ORIGINAL ARTICLE

DIAGNOSTIC ACCURACY OF CHEST RADIOGRAPH IN INTERSTITIAL LUNG DISEASE AS CONFIRMED BY HIGH-RESOLUTION COMPUTED TOMOGRAPHY (HRCT) CHEST

Faiza Akram[1], Shahid Hussain[2], Azmat Ali[1], Hamza Javed[3], Muhammad Fayyaz[4], Khalil Ahmed[5]

[1]Department of Radiology, Ayub Medical College, Abbottabad, [2]Disstt. Headquarter Hospital, Dir, [3]Abbottabad International Medical College, Abbottabad, [4]Prosthodontic Department, Dentistry Section Ayub Medical College, Abbottabad-Pakistan, [5]Free lancer

Background: Interstitial Lung Disease (ILD) - an umbrella term encompassing about 100 different pathophysiological entities are usually defined as an irreversible, progressive fibrotic changes in the lung parenchyma that leads to difficult breathing and reduced gaseous exchange at the alveolar level. We aimed to quantify the validity of CXR for the diagnosis of ILD taking HRCT as gold standard in the population of Hazara division. **Methods:** This validation study was conducted during 11 June till 12 Dec 2019 in the radiology department of Ayub Teaching Hospital, Abbottabad on 60 adult patients aged 30–60 years who presented with progressive exertional dyspnoea. The patients were enrolled into the study via non-probability, consecutive sampling technique. All the data was recorded on a self-developed structured questionnaire. Data was analyzed using SPSS version 20. **Results:** The mean age of study participants was 47.18±6.90 years SD with a range of 36–60years. The mean of time duration of symptoms was 9.66±1.7 years with a range of 7–12 years. There were 40 (66.7%) males and 20 (33.3%) females with a male to female ratio of 2:1. The sensitivity, specificity, PPV, NPV and Diagnostic Accuracy of CXR for the diagnosis of ILD as compared to HRCT was calculated to be 65.5%, 20%, 90%, 5% and 61.66% respectively. A chi square test of significance yielded a value of 0.51 for the diagnostic accuracy of CXR for ILD as compared to HRCT. Diagnostic ODDs ratio and Youden's Index yielded values of 47.37% and 0.145 respectively. All these parameters' points towards a lower utility of CXR for the diagnostic purpose in patients suspected with ILD. **Conclusion:** Chest x-ray is simple, non-invasive, economical and readily available alternative to HRCT but its specificity and diagnostic accuracy are questionable. CXR is a recommendable first line investigation for chest pathology workup but for a definitive diagnosis, one should not depend on CXR as it can miss the diagnosis.

Keywords: Interstitial Lung Diseases; Chest radiographs; HRCT chest; Validity Parameters

Citation: Akram F, Hussain S, Ali A, Javed H, Fayyaz M, Ahmed K. Diagnostic accuracy of chest radiograph in interstitial lung disease as confirmed by High-Resolution Computed Tomography (HRCT) Chest. J Ayub Med Coll Abbottabad 2022;34(4 Suppl. 1):1008–1012.

DOI: 10.55519/JAMC-04-S4-11183

INTRODUCTION

Interstitial Lung Disease (ILD)- an umbrella term encompassing about a 100 different pathophysiological entities is usually defined as an irreversible, progressive fibrotic changes in the lung parenchyma that leads to difficult breathing and reduced gaseous exchange at the alveolar level.[1,2] Interstitial Lung Disease begins as an inflammatory process; alveolitis, bronchiolitis or vasculitis that leads to decreased pulmonary functions and symptoms like dyspnoea, cough, tiredness etc.[3] ILD, recently more commonly referred to as diffuse interstitial lung diseases due to the generalized involvement of lungs (DILD), is classified into four categories on the basis of similarity in the pathophysiology and radiographic findings which includes:1) DILD of known causes 2) Idiopathic interstitial pneumonia 3)granulomatous DILD and 4) other DILDs like Langerhans cells histiocytosis etc.[4] A variety of causes have been enlisted in the literature including but not limited to environmental toxins, air pollution, smoking, infections, chemotherapy/ medicines, radiotherapy to chest, autoimmune/ connective tissue disorders and idiopathic ILD.[5,6]

