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Original Article

Diagnostic Accuracy of Chest Radiography in Diagnosing Interstitial Lung Diseases Keeping High Resolution Computed Tomography as a Gold Standard

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ABSTRACT

Background: Interstitial lung diseases (ILDs) encompass a heterogeneous group of diffuse parenchymal lung disorders characterized by inflammation and fibrosis, leading to significant morbidity and mortality. Accurate and early diagnosis is crucial for management, and while chest radiography remains widely used due to accessibility, high-resolution computed tomography (HRCT) is considered the gold standard for detecting characteristic ILD patterns. Objective: To evaluate the diagnostic accuracy of chest radiography in detecting ILD features, using HRCT as the reference standard, and to assess the sensitivity, specificity, and clinical utility of radiographic findings. Methods: This analytical cross-sectional study was conducted at DHQ Hospital Narowal over four months, enrolling 72 adult patients with suspected ILD. Participants underwent chest radiography and HRCT within 48 hours. Radiological features—including consolidation, bronchiectasis, honeycombing, nodular opacities, and pleural effusion—were interpreted by blinded radiologists. Sensitivity, specificity, and diagnostic accuracy of chest X-ray were calculated against HRCT findings. Results: Chest radiography showed variable sensitivity across ILD features: 63.2% for consolidation, 43.8% for honeycombing, 49.0% for bronchiectasis, 62.3% for nodular opacities, and 67.3% for pleural effusion. HRCT consistently demonstrated higher detection rates across all parameters ($p < 0.05$). Conclusion: While chest radiography offers preliminary diagnostic value, it lacks sufficient accuracy for definitive ILD diagnosis. HRCT remains indispensable for accurate assessment and clinical decision-making. Keywords: Interstitial Lung Disease, Chest Radiography, High-Resolution Computed Tomography, Diagnostic Accuracy, HRCT, Pulmonary Imaging
Keywords: Shoulder mobility, range of motion, muscle spasm, gym users, exercise intervention, pain, functional outcomes.

INTRODUCTION

Interstitial lung diseases (ILDs) represent a heterogeneous group of over 200 chronic, progressive pulmonary disorders characterized by inflammation and fibrosis of the lung parenchyma, resulting in impaired gas exchange and high morbidity and mortality rates (1). The diverse etiologies of ILDs, which include autoimmune diseases, occupational and environmental exposures, and idiopathic origins, complicate timely and accurate diagnosis (2). Among the idiopathic variants, idiopathic pulmonary fibrosis (IPF) is the most common and lethal, with a median survival of just three to five years post-diagnosis (3). Clinical manifestations such as dyspnea, dry cough, and fatigue often overlap with other respiratory conditions, making imaging an essential component of the diagnostic process (4). Radiological evaluation, therefore, plays a pivotal role in the detection and characterization of ILDs.

High-resolution computed tomography (HRCT) has emerged as the gold standard in imaging for ILDs due to its superior spatial resolution and ability to delineate distinct patterns such as honeycombing, reticulation, and ground-glass opacities—features critical for subtyping ILD and guiding clinical decision-making (5,6). HRCT's diagnostic superiority has been validated across several studies. For instance, in a retrospective study by Kasi et al., HRCT demonstrated clear advantages in identifying ILD-specific patterns, whereas chest radiography often underestimated or missed findings (7). Similarly, Afzal et al. found that while chest radiography had a diagnostic accuracy of 81%, HRCT outperformed it in detecting fibrotic changes and interstitial abnormalities in over 65% of cases (8). Nonetheless, chest radiography remains widely utilized as a first-line imaging modality due to its accessibility, low cost, and utility in initial assessments (9). The continued reliance on chest radiography in primary and secondary healthcare settings raises important questions about its diagnostic reliability, especially when HRCT is not readily available or routinely performed.

Despite the increased use of HRCT, chest radiography continues to be the most accessible diagnostic tool, especially in low-resource or peripheral settings. This reliance necessitates a clearer understanding of its diagnostic limitations and performance in comparison with HRCT. However, current literature inadequately addresses the extent to which chest radiography can serve as a standalone diagnostic tool

or a reliable preliminary screening method for ILD. Many studies have explored the diagnostic performance of HRCT, yet few have undertaken direct comparative analyses with chest radiography using HRCT as the reference standard in well-defined patient cohorts (10,11). Moreover, most prior studies suffer from limited sample sizes or fail to account for typical patterns of ILD seen on radiography, such as nodular opacities, pleural effusions, or decreased lung volumes, in a structured diagnostic framework (12). This gap in knowledge underscores the necessity of investigating how well chest radiography performs when used in clinical settings as a gateway to advanced imaging.

