

Original Research Article

DIAGNOSTIC ROLE OF TRANSTHORACIC ULTRASONOGRAPHY IN PATIENTS WITH INTERSTITIAL LUNG DISEASE: A PROSPECTIVE CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Interstitial lung diseases (ILDs) comprise a heterogeneous group of diffuse parenchymal lung disorders characterized by progressive fibrosis, impaired gas exchange, and respiratory disability. High-resolution computed tomography (HRCT) remains the imaging gold standard; however, its repeated use is limited by radiation exposure, cost, and limited accessibility. Transthoracic ultrasonography (TTUS) has emerged as a promising bedside imaging modality capable of identifying characteristic pulmonary and pleural abnormalities associated with ILD. **Objectives:** To evaluate the diagnostic role of transthoracic ultrasonography in patients with interstitial lung disease and to describe the sonographic findings in comparison with HRCT.

Materials and Methods: A prospective cross-sectional study was conducted in the Departments of Radiodiagnosis and Pulmonary Medicine, Indira Gandhi Medical College, Shimla. Thirty-one clinically suspected ILD patients underwent chest radiography, pulmonary function testing, HRCT, and transthoracic ultrasonography. Sonographic findings including pleural abnormalities, lung sliding and pleural effusion, were evaluated and compared with HRCT findings.

Results: Thirty-one patients were enrolled with a mean age of 63 years. Males constituted 64.5% of cases. Dyspnea (83.8%) was the commonest presenting symptom. HRCT demonstrated septal lines in 93.4%, irregular pleural margins in 79.3%, honeycombing in 51.6%, and ground-glass opacities in 45.3% of patients. On transthoracic ultrasonography thickened pleura were identified in 35%, pleural effusion in 13%, and preserved lung sliding in 96%.

Conclusion: Transthoracic ultrasonography is a simple, radiation-free, bedside imaging modality demonstrating characteristic findings in patients with interstitial lung disease. It may serve as a valuable complementary investigation for the diagnosis of ILD, particularly where HRCT is unavailable or repeated follow-up examinations are required.

Keywords: Interstitial lung disease; Lung ultrasound; Transthoracic ultrasonography; HRCT.

INTRODUCTION

Interstitial lung diseases (ILDs), also known as diffuse parenchymal lung diseases, comprise a heterogeneous group of disorders affecting the pulmonary interstitium, alveoli, peripheral airways,

and pulmonary vasculature. Progressive inflammation and fibrosis lead to impaired gas exchange, restrictive ventilatory dysfunction, and, if untreated, respiratory failure.^[1] Patients commonly present with exertional dyspnea, persistent dry cough, bi-basal inspiratory crackles, and progressive

decline in pulmonary function. Despite the classification of more than 200 ILD subtypes, early diagnosis remains challenging because of overlapping clinical and radiological features.^[2]

High-resolution computed tomography (HRCT) is considered the gold standard for the diagnosis and assessment of ILDs, providing detailed information on disease pattern, extent, severity, prognosis, and treatment response.^[3] Typical HRCT findings include reticular opacities, ground-glass attenuation, honeycombing, traction bronchiectasis, and interlobular septal thickening. However, repeated HRCT examinations are associated with cumulative radiation exposure, increased healthcare costs, and limited accessibility, highlighting the need for safe, cost-effective, and radiation-free imaging modalities for diagnosis and follow-up.^[4]

Transthoracic ultrasonography (TTUS), or lung ultrasound, has emerged as a promising bedside imaging technique for evaluating peripheral lung abnormalities in ILD. Characteristic sonographic findings, including pleural line irregularity, pleural thickening, reduced lung sliding, and pleural effusion, have shown good correlation with HRCT findings in several studies.^[5,6] Although previous research has demonstrated the diagnostic utility of TTUS, its routine clinical application remains limited, particularly in resource-constrained settings.^[7] Therefore, the present prospective cross-sectional study was undertaken to evaluate the diagnostic role of transthoracic ultrasonography in patients with interstitial lung disease, using HRCT as the reference standard, and to assess its potential as a practical adjunctive imaging modality in the evaluation of suspected ILD.

