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Original Research Paper

Respiratory Medicine

CLINICAL AND ETIOLOGICAL CHARACTERISTICS OF UNILATERAL PLEURAL EFFUSION

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ABSTRACT

Introduction: Unilateral pleural effusion (UPE) has varied causes, notably tuberculosis (TB), malignancy, and parapneumonic infections. In India, TB remains a leading etiology, but regional data are essential for targeted management. Our study aimed to assess the clinical, demographic, biochemical, and etiological profiles of UPE in a tertiary care center in Rajasthan. **Methods:** This cross-sectional study included 150 adults with confirmed UPE at Institute of Respiratory Diseases, SMS Medical College, Jaipur (1st Oct 2023–31st Sept 2024). Clinical evaluation, imaging, pleural fluid analysis (biochemistry, ADA, cytology, CBNAAT), and Light's criteria were applied. **Results:** Mean age was 52.4 years; 62.7% were males and 58% from rural areas. Dyspnea (94.7%), fever (78.7%), and cough (72%) were common. TB was the most frequent cause (41.3%), followed by malignancy (25.3%), parapneumonic effusions (18.7%), and cardiac causes (8%). Most effusions (89.3%) were exudative. ADA was significantly elevated in TB cases (mean 68.4 ± 24.6 U/L; $p < 0.001$), with an AUC of 0.92 at 30 U/L cutoff (sensitivity 91.9%, specificity 84.1%). Cytology had a 73.7% yield in malignancy. **Conclusion:** In our study, Tuberculosis was found to be most common cause of unilateral pleural effusion. ADA is a reliable marker for tuberculous pleuritis. Malignancy and parapneumonic effusions are also significant. Region-specific use of ADA and Light's criteria is crucial in high-burden settings.

KEYWORDS : Unilateral Pleural Effusion, Tuberculosis, Malignancy, ADA, Light's Criteria, Rajasthan

INTRODUCTION

Pleural effusion is the abnormal accumulation of fluid between the parietal and visceral pleura, disrupting the normal pleural balance maintained by hydrostatic, oncotic, and lymphatic pressures. Under physiological conditions, only ~0.13 ml/kg of pleural fluid is present to allow smooth lung movement during respiration. Disruption of these mechanisms due to infection, malignancy, or systemic illness can result in pleural effusion.

Globally, pleural effusion affects ~3,000 per million annually. Common causes include tuberculosis (TPE), malignancy (MPE), parapneumonic effusions (PPE), and effusions due to heart, liver, or kidney failure, as well as connective tissue diseases. In India, TB remains the predominant cause, reflecting its high endemicity. Symptoms typically include dyspnea, cough, chest pain, and systemic signs like fever and weight loss. Clinical suspicion, confirmed by imaging (chest X-ray / ultrasound of chest) and pleural fluid analysis following thoracocentesis, guides diagnosis.

Classification into transudates and exudates—based on Light's criteria—helps identify the underlying cause. Transudates result from systemic pressure imbalances (e.g., heart failure), while exudates are due to local inflammation, malignancy, or infection. ADA is a key biomarker for diagnosing TPE, with levels >40 U/L showing high sensitivity and specificity in TB-endemic regions. Other tools include cytology for malignancy and CBNAAT for TB.

Methodology

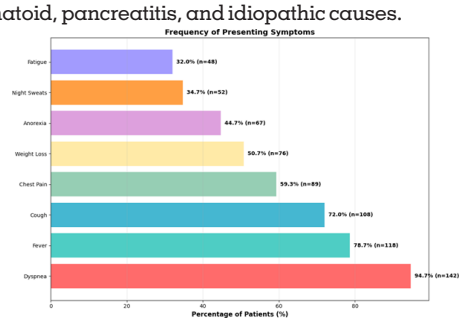
A cross-sectional study was conducted from October 2023 to September 2024 at the Institute of Respiratory Diseases, SMS Medical College, Jaipur, including 150 adult patients with confirmed UPE. Ethical clearance and informed consent were obtained. Inclusion criteria were adults (>18 years) with UPE; unstable and pregnant/lactating patients were excluded.

All patients underwent detailed history, physical examination, and investigations including CBC, renal/liver function tests, viral markers, chest imaging (X-ray ± CT/USG chest), and diagnostic thoracocentesis. Pleural fluid was analyzed for protein, glucose, LDH, ADA, cytology, and microbiological tests (AFB smear, CBNAAT). Light's criteria classified effusions, and additional procedures like pleural biopsy or bronchoscopy were done when indicated. Data were analyzed using SPSS v20 with descriptive and inferential statistics.

RESULTS

A total of 150 patients with unilateral pleural effusion were included in the study. The age distribution showed that the majority of patients were between 41–50 years (23.3%), followed by 51–60 years (20.7%), and 31–40 years (18.7%). There was a male predominance in this study with 62.7% males and 37.3% females. Regarding geographic distribution, 58% of patients were from rural areas, while 42% belonged to urban areas. The most common presenting symptom was dyspnea (94.7%), followed by fever (78.7%), cough (72%), chest pain (59.3%), weight loss (50.7%), anorexia (44.7%), night sweats (34.7%), and fatigue (32%).

Tuberculosis was the most frequent etiology accounting for 41.3% of cases, followed by malignant effusion (25.3%), parapneumonic effusion (18.7%), cardiac-related effusion (8%), and smaller proportions due to hepatic hydrothorax, rheumatoid, pancreatitis, and idiopathic causes.



