cause of pleural effusion in endemic regions, offering substantial advantages over conventional diagnostic techniques.

Keywords: Thoracoscopy, Pleural Effusion, Tuberculosis, Granulomatous Inflammation, Endemic Area

INTRODUCTION

Pleural effusion is a frequent clinical condition encountered in pulmonary practice, resulting from a wide range of diseases involving the pleura, lung parenchyma, or systemic disorders. Among the various causes, tuberculosis (TB) remains one of the most prevalent etiologies of exudative pleural effusion in developing countries, particularly in TB-endemic regions such as India [1,2]. Tuberculous pleural effusion (TPE) is the second most common form of extrapulmonary tuberculosis after lymph node involvement and contributes significantly to the global burden of TB [3].

The pathogenesis of TPE primarily involves a delayed hypersensitivity reaction to *Mycobacterium tuberculosis* antigens that have entered the pleural space, leading to an accumulation of lymphocytic exudative fluid rich in proteins and adenosine deaminase (ADA) [4]. While clinical presentation is usually nonspecific-characterized by fever, chest pain, and dyspnea-the diagnosis requires microbiological, biochemical, and histopathological confirmation [5].

In routine practice, pleural fluid analysis forms the first line of investigation. Tests such as ADA estimation, protein ratio, and cytological assessment help differentiate exudative from transudative effusions and provide indirect evidence for

tuberculosis [6]. However, the diagnostic yield of pleural fluid microscopy and culture for acid-fast bacilli (AFB) remains low-positive in only about 10-30% of cases [7]. Similarly, closed pleural biopsy, although widely used, offers a diagnostic accuracy of only 50-60% for tuberculosis and may fail to provide adequate tissue in cases of patchy pleural involvement [8].

Given these limitations, there has been a growing emphasis on medical thoracoscopy (also called pleuroscopy), which enables direct visualization of pleural surfaces and targeted biopsy under local anesthesia [9]. Thoracoscopy bridges the diagnostic gap between non-invasive investigations and surgical thoracotomy by allowing clinicians to observe pleural abnormalities such as nodules, thickening, and caseation, and to obtain large, representative tissue samples [10]. The diagnostic yield of thoracoscopy in pleural tuberculosis has been reported to range between 80% and 95%, far surpassing that of closed pleural biopsy [11,12].

In addition to its diagnostic precision, medical thoracoscopy is a safe and minimally invasive procedure, associated with low complication rates and rapid patient recovery [13]. It has proven particularly valuable in resource-limited, high TB-burden settings where conventional diagnostic modalities often fail to yield definitive results [14].

The eastern region of Uttar Pradesh, including Gorakhpur, represents one of India's TB-endemic zones, with a substantial number of patients presenting with pleural effusion of uncertain etiology. In such settings, timely and accurate identification of tuberculosis as the causative agent is critical to initiate appropriate therapy, prevent disease progression, and limit transmission.

Hence, this study was undertaken to evaluate the role of thoracoscopy in establishing tuberculosis as the cause of pleural effusion among patients attending the Department of Pulmonary Medicine at Baba Raghav Das Medical College, Gorakhpur. The study aimed to determine the diagnostic yield of thoracoscopy, characterize pleural findings suggestive of TB, and assess procedure-related safety in a TB-endemic region of northern India.

Materials and Methods

This prospective observational study was conducted in the Department of Pulmonary Medicine, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh, India, over a period of one year, from September 2024 to August 2025. The study included patients presenting with pleural effusion of unknown etiology after initial evaluation.

Patients aged 18 years and above with exudative pleural effusion, as defined by Light's criteria, and in whom no definitive diagnosis was reached after standard investigations, were enrolled in the study. Initial evaluation included detailed clinical examination, chest radiography, ultrasound of the thorax, and pleural fluid analysis for cytology, total and differential cell count, protein, sugar, adenosine deaminase (ADA), and acid-fast bacilli (AFB) smear. Patients with a transudative effusion, known malignancy, or those already receiving antitubercular therapy were excluded. Similarly, patients who were medically unfit for thoracoscopy due to severe hypoxemia, unstable cardiovascular status, or bleeding diathesis were also excluded from the study.

Eligible patients underwent medical thoracoscopy (pleuroscopy) under local anesthesia and conscious sedation. The procedure was performed in a dedicated bronchoscopy suite using a rigid thoracoscope after ensuring sterile precautions. Patients were positioned in the lateral decubitus position with the affected side up. Following intercostal infiltration with 2% lignocaine, a small incision was made, and a trocar was introduced into the pleural cavity. After evacuation of the pleural fluid, the pleural surfaces were carefully inspected for characteristic changes such as nodularity, pleural thickening, fibrinous adhesions, hyperemia, and caseous deposits. Representative targeted pleural biopsies were obtained from abnormal areas using biopsy forceps under direct vision.