Due to such a variety of causes and phenotypes of ILD, a significant proportion of patients go misdiagnosed at the initial presentation.[7] Accurate diagnosis of ILD poses a challenge even to competent clinicians/ radiologists because it requires a multidisciplinary integration of clinical signs and symptoms, pathological and radiological features.[8] This blend of information then needs to be compared with diagnostic criteria to make a differential and specific diagnosis.[8] ILD puts a high financial burden on the health care system, approx. $174 billion annually.[9]

A number of studies have reported HRCT to be superior to Chest Radiograph (CXR) for the diagnosis of ILD.[10,11] HRCT is regarded superior to other modalities in characterization of different lung parenchymal pathologies and the extent of

involvement.[12,13] It detects changes related to ILD well before they appear on CXR and therefore, can help in estimating prognosis, disease severity and response to treatment.[14,15] The major hurdles are the high cost, lack of easy availability and high risk of radiation.[16] Chest radiograph (CXR) is the preliminary investigation ordered for patients having pulmonary pathology.[4] The findings of a CXR are usually non-specific and lack sensitivity due to inherent limitation of not being able to visualize the mediastinum.[14,17] Therefore, a normal CXR does not exclude a diagnosis of ILD.[12] They still can aid to rule out other conditions like left heart failure, pulmonary metastasis etc.[12] Also, CXR has low cost, 800 times lower dose of radiation as compared to HRCT and easy availability.[15] Serial CXR provides valuable information on disease progression and/ or remission.[12]

Through this study, we aimed to quantify the validity of CXR for the diagnosis of ILD taking HRCT as gold standard in the population of Hazara division. There are a very few studies that have compared the CXR with HRCT for this spectrum of pathologies, therefore, it may help fill the knowledge gap in this area of research. Also, our findings will provide further evidence on the contradicting views about the diagnostic accuracy of CXR for ILD.

MATERIAL AND METHODS

This validation study was conducted during 11 June till 12 Dec 2019 in the radiology department of Ayub Teaching Hospital, Abbottabad on 60 adult patients aged 30–60 years who presented with progressive exertional dyspnoea. The patients were enrolled into the study via non-probability, consecutive sampling technique. The study was conducted after approval from medical ethics committee- Ayub Medical Institution, Abbottabad. All patients meeting the inclusion criteria admitted in the department of Medicine & Allied who were being investigated for presence of interstitial lung disease were included in the study. Patients known to have ischemic heart disease, chronic kidney disease, chronic liver disease or anaemia due to any cause or Patients with current or past history of malignancy anywhere in body were excluded from this study. The purpose and benefits of the study was explained to all patients and / or their relatives and they were assured of the confidentiality of data and informed written consent was obtained from all patients. A chest radiograph was obtained for each patient suspected to have interstitial lung disease based on their presenting history. An HRCT chest was also done for each study participant to validate the findings in chest radiograph. A consultant radiologist with at least 5 years of clinical experience was requested to interpret both the radiograph as well as the HRCT scan in light of presenting history and findings on physical examination to establish the diagnosis of interstitial lung disease. All the data was recorded on a self-developed structured questionnaire. Data was analyzed using SPSS version 20. Mean±SD was calculated for numerical variables like age. Frequencies and percentages were calculated for categorical variables such as gender and diagnosis of interstitial lung disease on x-ray as well as HRCT. A 2x2 contingency table was constructed to measure the diagnostic validity parameters. Post-stratification chi square test of significance was applied to see any correlation between the chest radiographs based and HRCT based diagnoses. Data was presented in tables, charts and diagrams.