MATERIALS AND METHODS

This prospective cross-sectional study was conducted jointly in the Departments of Radiodiagnosis and Pulmonary Medicine at Indira Gandhi Medical College and Hospital (IGMC), Shimla, Himachal Pradesh, India, over an 18-month period from July 2017 to December 2018. The study was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants prior to enrolment. Thirty-one consecutive patients with clinically suspected interstitial lung disease (ILD), based on clinical features and/or pulmonary function test findings suggestive of restrictive lung disease, were included in the study. Patients who were pregnant, refused

consent, had sputum or bronchoalveolar lavage positive for acid-fast bacilli, pulmonary malignancy, asthma, chronic obstructive pulmonary disease, or kyphoscoliotic chest deformity were excluded. Demographic details, smoking status, occupational exposure, presenting symptoms, and relevant clinical findings were recorded. Spirometry was performed using a Vitalograph Model 6800 spirometer, and pulmonary function patterns were classified according to standard spirometric criteria. All patients underwent chest radiography, high-resolution computed tomography (HRCT), and transthoracic ultrasonography (TTUS). HRCT was performed using a 64-slice multidetector CT scanner (GE LightSpeed VCT XTe) with 1-mm slice thickness and high-resolution reconstruction, and images were evaluated for ground-glass opacities, reticular opacities, interlobular septal thickening, honeycombing, irregular pleural margins, subpleural cysts, traction bronchiectasis, nodules, consolidation, and subpleural sparing. Disease severity was assessed using the Warrick scoring system. TTUS was performed using a GE LOGIQ P6 ultrasound machine with high-frequency linear (6–13 MHz) and low-frequency convex (3–5 MHz) transducers. Both hemithoraces were systematically scanned in anterior, lateral, and posterior regions, and sonographic parameters including pleural thickness, pleural surface irregularity, lung sliding, and pleural effusion were recorded. Data were analyzed using linear regression analysis, and correlations between TTUS findings and HRCT severity were assessed using Pearson's correlation coefficient, with a p-value <0.05 considered statistically significant.

RESULTS

Baseline Characteristics

Thirty-one patients diagnosed with interstitial lung disease were included in the study. The mean age was 63.0 years (range: 38–86 years). Males constituted nearly two-thirds of the study population (64.5%), resulting in a male-to-female ratio of 1.8:1. Most patients were non-smokers (54.8%), while occupational exposure was identified in five patients (16.1%). Dyspnea was the predominant presenting symptom (83.8%), followed by dry cough (58.0%) and chest pain (45.1%). Restrictive ventilatory defect was observed in 90% of patients on spirometry.

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants

Characteristic	n (%)
Mean age (years)	63.0
Male	20 (64.5)
Female	11 (35.5)
Smokers	14 (45.2)
Non-smokers	17 (54.8)
Occupational exposure	5 (16.1)
Dyspnea	26 (83.8)
Dry cough	18 (58.0)

Chest pain	14 (45.1)
Restrictive spirometry	27 (90.0)

Chest Radiography Findings

Abnormal chest radiographs were observed in 26 (83.8%) patients. Reticulonodular opacities represented the commonest radiographic abnormality (54.8%), followed by bilateral hilar lymphadenopathy (16.1%), pleural effusion (16.1%), and apicobasal gradient (12.9%).

Table 2: Chest Radiographic Findings

Finding	n (%)
Reticulonodular pattern	17 (54.8)
Bilateral hilar lymphadenopathy	5 (16.1)
Pleural effusion	5 (16.1)
Apicobasal gradient	4 (12.9)

HRCT Findings

HRCT demonstrated septal lines in 93.4% of patients, making it the commonest imaging abnormality. Irregular pleural margins were observed in 79.3%, honeycombing in 51.6%, ground-glass opacities in 45.3%, and subpleural

cysts in 29.0%. According to Warrick scoring, nearly half of the patients (45.1%) had severe pulmonary involvement (score 16–25). Additional HRCT findings included pulmonary nodules, apicobasal gradient, traction bronchiectasis, consolidation, and emphysematous changes.