Dyspnea was universally present across all etiologies (91.9%–100%), but fever and night sweats were significantly more common in tuberculous cases ($p < 0.001$).

Table 1: Etiological Spectrum Of Unilateral Pleural Effusion

Etiology	Number (n = 150)	Percentage (%)
Tuberculous	62	41.3
Malignant	38	25.3
Parapneumonic	28	18.7
Cardiac	12	8.0
Hepatic Hydrothorax	6	4.0
Rheumatoid	2	1.3
Pancreatitis	1	0.7
Idiopathic	1	0.7

Tuberculous pleuritis emerged as the leading cause (41.3%), followed by malignant effusions (25.3%) and parapneumonic effusions (18.7%).

Table 2: Pleural Fluid Biochemical Parameters According To Etiology

Parameter	Tuberculous (n=62)	Malignant (n=38)	Parapneumonic (n=28)	Cardiac (n=12)	p-value
Protein (g/dL)	5.2 ± 1.2	4.8 ± 1.4	4.6 ± 1.8	2.8 ± 0.8	<0.01
LDH (U/L)	650 ± 280	580 ± 320	780 ± 450	180 ± 80	<0.01
Glucose (mg/dL)	82 ± 25	75 ± 28	45 ± 35	95 ± 22	<0.01
Total Cells (/µl)	2,200 ± 1,800	2,800 ± 2,200	4,800 ± 3,200	800 ± 400	<0.01
Lymphocytes (%)	85 ± 12	70 ± 20	35 ± 25	78 ± 15	<0.01
ADA (U/L)	68.4 ± 24.6	22.8 ± 12.4	34.6 ± 18.2	15.2 ± 8.6	<0.001

Pleural fluid biochemical parameters varied significantly among etiologies. Protein, LDH, glucose, total cell count, lymphocyte proportion, and ADA levels were all significantly elevated in tuberculous effusions. ADA was notably higher in tuberculosis ($p < 0.001$).

DISCUSSION

This study provides important insights into the clinical, demographic, and etiological spectrum of unilateral pleural effusion (UPE) in a tertiary care setting in Rajasthan. Our findings align with broader Indian data while also reflecting regional variations. A predominance of middle-aged males (mean age 52.4 years; 62.7%) was observed, consistent with prior Indian studies by Sharma et al. and Khilar et al. [7,8]. This male preponderance likely relates to higher smoking rates, occupational exposures, and healthcare-seeking behaviors. The high proportion of rural patients (58%) highlights the ongoing burden of tuberculosis (TB) in underserved populations[8].

Dyspnea (94.7%) was the most common symptom, followed by fever, cough, chest pain, and weight loss—findings consistent with Saini et al. [9] and indicative of the physiological impact of pleural fluid accumulation. Constitutional symptoms such as night sweats and weight loss were especially associated with TB, as reported in earlier studies [10].

Tuberculosis remained the most common cause of UPE (41.3%), corroborating Indian studies [8,10], in contrast to Western populations where malignancy predominates [9]. Malignant effusions (25.3%), primarily due to lung and breast cancers, aligned with global patterns, though 15.8% had unknown primaries, reflecting diagnostic challenges [10]. Parapneumonic effusions (18.7%) underscore the burden of bacterial infections such as Streptococcus pneumoniae and Staphylococcus aureus[9,10].

Diagnostic evaluation using Light's criteria revealed that 89.3% of effusions were exudative, a finding typical in tertiary care settings. ADA was highly diagnostic for TB, with a mean level of 68.4 ± 24.6 U/L, sensitivity of 91.9%, specificity of 84.1%, and an AUC of 0.92 at a cutoff of 30 U/L—comparable to findings from Liang et al. and other meta-analyses [11–14]. Lymphocytic predominance (85 ± 12%) in TB cases contrasted with malignant effusions (70 ± 20%), supporting its diagnostic utility.

Therapeutically, tuberculous effusions responded well to medical treatment, consistent with global guidelines. Nearly half of the malignant effusions (47.4%) required pleurodesis for symptom relief [9,10]. Parapneumonic effusions were often complex and frequent need for chest tube drainage (78.6%) or decortication [9,10].

In summary, pleural fluid ADA demonstrated excellent diagnostic performance in identifying tuberculous effusion, with a Youden Index of 0.76 and overall diagnostic accuracy of 86.7% [11–14]. These results reaffirm role of ADA in TB-endemic areas and support the continued relevance of Light's criteria in pleural effusion evaluation.

CONCLUSION:

Comparatively, our findings reinforce Indian data while highlighting regional nuances—such as a slightly higher tuberculosis burden and rural predominance. They also demonstrate the continuing relevance of ADA and Light's criteria in endemic settings and the evolving role of cytology and biopsy in malignancy. Limitations include single-center design, referral bias, and lack of longitudinal follow-up.

Abbreviations

AFB- Acid fast bacilli
ADA- Adenosine Deaminase
CBC- Complete Blood Count
CBNAAT- Cartridge based Nucleic Acid Amplification Test
LDH- Lactate Dehydrogenase
MPE- Malignant Pleural Effusion
PPE- Parapneumonic pleural effusion
TPE- Tubercular Pleural Effusion
TB- Tuberculosis
UPE- Unilateral Pleural Effusion

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Competing Interest:

The authors declare that they have no competing interests.

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