RESULTS

The mean age of study participants was 47.18±6.90 years SD with a range of 36–60 years. The mean of time duration of symptoms was 9.66±1.7 years with a range of 7-12 years. There were 40 (66.7%) males and 20 (33.3%) females with a male to female ratio of 2:1. These results are represented in table-1.

Diagnosis of interstitial lung disease was made on chest x-ray in 40 (66.7%) patients. While the diagnosis of interstitial lung disease on HRCT chest was made in 55 (91.7%) patients as shown in the figure-1.

A 2x2 contingency table was created by cross-tabulating ILD on Chest X-ray (CXR) and ILD on HRCT chest. Chi- square test was applied on the diagnostic accuracy of CXR for the diagnosis of ILD as compared to the gold standard- HRCT chest. *p*-value of 0.51 was calculated which is statistically non-significant, as shown in the table-2.

The values for the validity parameters were calculated from the table-2. As shown in table 3, all the validity parameters of CXR for the diagnosis of ILD yields very low results as compared to the gold standard. Thus, CXR cannot be considered a good diagnostic tool for ILD. When the diagnostic accuracy was stratified by age and sex, no statistically significant association was observed. P value is not significant ($p \leq 0.05$) in none of the scenarios, as seen in the table-4.

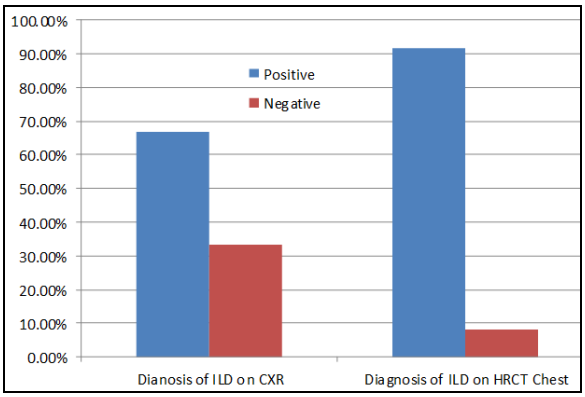

Figure-1: Frequency of diagnosis of ILD on Chest X-ray (CXR) and HRCT Chest

Table 1: Descriptive statistics of study participants

Parameters	Mean	Standard Deviation
Age (yrs.)	47.18	6.90
Duration of Symptoms (yrs.)	9.47	1.7
Gender	Male	Female
	40 (66.7%)	20 (33.3%)

Table 2: 2x2 Contingency Table of Chest X-ray (CXR) with HRCT chest

		ILD on HRCT		Total	Chi-Square Test
		Present	Absent		
ILD on CXR	Present	(TP) 36	(FP) 4	40	p= 0.51
	Absent	(FN) 19	(TN) 1	20	
Total		55	5	60	

Table 3: Validity Parameters

Parameter	Formula	Value
Sensitivity	TP/ (TP+FN) x 100	65.5%
Specificity	TN/ (TN+FP) x 100	20%
Positive Predictive value	TP/ (TP+FP) x100	90%
Negative Predictive value	TN/ (TN+FN) x100	5%
Diagnostic ODDS Ratio (DOR)	(TP/FN) / (FP/TN) x100	47.37%
Diagnostic Accuracy	(TP+TN) / (TP+TN+FP+FN) x100	61.66%
Youden's Index	(Sensitivity + Specificity) – 1	0.145

Table-4: Stratification of Diagnostic Accuracy by Gender and Age of patients

Parameters		ILD on HRCT		Total	*p*-value
		Present	Absent		
ILD on CXR in Male	Present	25	4	29	0.19
	Absent	11	0	11	
	Total	36	4	40	
ILD on CXR in Female	Present	11	0	11	0.26
	Absent	8	1	9	
	Total	19	1	20	
ILD on CXR in Age ≤ 47 (years)	Present	16	3	19	0.25
	Absent	20	1	21	
	Total	36	4	40	
ILD on CXR in Age >47 (years)	Present	11	1	12	0.40
	Absent	8	0	8	
	Total	19	1	20	