Table 3: HRCT Findings in Patients with ILD

Finding	n (%)
Septal lines	29 (93.4)
Irregular pleural line	23 (79.3)
Honeycombing	16 (51.6)
Ground-glass opacity	14 (45.3)
Subpleural cyst	9 (29.0)

Table 4: Distribution of Warrick Scores

Score	n (%)
1–8	7 (22.5)
9–15	9 (29.0)
16–25	14 (45.1)
25–30	1 (3.2)

Transthoracic Ultrasonographic Findings

Transthoracic ultrasonography (TTUS) identified characteristic pleural and subpleural abnormalities in the majority of patients with interstitial lung disease. Pleural line thickening was present in 11 patients (35.5%), while pleural effusion was detected in four patients (12.9%). Lung sliding was

preserved in most patients (96.8%), with only one patient demonstrating reduced pleural movement. Pleural line irregularity and fragmentation were frequently observed in areas corresponding to fibrotic changes identified on HRCT. These findings support the ability of TTUS to detect peripheral pulmonary abnormalities associated with ILD.

Table 5: Transthoracic Ultrasonographic Findings in Patients with ILD

Ultra-sonographic finding	n (%)
Pleural line thickening	11 (35.5)
Pleural effusion	4 (12.9)
Reduced lung sliding	1 (3.2)
Preserved lung sliding	30 (96.8)

DISCUSSION

The present prospective cross-sectional study evaluated the role of transthoracic ultrasonography (TTUS) in patients with interstitial lung disease (ILD) and compared its findings with high-resolution computed tomography (HRCT), the current imaging reference standard. The findings demonstrate that TTUS is capable of identifying characteristic pleural and peripheral pulmonary abnormalities associated with ILD and may serve as a valuable adjunctive imaging modality, particularly

in settings where HRCT is unavailable or repeated imaging is required.

The mean age of the study population was 63 years, with a predominance of male patients (64.5%). These findings are consistent with previous studies reporting that ILDs, particularly idiopathic pulmonary fibrosis, predominantly affect older adults and are more common among males due to occupational and environmental exposures. Similar demographic characteristics have been reported by Nataranjan et al., supporting the age and sex distribution observed in the present study. Likewise, dyspnea (83.8%) and dry cough (58.0%) were the

predominant presenting symptoms, which agree with previous reports describing these as the characteristic clinical manifestations of ILD (8,9).

HRCT demonstrated interlobular septal thickening (93.4%), irregular pleural margins (79.3%), honeycombing (51.6%), and ground-glass opacities (45.3%), confirming its pivotal role in identifying the extent and pattern of pulmonary fibrosis. These findings are comparable to those reported by Donuru et al., and Torres et al., who identified septal thickening, honeycombing, and subpleural fibrosis as typical imaging features of fibrotic ILDs.^[10,11] The high proportion of patients with severe Warrick scores in the present study further reflects the advanced stage of disease in many of the enrolled patients.

Transthoracic ultrasonography identified pleural line thickening in 35.5% of patients and pleural effusion in 12.9%, while preserved lung sliding was observed in 96.8% of cases. Pleural line irregularity and fragmentation were frequently observed in regions corresponding to HRCT abnormalities, indicating that TTUS is particularly useful for detecting peripheral fibrotic lung changes. Similar observations have been reported by Thakur et al. and Sartori et al., who demonstrated that pleural line abnormalities improve the diagnostic accuracy of lung ultrasound in differentiating pulmonary fibrosis from other causes of diffuse lung involvement. These findings support the role of TTUS as a complementary imaging technique for evaluating patients with suspected ILD.

The principal advantage of TTUS is that it is non-invasive, radiation-free, portable, inexpensive, and can be performed at the bedside. These characteristics make it especially valuable for serial follow-up examinations, critically ill patients, and healthcare settings with limited access to HRCT.^[14] Although TTUS cannot replace HRCT because ultrasound evaluates only peripheral lung lesions adjacent to the pleural surface, it can facilitate early diagnosis, monitor disease progression, and reduce the need for repeated radiation exposure.^[15] Our findings are consistent with those reported by Vizioli et al., who demonstrated that combining lung ultrasound with conventional chest radiography improved the detection of ILD while reducing unnecessary HRCT examinations.^[16]

The strengths of this study include its prospective design and the use of standardized HRCT and TTUS protocols in all participants, allowing direct comparison between the two imaging modalities. However, the study has certain limitations. The sample size was relatively small, and the study was conducted at a single tertiary care centre, which may limit the generalizability of the findings. Furthermore, TTUS is limited to the assessment of peripheral pulmonary lesions and cannot adequately evaluate centrally located parenchymal abnormalities. Larger multicentre studies are required to validate these findings and establish standardized ultrasound protocols for the diagnosis

and follow-up of patients with interstitial lung disease.