The collected specimens were divided into portions for histopathological and microbiological analysis. Histopathological examination (HPE) was carried out using hematoxylin and eosin (H&E) staining to detect granulomatous inflammation and caseation necrosis, which are indicative of tuberculosis. Microbiological testing included Ziehl-Neelsen (ZN) staining for acid-fast bacilli, mycobacterial culture, and Cartridge-Based Nucleic Acid Amplification Test (CBNAAT) for *Mycobacterium tuberculosis*. Pleural fluid samples collected during the procedure were also sent for repeat biochemical and cytological examination, along with ADA and AFB testing, to complement tissue findings.

Post-procedure monitoring was conducted for all patients for at least 24 hours to identify any complications such as bleeding, persistent air leak, or infection. Chest radiographs were performed within 2 hours of the procedure to rule out pneumothorax. Any minor complications such as transient pain or air leak were managed conservatively.

The primary outcome measure of the study was the diagnostic yield of thoracoscopy for tuberculosis, defined as histopathological or microbiological confirmation of TB in pleural tissue. Secondary outcomes included the description of thorascopic findings and the documentation of any procedure-related complications. Data were entered in Microsoft

Excel and analyzed using descriptive statistical methods. Continuous variables were expressed as mean $\pm$ standard deviation (SD), and categorical data were presented as frequencies and percentages.

Results

A total of 60 patients with undiagnosed exudative pleural effusion were included in the study. All patients underwent medical thoracoscopy successfully, and adequate pleural biopsy specimens were obtained in each case. The demographic and clinical characteristics of the study population, thoracoscopic findings, histopathological and microbiological results, and procedure-related complications are summarized below.

Demographic Profile

The mean age of the study population was 42.3 ± 12.8 years (range: 18-70 years). Among the 60 patients, 39 (65%) were males and 21 (35%) were females, resulting in a male-to-female ratio of approximately 1.9:1. The most common presenting symptoms were pleuritic chest pain (80%), dry cough (72%), fever (68%), and breathlessness (60%). The majority of effusions were unilateral and right-sided (58%).

Table 1: Demographic and Clinical Profile of Patients (n = 60)

Parameter	Number of Cases	Percentage (%)
Age (years)	42.3 ± 12.8 (mean $\pm$ SD)	-
Gender		
Male	39	65
Female	21	35
Side of pleural effusion		
Right	35	58
Left	25	42
Clinical symptoms		
Chest pain	48	80
Cough	43	72
Fever	41	68
Dyspnea	36	60

Thoracoscopic Findings

On thoracoscopic examination, the most common findings were nodular pleura in 27 patients (45%), followed by diffuse pleural thickening in 18 (30%), fibrinous adhesions in 9 (15%), and caseous plaques in 6 (10%). All patients had an exudative effusion, and the pleural cavity was free from extensive loculations, allowing complete visualization of the pleural surfaces.

Table 2: Thoracoscopic Findings in Study Population (n = 60)

Thoracoscopic Findings	Number of Cases	Percentage (%)
Nodular pleura	27	45
Diffuse pleural thickening	18	30
Fibrinous adhesions	9	15
Caseous plaques	6	10

Distribution of Thoracoscopic Findings among Study Participants (n = 60)

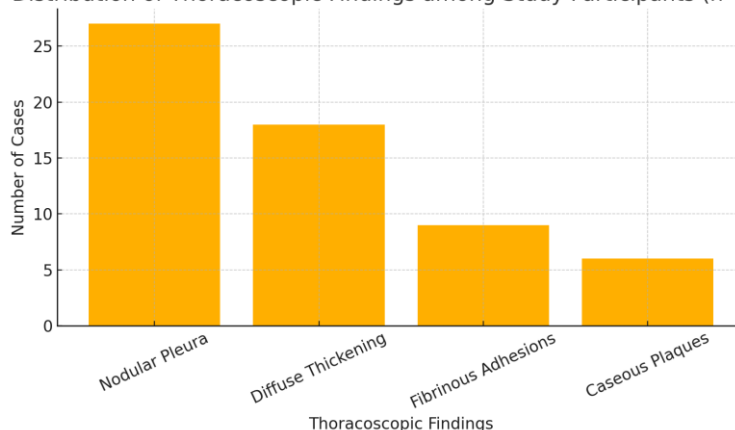


Figure 1: Distribution of Thoracoscopic Findings among Study Participants (n = 60) Nodular pleura was the most common finding (45%), followed by diffuse pleural thickening (30%), fibrinous adhesions (15%), and caseous plaques (10%).