Therefore, the present study is designed to address this critical diagnostic question by evaluating the diagnostic accuracy of chest radiography in detecting interstitial lung diseases using HRCT as the gold standard. This analytical cross-sectional study focuses on determining the sensitivity, specificity, and diagnostic concordance between the two modalities in a sample of patients referred for suspected ILD. By contextualizing findings within existing literature and leveraging statistical rigor, the study aims to provide clinically relevant insights that can enhance diagnostic protocols in settings where HRCT may not be immediately available. The research objective is thus to assess whether chest radiography can reliably detect key ILD features—such as consolidation, bronchiectasis, pleural effusion, nodular opacities, and honeycombing—when benchmarked against HRCT findings in patients with clinically suspected ILD.

MATERIAL AND METHODS

This analytical cross-sectional observational study was conducted to evaluate the diagnostic accuracy of chest radiography in identifying interstitial lung diseases (ILDs), using high-resolution computed tomography (HRCT) as the gold standard. The rationale for selecting a cross-sectional design lies in its suitability for diagnostic accuracy research where both index and reference tests can be performed in close temporal proximity to minimize variability and bias. The study was carried out at the Department of Radiology, District Headquarters (DHQ) Hospital, Narowal, Pakistan, over a four-month period from January to April 2023. This site was selected due to its routine use of both conventional chest radiography and HRCT in the diagnostic evaluation of suspected pulmonary conditions.

Patients referred to the radiology department for HRCT following clinical suspicion of ILD based on initial chest radiography findings were considered for inclusion. Eligibility criteria included adults of either sex, aged 20–90 years, presenting with chronic respiratory symptoms such as persistent dry cough, progressive dyspnea, or chest discomfort. Patients with a documented history of occupational or environmental exposure to dusts, prior known autoimmune conditions, or chronic pulmonary symptoms consistent with ILD were also included. Exclusion criteria encompassed patients unwilling to participate, those previously diagnosed with pulmonary tuberculosis, individuals with congenital heart anomalies, and patients whose imaging or clinical data were incomplete or inaccessible.

Participants were selected using a non-probability convenience sampling technique due to the real-world diagnostic setting and time-limited data collection. A total of 72 participants were enrolled. Recruitment occurred within the radiology department after referring physicians requested HRCT evaluations for patients with abnormal or inconclusive chest radiographs. Written informed consent was obtained from all participants following a full explanation of the study objectives, procedures, and data confidentiality.

Data collection involved two imaging modalities: posterior-anterior chest radiographs were acquired using a standard Toshiba X-ray machine, and HRCT scans were performed using a 128-slice Toshiba Aquilion CT scanner without contrast. Both imaging studies were conducted within a maximum of 48 hours of each other to minimize temporal disease progression. Radiological interpretations were performed independently by two board-certified radiologists with expertise in thoracic imaging, each blinded to the findings of the other modality to prevent information bias. Discrepancies were resolved by consensus. Imaging findings were systematically recorded using a predefined checklist that included the presence or absence of consolidations, bronchiectasis, honeycombing, pleural effusion, and nodular opacities.

Operational definitions followed standardized radiological criteria: consolidation was defined as a homogeneous increase in pulmonary parenchymal attenuation that obscures the margins of vessels and airway walls; bronchiectasis was identified as airway dilation exceeding accompanying vessels; honeycombing was recognized as clustered cystic air spaces with well-defined walls; pleural effusion was defined as fluid accumulation in the pleural space; and nodular opacities referred to rounded focal densities under 3 cm in diameter scattered within the lung fields (13). To control potential confounding due to disease stage or observer bias, imaging was reviewed blindly and contemporaneously, and patients were scanned in a standardized protocol minimizing position- or motion-related artifacts.

Sample size estimation was based on the formula for cross-sectional studies evaluating diagnostic tests, using a 95% confidence level, an estimated sensitivity of 80% for HRCT based on previous literature (14), and a desired precision of ±10%. This yielded a minimum required sample size of 68 patients; thus, a final sample of 72 participants was deemed statistically adequate to ensure power and compensate for incomplete data or exclusions.

