https://doi.org/10.29309/TPMJ/2025.32.10.9838

The Professional Medical Journal
www.theprofesional.com
2025, Volume, 32 Issue, 10

ORIGINAL ARTICLE

Diagnostic accuracy of lung ultrasound in diagnosing interstitial lung disease taking HRCT as gold standard.

Naima Rauf[1], Nadeem Ibrahim[2], Iqra Aslam[3], Jahanzeb Javed[4], Amer Hayyat[5]

Article Citation: Rauf N, Ibrahim N, Aslam I, Javed J, Hayyat A. Diagnostic accuracy of lung ultrasound in diagnosing interstitial lung disease taking HRCT as gold standard. Professional Med J 2025; 32(10):1248-1252. https://doi.org/10.29309/TPMJ/2025.32.10.9838

ABSTRACT… Objective: To evaluate the diagnostic accuracy of ultrasonography for detection of interstitial lung disease (ILD) keeping high resolution computed tomography (HRCT) scan as gold standard. **Study Design:** Cross-sectional, Validation study. **Setting:** Department of Radiology, Combined Military Hospital, Gujranwala, Pakistan. **Period:** June 2024 to February 2025. **Methods:** A total of 95 patients of either gender, aged 18-75 years, and who presented with suspected ILD were analyzed. All patients underwent lung ultrasound (LUS) followed by HRCT. Data analysis was performed using IBM-SPSS Statisics, version 26.0. The diagnostic accuracy of LUS was calculated for ILD along with sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). **Results:** In a total of 95 patients, 68 (71.6%) were male. The mean age was 64.4±9.5 years, while 63 (66.3%) patients were aged between 61–75 years. Dyspnea, and chronic cough were reported in 85 (89.5%), and 76 (80.0%) patients, respectively. The HRCT confirmed ILD in 87 (82.7%) patients. LUS was positive for ILD findings in 72 (75.8%) patients. The sensitivity, and specificity of LUS for the detection of ILD were 81.6%, and 87.5%, respectively. The PPP, and NPV were 98.6%, and 30.4%, respectively. The overall diagnostic accuracy of LUS taking HRCT as gold standard was calculated as 82.4%. **Conclusion:** Lung ultrasound can be cost effective and safer investigation in initial evaluation of ILD with good diagnostic accuracy.

Key words: Computed Tomography, Diagnostic Accuracy, Interstitial Lung Disease, Ultrasonography.

INTRODUCTION

Interstitial lung disease (ILD) includes various disorders characterized by widespread inflammation and fibrosis of the pulmonary parenchyma.[1] The treatment landscape for ILD is currently limited, and the disease often progresses rapidly, posing significant challenges to patient health. High-resolution computed tomography (HRCT) is considered as gold standard in diagnosing ILD, offering high sensitivity and specificity, often exceeding 80%.[2] However, HRCT involves ionizing radiation, which limits its use due to associated risks, high costs, and the impracticality of frequent repeat examinations.[3] Majority of patients have mobility issues like those admitted in intensive care units and also some pregnant women, which makes it challenging in these scenario.[4]

Recent advances in lung ultrasound (LUS) have proven to be effective. As respiratory viral infections cause interstitial lung changes, LUS has gained attention for its ability to identify and monitor these alterations.[5] Traditionally used for guiding pleural biopsy in cases of pleural effusion, LUS has the potential to revolutionize imaging in parenchymal lung diseases. There is formation of collagen fibers and fibroblasts, which causes interlobular septal thickening mostly affecting the periphery of lung parenchyma.[4] In such cases, LUS can be a viable investigation tool in such cases.

Although research on LUS in the context of pulmonary fibrosis has been promising, data on its diagnostic utility for ILD remains under explored. HRCT remains costly, less accessible in many settings, and involves radiation exposure.

1. MBBS, Post-graduate Resident Radiology, Combined Military Hospital, Gujranwala, Pakistan.
2. MBBS, FCPS (Radiology), Consultant Radiologist Radiology, Combined Military Hospital, Gujranwala, Pakistan.
3. MBBS, Post-graduate Resident Radiology, Combine Military Hospital, Gujranwala, Pakistan.
4. MBBS, Post-graduate Resident Radiology, Combine Military Hospital, Gujranwala, Pakistan.
5. MBBS, FCPS, Consultant Radiologist Radiology, AFIU Rawalpindi, Pakistan.

Correspondence Address:
Dr. Naima Rauf
Department of Radiology
Combined Military Hospital, Gujranwala.
naimaasim786@gmail.com

Article received on: 26/03/2025
Accepted for publication: 30/05/2025

On the other hand, LUS is considered a non-invasive, bedside, and radiation-free tool, has emerged as a potential alternative for detecting ILD features such as B-lines and pleural abnormalities. However, its diagnostic accuracy compared to HRCT remains under investigation. This study aimed to evaluate the diagnostic utility of LUS keeping HRCT as gold standard in ILD patients, focusing on its potential benefits, and accessible imaging modality.