Histopathological and Microbiological Findings

Histopathological examination revealed granulomatous inflammation with caseation necrosis in 42 patients (70%), which was diagnostic of tuberculosis. Non-specific chronic inflammation was seen in 12 patients (20%), while malignancy was detected in 6 cases (10%).

Microbiological evaluation of pleural tissue and fluid demonstrated AFB positivity in 24 patients (40%) on Ziehl-Neelsen staining, culture positivity in 21 patients (35%), and CBNAAT positivity in 30 patients (50%). Combining histopathological and microbiological results, the overall diagnostic yield of thoracoscopy for tuberculosis was 85% (51/60).

Table 3: Histopathological and Microbiological Findings (n = 60)

Parameter	Number of Positive Cases	Percentage (%)
Histopathological diagnosis		
Granulomatous inflammation with caseation necrosis	42	70
Non-specific inflammation	12	20
Malignancy	6	10
Microbiological confirmation		
AFB smear positive (ZN stain)	24	40
Culture positive for <i>M. tuberculosis</i>	21	35
CBNAAT positive	30	50
Overall diagnostic yield for TB	51	85

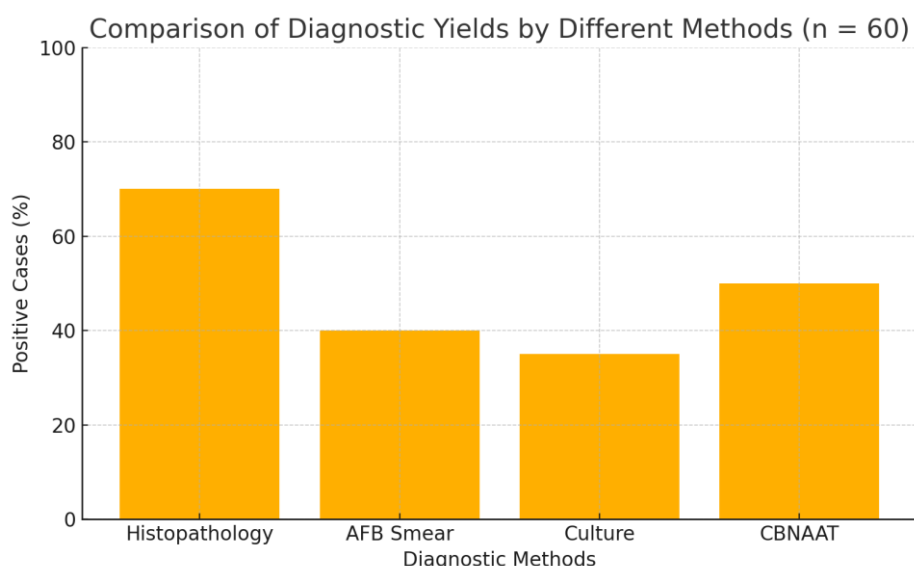


Figure 2: Comparison of Diagnostic Yields by Different Methods (n = 60). This graph illustrates the diagnostic performance of various modalities used in the study. Histopathology showed the highest diagnostic yield (70%), followed by CBNAAT (50%), AFB smear (40%), and culture (35%).

Complications

The thoracoscopy procedure was well tolerated by all patients. Minor complications such as mild chest pain occurred in 6 cases (10%) and transient air leak in 3 cases (5%), both of which resolved with conservative management. No major complications such as significant bleeding, infection, or procedure-related mortality were reported.

Table 4: Procedure-Related Complications (n = 60)

Complication	Number of Cases	Percentage (%)
Mild chest pain	6	10
Transient air leak	3	5
Significant bleeding	0	0
Infection	0	0
Mortality	0	0

Medical thoracoscopy successfully established the diagnosis of tuberculosis in 51 out of 60 patients with undiagnosed exudative pleural effusion, yielding an overall diagnostic accuracy of 85%. The procedure was found to be safe, minimally invasive, and associated with only minor, self-limiting complications.