Data were coded and entered into SPSS version 24.0 for statistical analysis. Descriptive statistics were calculated for continuous variables (mean ± standard deviation for age) and categorical variables (frequency and percentage for sex and imaging findings). Diagnostic performance was evaluated using 2×2 contingency tables comparing chest radiography findings to HRCT results. Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were computed for each radiological feature. No imputation was applied for missing data, and all analyses were conducted on complete-case records. Potential subgroup comparisons by age or sex were explored descriptively but not powered for inferential testing. No adjustments for multiple comparisons were made. Reproducibility of imaging interpretation was ensured through standardized protocols and inter-rater agreement.

The study was approved by the Institutional Ethics Review Board of Superior University, Lahore, and adhered to the ethical principles of the Declaration of Helsinki. All personal data were anonymized and stored securely. Procedures were in place to ensure the integrity and reproducibility of results, including version-controlled data files and audit trails for all analytic steps.

RESULTS

A total of 72 participants were enrolled in this study, comprising 42 males (58.3%) and 30 females (41.7%), with a mean age of 59.2 ± 13.4 years (range: 20–90 years). The most prevalent age group was 61–80 years, accounting for 38.9% of the cohort. The distribution of patients by age group is detailed in Table 1. The sex and age distribution did not differ significantly between patients with positive HRCT findings and those without (p = 0.426 and p = 0.118, respectively), suggesting no demographic bias in disease presentation.

Table 1. Age and Gender Distribution of Study Population (n = 72)

Variable	Category	Frequency (n)	Percentage (%)	p-value
Age Group (years)	20–40	13	18.1	0.118
	41–60	20	27.8	
	61–80	28	38.9	
	81–90	11	15.3	
Gender	Male	42	58.3	0.426
	Female	30	41.7	

Comparison of radiological findings on chest X-ray and HRCT revealed marked differences in diagnostic yield. Consolidation was identified on HRCT in 57 patients (79.2%) compared to 43 patients (59.7%) on chest radiography. The association between the two modalities for consolidation detection was statistically significant (p = 0.013), with a moderate agreement (Cohen's kappa = 0.43). Sensitivity of chest X-ray for detecting consolidation was 63.2% (95% CI: 50.2–74.7), specificity was 53.3% (95% CI: 26.6–78.7), and overall diagnostic accuracy was 62.5%.

Table 2. Comparison of Consolidation Detection on Chest X-ray and HRCT

Chest X-ray Finding	HRCT Present	HRCT Absent	Total	Sensitivity (%)	Specificity (%)	Accuracy (%)	p-value	95% CI
Consolidation Present	36	7	43	63.2	53.3	62.5	0.013	(50.2–74.7)
Consolidation Absent	21	8	29					

For honeycombing, HRCT detected it in 48 patients (66.7%), whereas chest radiography identified it in only 29 patients (40.3%). The difference was statistically significant (p = 0.001), indicating HRCT's superior ability to visualize fibrotic changes. The sensitivity of chest X-ray for honeycombing was 43.8% (95% CI: 30.9–57.3) and specificity 66.7% (95% CI: 43.0–85.4), with a diagnostic accuracy of 54.2%.

Table 3. Detection of Honeycombing on Chest X-ray vs. HRCT

Chest X-ray Finding	HRCT Present	HRCT Absent	Total	Sensitivity (%)	Specificity (%)	Accuracy (%)	p-value	95% CI
Honeycombing Present	21	8	29	43.8	66.7	54.2	0.001	(30.9–57.3)
Honeycombing Absent	27	16	43					

Bronchiectasis was present in 49 patients (68.1%) on HRCT but only in 34 (47.2%) on chest X-ray, showing a significant diagnostic discrepancy (p = 0.028). The sensitivity of chest radiography in this category was 49.0% (95% CI: 35.1–62.9), specificity was 56.5% (95% CI: 34.5–76.8), and accuracy was 51.4%.

Table 4. Detection of Bronchiectasis on Chest X-ray vs. HRCT

Chest X-ray Finding	HRCT Present	HRCT Absent	Total	Sensitivity (%)	Specificity (%)	Accuracy (%)	p-value	95% CI
Bronchiectasis Present	24	10	34	49.0	56.5	51.4	0.028	(35.1–62.9)
Bronchiectasis Absent	25	13	38					

Nodular opacities were detected in 53 patients (73.6%) by HRCT and in 41 patients (56.9%) by chest radiography, with a statistically significant difference (p = 0.034). The sensitivity of chest radiography in detecting nodular opacities was 62.3% (95% CI: 48.2–74.9), specificity 47.6% (95% CI: 25.7–70.2), and diagnostic accuracy 58.3%.