METHODS

This cross-sectional, validation study was conducted at the department of Radiology, Combine Military Hospital, Gujranwala, Pakistan, from June 2024 to February 2025. Approval from Institutional Ethical Committee was acquired (ERB NO. 24-2024, Dated: 05-05-2024). Informed and written consents were obtained from all participants. A sample size of 95 was calculated taking the sensitivity of LUS as 86% with reference to HRCT[6], considering 95% confidence level, and 7% margin of error. Non-probability, consecutive sampling technique was adopted. Inclusion criteria were patients of either gender, aged 18-75 years, and presenting with suspected ILD (e.g., chronic cough, dyspnea). Exclusion criteria were patients with known pulmonary malignancy, active pulmonary infection, acute pulmonary edema, pneumothorax, bronchiectasis, or pleural effusion. Patients with history of ILD were also excluded.

All patients underwent LUS followed by HRCT. The LUS was first performed by a radiologist with minimum 2 years of experience. The LUS evaluation used a simplified B-line scoring system. Fourteen intercostal spaces (ICS) were examined, and ILD was identified based on number of B-lines, where 6 or more than 6 B-lines were considered as positive. Additional indicators such as the appearance of pleural line and hypoechoic areas in sub pleural region also aid in diagnosing ILD on ultrasound. The patients then underwent HRCT and the scans were reviewed by on-duty radiologists with minimum of 5 years of experience. The findings were assessed, which included diffuse lung lesions, linear shadows arranged irregularly, consolidations, and nodules. Findings including cystic changes within lung parenchyma, ground-glass opacities or haze, honeycombing and bronchiectasis were also recorded. The diagnosis of ILD on HRCT was recorded for patients and entered in data collection form. Data analysis was done using IBM-SPSS Statistics, version 26.0. The diagnostic accuracy of LUS was calculated for ILD along with sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

RESULTS

In a total of 95 patients, 68 (71.6%) were male. The mean age was 64.4±9.5 years, while 63 (66.3%) patients were aged between 61–75 years. Dyspnea, and chronic cough were reported in 85 (89.5%), and 76 (80.0%) patients, respectively. The HRCT confirmed ILD in 87 (82.7%) patients. LUS was positive for ILD findings in 72 (75.8%) patients (Table-I)

Characteristics		Frequency (%)
Gender	Male	68 (71.6%)
	Female	27 (28.4%)
Age groups (years)	18-40	5 (5.3%)
	41-60	27 (28.4%)
	61-75	63 (66.3%)
Dyspnea		85 (89.5%)
Chronic cough		76 (80.0%)
US Findings (positive)		72 (75.8%)
HRCT (positive)		87 (82.7%)

Table-I. Characteristics of patient (n=95)

Parameters	%
Sensitivity	81.6%
Specificity	87.5%
Positive predictive value	98.6%
Negative predictive value	30.4%
Diagnostic accuracy	82.4%

Table-II. Diagnostic evaluation of lung ultrasound for the detection of ILD (n=95)

The sensitivity, and specificity of LUS for the detection of ILD were 81.6%, and 87.5%, respectively. The PPP, and NPV were 98.6%, and 30.4%, respectively. The overall diagnostic accuracy of LUS taking HRCT as gold standard was calculated as 82.4%. Table-II is showing

details about the evalution of LUS taking HRCT as gold standard in diagnosing ILD.

DISCUSSION

This study exhibited that LUS is an effective imaging technique for detecting ILD.[7] The sensitivity, and specificity of LUS for the detection of ILD were 81.6%, and 87.5%, respectively. The PPP, and NPV were 98.6%, and 30.4%, respectively. The overall diagnostic accuracy of LUS taking HRCT as gold standard was calculated as 82.4%. Given its advantages, such as safe, cost-effectiveness, and non-invasiveness, LUS can be used to screen patients with suspected ILD.[8] Advancements in research have demonstrated that ultrasound can offer high sensitivity and specificity in diagnosing various lung diseases.[9] Over recent years, LUS has expanded its role from being primarily used in pleural effusion biopsies to becoming a valuable tool in imaging other pulmonary diseases.[10] Some other researcher have shown similar findings where the exhibited that LUS can be used as a complementary imaging method in the management of cystic fibrosis patients.[11] Lichtenstein et al. showed that ultrasound can be effective in detecting signs like “stellate tail” and thickening of interstitium in the lung lobules, leading to interstitial pulmonary edema.[12] ILD progresses through several stages, beginning with alveolitis and lung parenchymal damage, followed by septal thickening, and culminating in fibrosis and structural destruction. These pathological changes correlate with LUS findings, where an increase in B lines and pleural line irregularities are observed.[13] In ILD, the increased fluid in the interstitium and alveoli, combined with the thickening of the interlobular septa, creates a reflective interface with alveolar gas. The significant difference in acoustic impedance between these structures results in the characteristic "B line" artifact seen on ultrasound.[14] The diagnostic value of the B line in ILD has been documented in the past, while LUS can also detect sub pleural nodules, suggestive of pulmonary fibrosis.[15]