CONCLUSION

Transthoracic ultrasonography demonstrated characteristic findings in patients with interstitial lung disease. Pleural line thickening and irregularity further enhanced the detection of peripheral fibrotic lung involvement. The close agreement between TTUS findings and HRCT abnormalities suggests that lung ultrasound is a valuable, radiation-free, bedside imaging modality for the evaluation of ILD. Although HRCT remains the diagnostic reference standard, TTUS can serve as an effective complementary investigation for the initial assessment and follow-up of patients with diffuse interstitial lung disease.

REFERENCES

1. Althobiani MA, Russell AM, Jacob J, Ranjan Y, Folarin AA, Hurst JR, et al. Interstitial lung disease: a review of classification, etiology, epidemiology, clinical diagnosis, pharmacological and non-pharmacological treatment. *Front Med (Lausanne)*. 2024;11:1296890.
2. Kanchustambham V, Sankari A. Interstitial lung disease. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK541084/>
3. Drimus JC, Duma RC, Trăilă D, Mogoșan CD, Manolescu DL, Fira-Mladinescu O. High-resolution CT findings in interstitial lung disease associated with connective tissue diseases: differentiating patterns for clinical practice—a systematic review with meta-analysis. *J Clin Med*. 2025;14(17):6164.
4. Makol A, Nagaraja V, Amadi C, Pugashetti JV, Caoili E, Khanna D. Recent innovations in the screening and diagnosis of systemic sclerosis-associated interstitial lung disease. *Expert Rev Clin Immunol*. 2023;19(6):613-626.
5. Srivastava GN, Chokhani A, Verma A, Siddiqui Z. Transthoracic ultrasonography in patients with interstitial lung disease. *Lung India*. 2020;37(5):400-406.
6. Marini TJ, Rubens DJ, Zhao YT, Weis J, O'connor TP, Novak WH, Kaproth-Joslin KA. Lung ultrasound: the essentials. *Radiology: Cardiothoracic Imaging*. 2021 Apr 29;3(2):e200564.
7. Rabello E, de-Paris F. Tuberculosis diagnostic methods: clinical applicability, implementation challenges, and integrated testing strategies. *Pathogens*. 2026;15(2):142.
8. Natarajan S, Subramanian P. Idiopathic pulmonary fibrosis: a study of 46 patients from Western India: clinical presentations and survival. *Turk Thorac J*. 2015;16(3):114-120.
9. Feltre-Martínez L, Orozco S, Alonso A, Millan-Billi P, Barril S, Ruibal G, et al. Older patients with interstitial lung disease feature a distinct clinical profile. *Open Respir Arch*. 2024;6(4):100374.
10. Donuru A, Torigian DA, Knollmann F. Uncommon causes of interlobular septal thickening on CT images and their distinguishing features. *Tomography*. 2024;10(4):574-608.
11. Torres PPTES, Rabahi MF, Moreira MADC, Escuissato DL, Meirelles GSP, Marchiori E. Importance of chest HRCT in the diagnostic evaluation of fibrosing interstitial lung diseases. *J Bras Pneumol*. 2021;47(3):e20200096.
12. Thakur CS, Sharma Thakur YK, Makhalk S, Tomar A, Negi R, Thakur S. Transthoracic ultrasound as an assessment tool for pleural effusion, pleural adhesion, and pleural thickening in patients undergoing thoracoscopy. *Pol J Radiol*. 2025;90:e74-e83.

13. Sartori S, Tombesi P. Emerging roles for transthoracic ultrasonography in pleuropulmonary pathology. *World J Radiol.* 2010;2(2):83-90.
14. Georgakopoulou VE, Spandidos DA, Corlateanu A. Diagnostic tools in respiratory medicine. *Biomed Rep.* 2025;23(1):112.
15. Trenker-Burchert C, Dohse M, Findeisen H, Schuler A, Görg C. Emerging role of transcutaneous ultrasound in the diagnosis of lung cancer. *Cancers (Basel).* 2025;17(23):3873.
16. Vizioli L, Ciccarese F, Forti P, Chiesa AM, Giovagnoli M, Mughetti M, et al. Integrated use of lung ultrasound and chest X-ray in the detection of interstitial lung disease. *Respiration.* 2017;93(1):15-22.