DISCUSSION

In this study, mean age was 47.18±6.90 years with majority of the patients (48.17%) between 41–50 years of age. These findings are comparable to the study of Baskey *et al* and Afzal *et al* who had found mean age range 41–50 years & mean age of 40.21±2.29 years respectively.[14,18] As majority of the ILDs have a long natural history that is why they usually present in older adults in the fifth or greater decade of life. Some types of ILDs e.g., sarcoidosis, connective – tissue disease associated lung disease, and inherited forms of lung disease present in younger adults.[19]

The mean duration of symptoms of ILD for our study participants is 9.47±1.7 years. A study conducted in Jharkand reported that 65.7% of their study participants had the symptoms for more than one year while the rest of their study population had a more recent onset of symptoms.[14] Male patients were 66.7% of our study population while 33.3% were females. This finding is in correlation with the well-known fact that ILD affects men more commonly.[11]

CXR made a positive diagnosis of ILD in66.7% while HRCT was positive in 91.70% of our study subjects. A study conducted in Pakistan also reported that CXR was positive for ILD in 58.39% of their study participants.[18] CXR is a widely available, inexpensive, non-invasive investigation but it misses abnormalities in 10% of biopsy proven patients.[4] It can be normal in early disease and may be unable to characterize ILD.[14,15] It cannot be used as sole diagnostic investigation in such patients but is used as baseline investigation in cases of clinical suspicion of ILD.[12]

The sensitivity, specificity, PPV, NPV and Diagnostic Accuracy of CXR for the diagnosis of ILD as compared to HRCT in our sample were calculated to be 65.5%, 20%, 90%, 5% and 61.66% respectively. A chi square test of significance yielded a value of 0.51 for the diagnostic accuracy of CXR for ILD as compared to HRCT. Diagnostic ODDs ratio and Youden's Index yielded values of 47.37% and 0.145. All these parameters' points towards a lower utility of CXR for the diagnostic purpose in patients suspected with ILD. Afzal *et al*. in their study has shown the sensitivity, specificity, PPV, NPV and accuracy of chest x-ray as 80.0%, 82.98%, 90.0%, 68.4% and 81.02% respectively for diagnosing ILD.[18] They reported CXR to be an acceptable alternative to the HRCT chest but our results are contradictory to their findings.[18]

In another study by Coutinho *et al*, sensitivity, specificity, positive and negative predictive values for the x-ray diagnosis of interstitial lung disease was found to be 70%, 90%, 62.3% and 93% respectively.[20] Senger *et al* assessed the HRCT of 60 patients in India for the different interstitial lung diseases and compared the results with histopathology reports and reported a good correlation between the HRCT diagnosis of the different subtype of ILD and it histopathology diagnosis.[11] We stratified the diagnostic accuracy of CXR as compared to the HRCT for age and gender. We found no significant difference in the ability of CXR to diagnose ILD in either sex or at older age. The diagnostic accuracy of CXR does not increase with age nor is it significantly higher for any specific gender. To our knowledge, no other study has discussed such stratification of their data for gender or age.

CONCLUSION

Chest x-ray is simple, non-invasive, economical and readily available alternative to HRCT but its specificity and diagnostic accuracy are questionable. CXR is a recommendable first line investigation for chest pathology workup but for a definitive diagnosis, one should not depend on CXR as it can miss the diagnosis.

AUTHORS' CONTRIBUTION

FA, SH, AA: Study design and conception, proof reading. HJ, MF, KA: Literature search, data collection and data interpretation.

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Submitted: July 27, 2022	*Revised: September 16, 2022*	*Accepted: October 5, 2022*

Address for Correspondence:

Dr. Azmat Ali, Department of Radiology, Ayub Medical College, Abbottabad-Pakistan
Cell: +92 331 120 3021
Email: drazmat772@gmail.com