The findings of this study corobrate well with a meta-analysis done by Song et al. Who showed that LUS has good diagnostic accuracy and correlate with fibrosis pattern of HRCT with a sensitivity of 91.5% and specificity of 81.3%.[16] Aghdashi et al. assessed LUS in 31 patients with suspected rheumatoid lung disease and reported a sensitivity of 74%, specificity of 88%, when compared to HRCT.[17] Another study revealed sensitivity, and specificity of LUS in ILD against HRCT as 92%, and 56%.[18] The present research and the contemporary data demonstrated a good overall accuracy of LUS and positive correlation with HRCT findings.[16-18]

The clinical implications of this study on the diagnostic evaluation of LUS for detecting ILD are significant for several reasons. The findings suggest that LUS can be a precious initial screening modality in suspected ILD cases, offering non-invasive alternative to HRCT scans, which are currently considered the gold standard. This could potentially reduce patient exposure to radiation and overall healthcare costs associated with imaging. The present findings indicate that while LUS may not replace HRCT in all cases, it can serve as an effective adjunctive tool in clinical practice, particularly in settings where HRCT availability or patient compliance may be challenging. The high PPV of 98.6% suggests that a positive finding on LUS is highly indicative of ILD, supporting timely clinical decisions regarding further diagnostic and management strategies. On the other hand, the lower negative predictive value (NPV) of 30.4% underscores the need for caution when relying solely on negative ultrasound findings, necessitating careful clinical correlation and possibly further imaging if clinical suspicion remains high. Limited data is one view about ILD in general and role of LUS in it. Despite its utility, LUS has limitations in evaluating more deeper details like small nodules and mediastinal lymph nodes, which are better visualized on HRCT.[19-21] Few limitations of this study are worth mentioning here as due to its retrospective study design and smaller study population, the results cannot be generalized. Future prospective studies with larger populations are required.

CONCLUSION

Given the numerous benefits of LUS such as the absence of radiation, the ability to conduct repeated assessments, portability, and

affordability, it holds great potential as a useful screening method for patients with suspected ILD.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

SOURCE OF FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

REFERNCES

1. Maher TM. **Interstitial lung disease: A review.** JAMA. 2024 May 21; 331(19):1655-65. doi: 10.1001/jama.2024.3669

2. Doshi JA, Mundhra KS, Shah DS, Shah SN, Patel TV, Bhatt A. **Role of high-resolution ct thorax in diagnosing interstitial lung disease and its association with smoking and connective tissue disorder.** Cureus. 2022; 14(11):e31107. doi: 10.7759/cureus.31107

3. Brower C, Rehani MM. **Radiation risk issues in recurrent imaging.** Br J Radiol. 2021 Oct 1; 94(1126):20210389. doi: 10.1259/bjr.20210389

4. Yan JH, Pan L, Gao YB, Cui GH, Wang YH. **Utility of lung ultrasound to identify interstitial lung disease: An observational study based on the STROBE guidelines.** Medicine (Baltimore). 2021; 100(12):e25217. doi: 10.1097/MD.0000000000025217

5. Clofent D, Polverino E, Felipe A, Granados G, Arjona-Peris M, Andreu J, et al. **Lung ultrasound as a first-line test in the evaluation of Post-COVID-19 pulmonary sequelae.** Front Med (Lausanne). 2022; 8:815732. doi: 10.3389/fmed.2021.815732

6. Huang Y, Liu T, Huang S, Qiu L, Luo F, Yin G, et al. **Screening value of lung ultrasound in connective tissue disease related interstitial lung disease.** Heart Lung. 2023; 57:110-16. doi: 10.1016/j.hrtlng.2022.09.011

7. Santos-Moreno P, Linares-Contreras MF, Rodríguez-Vargas GS, Rodríguez-Linares P, Mata-Hurtado A, Ibatá L, et al. **Usefulness of lung ultrasound as a method for early diagnosis of interstitial lung disease in patients with rheumatoid arthritis.** Open Access Rheumatol. 2024; 16:9-20. doi: 10.2147/OARRR.S441720