Discussion

Pleural effusion is a common clinical manifestation of extrapulmonary tuberculosis, especially in TB-endemic regions such as India [1,2]. Establishing a definitive diagnosis of tuberculous pleural effusion (TPE) continues to pose a diagnostic challenge due to the paucibacillary nature of the disease and the low sensitivity of conventional tests [3]. In the present study, thoracoscopy proved to be a highly effective diagnostic tool, providing a diagnostic yield of 85% in patients with undiagnosed exudative pleural effusion. These results are in close agreement with previous studies that have reported diagnostic yields ranging from 80% to 95% for thoracoscopic diagnosis of pleural tuberculosis [9-12].

In our study, histopathological examination revealed granulomatous inflammation with caseation necrosis in 70% of cases, confirming tuberculosis. Microbiological confirmation was achieved in 55% of patients through AFB smear, culture, or CBNAAT testing. This combination of histopathological and microbiological evidence significantly enhanced diagnostic accuracy. Similar findings have been documented by Valdés et al. [4], who observed granulomatous pleuritis in 80% of cases, and by Baumann et al. [5], who emphasized the complementary role of histology and culture in establishing a definitive diagnosis.

Conventional methods such as pleural fluid ADA estimation, cytology, and AFB staining provide valuable clues but are limited by low specificity and sensitivity in endemic regions [6,7]. In our series, pleural fluid analysis alone failed to confirm the diagnosis in a majority of patients, consistent with previous reports showing AFB positivity in only 10-30% of TPE cases [7]. The diagnostic yield of closed pleural biopsy (Abrams or Cope needle) has also been reported to be around 40-60% [8], mainly due to random sampling errors and the patchy distribution of tuberculous lesions within the pleura.

In contrast, medical thoracoscopy (pleuroscopy) allows direct visualization of pleural abnormalities such as nodules, fibrinous adhesions, and caseous deposits, which are highly suggestive of tuberculosis [9,10]. In our study, nodular pleura (45%) and diffuse thickening (30%) were the most frequent thoracoscopic findings, which correlate well with observations by Loddenkemper [9] and Lee & Colt [10], who reported similar pleural morphologies in tuberculous effusions. The ability to obtain targeted pleural biopsies under direct vision significantly increases diagnostic accuracy, as supported by Dixit et al. [11] and Bhatnagar & Maskell [12], who both reported yields exceeding 85% with thoracoscopy.

Apart from its diagnostic superiority, medical thoracoscopy is a safe and minimally invasive procedure. In our study, only minor complications such as mild chest pain (10%) and transient air leak (5%) were noted, both of which resolved with conservative management. These findings are consistent with previous literature indicating that thoracoscopy carries a low complication rate (2-10%) and negligible mortality [13,14]. No cases of significant bleeding, infection, or procedure-related mortality were observed, reaffirming the procedure's excellent safety profile.

Furthermore, the diagnostic utility of thoracoscopy is not limited to tuberculosis alone. It also enables early recognition of malignant pleural effusions and other pleural pathologies, thereby preventing diagnostic delays and facilitating appropriate treatment. In endemic regions like eastern Uttar Pradesh, where tuberculosis remains a dominant cause of exudative pleural effusion, incorporating thoracoscopy into the diagnostic algorithm can reduce time to diagnosis, guide early initiation of antitubercular therapy, and prevent chronic pleural fibrosis.

Limitations

The present study was conducted at a single tertiary care center with a moderate sample size, which may limit generalizability. Long-term follow-up to assess clinical outcomes after initiation of therapy was not included. Future multicentric studies with larger cohorts and integration of molecular diagnostic techniques (such as next-generation sequencing) may further enhance diagnostic precision and shorten diagnostic turnaround times.

In summary, the findings of this study reaffirm that medical thoracoscopy provides a high diagnostic yield (85%) and an excellent safety profile in diagnosing tuberculosis as the cause of pleural effusion in a TB-endemic setting. Its ability to combine visual, histopathological, and microbiological evaluation makes it an indispensable tool in the diagnostic workup of exudative pleural effusion, particularly in regions like eastern Uttar Pradesh where tuberculosis is highly prevalent.

Conclusion

Medical thoracoscopy is a safe, minimally invasive, and highly effective diagnostic modality for evaluating undiagnosed exudative pleural effusion in tuberculosis-endemic regions. In this study, it achieved a high diagnostic yield of 85% for pleural tuberculosis, primarily through direct visualization and targeted pleural biopsy. Given its superior accuracy and low complication rate, thoracoscopy should be incorporated as a standard diagnostic tool in the workup of pleural effusion where tuberculosis is strongly suspected but not confirmed by conventional methods.

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Conflicts of interests: The authors declare no conflicts of interest.

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