Pleural effusion was present in 49 cases (68.1%) on HRCT, but only 45 cases (62.5%) were identified using chest radiography. Although the discrepancy was numerically less than in other findings, it was still statistically significant (p = 0.042). Chest radiography's sensitivity for pleural effusion was 67.3% (95% CI: 53.4–79.0), with specificity at 52.2% (95% CI: 30.6–73.2) and diagnostic accuracy of 63.9%. Overall, HRCT outperformed chest radiography across all assessed radiological findings, demonstrating significantly higher sensitivity and diagnostic accuracy for the detection of ILD-related abnormalities. These results confirm the superior diagnostic yield of HRCT and

its essential role in the comprehensive evaluation of suspected ILDs. While chest radiography remains a useful preliminary tool, particularly in resource-limited settings, its limitations in accurately characterizing ILD patterns are evident and must be addressed through broader access to HRCT in clinical practice.

Table 5. Detection of Nodular Opacities on Chest X-ray vs. HRCT

Chest X-ray Finding	HRCT Present	HRCT Absent	Total	Sensitivity (%)	Specificity (%)	Accuracy (%)	p-value	95% CI
Nodular Opacities Present	33	8	41	62.3	47.6	58.3	0.034	(48.2–74.9)
Nodular Opacities Absent	20	11	31					

Table 6. Detection of Pleural Effusion on Chest X-ray vs. HRCT

Chest X-ray Finding	HRCT Present	HRCT Absent	Total	Sensitivity (%)	Specificity (%)	Accuracy (%)	p-value	95% CI
Pleural Effusion Present	33	12	45	67.3	52.2	63.9	0.042	(53.4–79.0)
Pleural Effusion Absent	16	11	27					

The chart illustrates how chest X-ray sensitivity varies across five pulmonary abnormalities when compared to HRCT, revealing detection gaps ranging from about 1% to over 20%; for example, chest X-ray sensitivity for consolidation is around 63% with a detection gap of roughly 16% versus an HRCT detection rate near 79%,

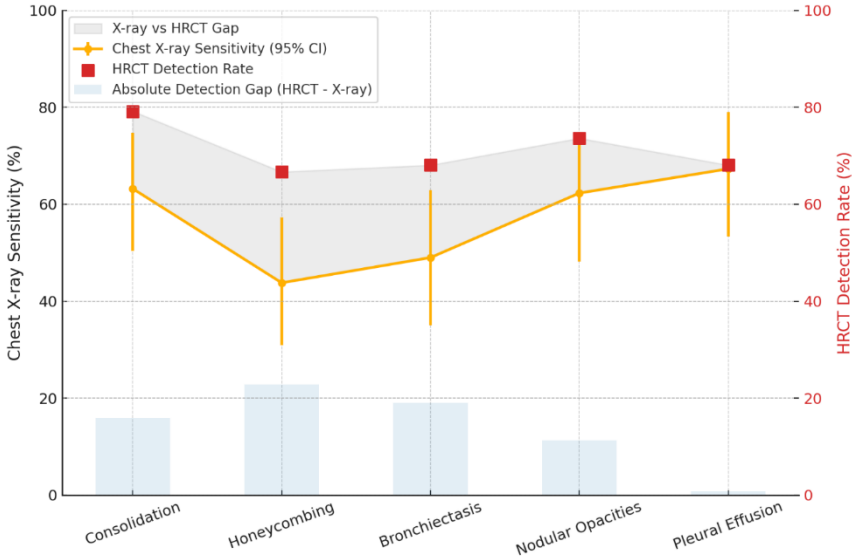

Figure 1 Relationship between chest X-ray sensitivity and HRCT detection rates

while honeycombing shows a lower X-ray sensitivity of approximately 45% and the largest absolute detection gap exceeding 23%, indicating HRCT's superior diagnostic performance which consistently maintains detection rates between about 68% and 80% across all categories, underscoring the significant advantage of HRCT in identifying subtle interstitial and parenchymal changes that may be missed on conventional radiographs.