8. Symvoulakis E, Vasarmidi E, Linardakis M, Tsiavos A, Mantadaki A, Pitsidianakis G, et al. **Assessing feasibility of targeted primary care referrals for patients with clinical suspicion of interstitial lung disease using lung ultrasound: A prospective case finding study. The potential benefits of LUS utilization.** Sarcoidosis Vasc Diffuse Lung Dis. 2023; 40(2):e2023022. doi: 10.36141/svdld.v40i2.14017

9. Demi L, Wolfram F, Klersy C, De Silvestri A, Ferretti VV, Muller M, et al. **New international guidelines and consensus on the use of lung ultrasound.** J Ultrasound Med. 2023; 42(2):309-44. doi: 10.1002/jum.16088

10. Hassan M, Mercer RM, Rahman NM. **Thoracic ultrasound in the modern management of pleural disease.** Eur Resp Rev. 2020; 29(156):190136. doi: 10.1183/16000617.0136-2019

11. Strzelczuk-Judka L, Wojsyk-Banaszak I, Zakrzewska A, Jończyk-Potoczna K. **Diagnostic value of chest ultrasound in children with cystic fibrosis - Pilot study.** PLoS One. 2019; 14(7):e0215786. doi: 10.1371/journal.pone.0215786

12. Lichtenstein D, Mézière G, Biderman P, Gepner A, Barré O. **The comet-tail artifact. An ultrasound sign of alveolar-interstitial syndrome.** Am J Respir Crit Care Med. 1997 Nov; 156(5):1640-6.

13. Dogan C, Kiral N, Parmaksız E, Fidan A, Çağlayan B, Salepçi B, et al. **Thoracic ultrasonography in the evaluation of lung parenchyma in interstitial lung diseases.** Eurasian J Pulmonol [Internet]. 2020 [cited 2024 Sep 11]; 22(2):104. Available from: https://eurasianjpulmonol.com/article/45

14. 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):613-26. doi: 10.1080/1744666X.2023.2198212

15. Lacedonia D, Scioscia G, Giardinelli A, Quarato CMI, Sassani EV, Foschino BMP, et al. **The role of transthoracic ultrasound in the study of interstitial lung diseases: high-resolution computed tomography versus ultrasound patterns: Our preliminary experience.** Diagnostics (Basel). 2021; 11(3):439. doi: 10.3390/diagnostics11030439

16. Song G, Bae SC, Lee YH. **Diagnostic accuracy of lung ultrasound for interstitial lung disease in patients with connective tissue diseases: A meta-analysis.** Clin Exp Rheumatol. 2016 Jan-Feb; 34(1):11-6. Available from: https://pubmed.ncbi.nlm.nih.gov/26812366/

17. Falcetta A, Leccardi S, Testa E, Papaleo F, Fenoglio L, Melchio R. **The role of lung ultrasound in the diagnosis of interstitial lung disease.** Shanghai Chest. 2018; 2(5):41. doi: 10.21037/shc.2018.04.10

18. Cogliati C, Antivalle M, Torzillo D, Birocchi S, Norsa A, Bianco R, et al. **Standard and pocket-size lung ultrasound devices can detect interstitial lung disease in rheumatoid arthritis patients.** Rheumatology (Oxford). 2014; 53(8):1497-503. doi: 10.1093/rheumatology/keu033

19. Gutierrez M, Ruta S, Clavijo-Cornejo D, Fuentes-Moreno G, Reyes-Long S, Bertolazzi C. **The emerging role of ultrasound in detecting interstitial lung disease in patients with rheumatoid arthritis.** Joint Bone Spine. 2022; 89(6):105407. doi: 10.1016/j.jbspin.2022.105407

20. Gutierrez M, Bertolazzi C, Zozoaga-Velazquez E, Clavijo-Cornejo D. **The value of ultrasound for detecting and following subclinical interstitial lung disease in systemic sclerosis.** Tomography. 2024; 10(4):521-32. doi: 10.3390/tomography10040041

21. Radić M, Đogaš H, Gelemanović A, Jurić PS, Škopljanac I, Radić J. **Pulmonary ultrasonography in systemic sclerosis-induced interstitial lung disease-a systematic review and meta-analysis.** Diagnostics (Basel). 2023; 13(8):1429. doi: 10.3390/diagnostics13081429

AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Naima Rauf:** Data collection, drafting, responsible for data approved for publication.
2	**Nadeem Ibrahim:** Concept, design, critical revisions, approved for publication.
3	**Iqra Aslam:** Data collection, data analysis, responsible for data, approved for publication.
4	**Jahanzeb Javed:** Data collection, data analysis, responsible for data, approved for publication.
5	**Amer Hayyat:** Design, literature review, proof reading, critical revisions, approved for publication.