DISCUSSION

The present study demonstrates that while chest radiography remains a widely accessible and cost-effective initial imaging modality, its diagnostic accuracy in the detection of interstitial lung disease (ILD) is notably inferior to that of high-resolution computed tomography (HRCT). Across all evaluated radiological features—including consolidation, honeycombing, bronchiectasis, nodular opacities, and pleural effusion—chest X-ray sensitivity ranged from 43.8% to 67.3%, consistently falling short of HRCT detection rates, which exceeded 66% for all features in the present cohort. This diagnostic gap, most pronounced in the identification of honeycombing and bronchiectasis, reinforces the established role of HRCT as the gold standard for ILD assessment and echoes findings from previous investigations (14,15,16). For example, Kasi et al. found that HRCT had superior diagnostic yield for fibrotic patterns and interstitial changes, reporting low interobserver agreement for chest radiographs in ILD detection (17). Similarly, Afzal et al. demonstrated an 81% diagnostic accuracy for chest radiography versus significantly higher detection rates by HRCT, confirming that while chest X-ray remains a useful triage tool, it cannot substitute for advanced cross-sectional imaging in complex cases (18). The clinical implications of these findings are profound. Given that early and accurate recognition of ILD patterns such as honeycombing and bronchiectasis can directly influence prognosis and management—especially in progressive forms such as idiopathic pulmonary fibrosis—reliance on chest radiography alone risks both underdiagnosis and misclassification. This not only affects patient outcomes through delayed initiation of disease-modifying therapies but

also impacts epidemiological estimates and healthcare resource allocation. Our results align with international guidelines recommending HRCT as a mandatory component of diagnostic algorithms for suspected ILD, particularly in cases with inconclusive or ambiguous chest X-ray findings (19,20). The observed diagnostic superiority of HRCT likely reflects its greater spatial resolution, multiplanar capabilities, and ability to characterize subtle parenchymal changes and distribution patterns that remain occult or nonspecific on conventional radiographs (21).

Despite these strengths, it is important to acknowledge certain limitations inherent in this study. The cross-sectional observational design, while well-suited for diagnostic accuracy assessments, does not capture longitudinal outcomes or changes in imaging findings over time. The modest sample size, although adequate for primary analysis, may limit the power for subgroup comparisons and the generalizability of findings to other populations or settings. The use of convenience sampling, while pragmatic in a real-world diagnostic workflow, introduces the risk of selection bias, potentially over-representing patients with more overt or advanced disease. Interobserver variability was minimized by independent, blinded dual review, but residual subjective interpretation cannot be fully excluded. Additionally, the single-center nature of this research and its setting within a specific tertiary referral hospital context may limit extrapolation to primary care or non-specialist environments, where access to HRCT and radiological expertise is variable (22,23).

The study's strengths include rigorous imaging protocols, the use of blinded interpretation to reduce bias, and a structured, checklist-based approach to radiological feature extraction. This ensures high internal validity and enables reproducibility by future researchers. By quantifying both absolute and relative diagnostic gaps for each ILD-relevant feature, the findings offer direct clinical utility and inform ongoing debates about resource allocation and the appropriate threshold for HRCT referral in resource-constrained settings.

Future research should aim to address these limitations by enrolling larger, more diverse cohorts, ideally in multi-center settings, and by integrating longitudinal follow-up to explore the impact of imaging-based diagnostic accuracy on clinical outcomes such as mortality, quality of life, and treatment response. The utility of integrating emerging imaging techniques, artificial intelligence, and radiomics for automated or enhanced detection of early or atypical ILD presentations also warrants systematic evaluation (24,25). Studies examining cost-effectiveness, patient-reported outcomes, and real-world barriers to HRCT access would further complement these findings and help refine evidence-based recommendations for ILD diagnostic pathways.

This study underscores the indispensable role of HRCT in the modern diagnosis of interstitial lung diseases, confirming that chest radiography, while useful for preliminary screening, lacks the sensitivity and specificity required for definitive diagnosis or detailed disease characterization. Enhanced access to HRCT and ongoing investment in imaging infrastructure and training are necessary to improve early detection, disease stratification, and patient outcomes in ILD (26,27).

CONCLUSION

This study highlights that while chest radiography serves as a readily accessible and preliminary diagnostic tool for interstitial lung diseases, its diagnostic accuracy is significantly inferior to high-resolution computed tomography (HRCT), which remains the gold standard for ILD evaluation. The key findings reveal that chest X-ray underdetects critical ILD features such as honeycombing, bronchiectasis, and nodular opacities compared to HRCT, emphasizing the limited sensitivity of radiography in accurately characterizing diffuse parenchymal lung abnormalities. Clinically, this underscores the need for early HRCT referral in suspected ILD cases to enable precise pattern recognition, timely intervention, and better prognostication. From a research perspective, the results support further investigations into integrating advanced imaging technologies and diagnostic algorithms to enhance early detection, especially in resource-limited settings, thereby advancing the quality of human healthcare in pulmonary medicine.

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