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Diagnostic Accuracy of Chest X-Ray in Detecting Interstitial Lung Disease Taking HRCT as Gold Standard

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Both authors equally contributed to the study and approved the final manuscript

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ABSTRACT

Objective: To determine diagnostic accuracy of chest X-rays to diagnose interstitial lung disease keeping high resolution computed tomography as gold standard. **Methods:** This validation study was conducted at "Radiology department of Islamabad Diagnostic Center, Islamabad from 21st June to 21st December 2024. Ninety two patients clinically suspected cases of interstitial lung disease were included in the study. They underwent chest X-rays and HRCT chest to see for presence of characteristic radiological findings of interstitial lung disease. Based on findings, diagnostic accuracy parameters were calculated by drawing 2x2 contingency tables. Data was statistically analyzed using SPSS version 25. **Results:** Median age was 52.00 (69.00 – 35.00) years. There were 35 (38.00%) males and 57 (62.00%) females. Median duration of symptoms was 9.00 (14.00 – 7.00) weeks. Sensitivity, specificity, accuracy, positive predictive value and negative predictive value of chest x-ray to diagnose interstitial lung disease with chest HRCT being the gold standard were 67.16%, 48.00%, 61.96%, 77.59% and 35.29%, respectively. **Conclusion:** Diagnostic accuracy of chest X-rays to diagnose interstitial lung disease was 61.96%.

INTRODUCTION

"Interstitial lung disease (ILD)" is consist of a massive group of heterogeneous disorders that result in the pathological damage of the parenchyma of the lung ultimately leading to fibrosis of the lung. [1] In general, ILD is a progressive disease that follows a continuously worsening clinical course but can also present as a case of acute respiratory distress which can potentially threaten the life of the ailing patients. [2] Globally, a rise has been observed in the magnitude of ILD with approximated incidence of 207.2 per one hundred thousand population. [3]

When it comes to pathophysiological process that results in development of ILD, not only it is poorly understood but also has demonstrated variation but it has been found that there is a strong association of pathogenesis of ILD and genetics. [4] In majority of the cases of ILD etiology is idiopathic but other associated risk factors include systemic disorders, inhalational exposure to certain allergens, drugs, smoking, hepatitis C, tuberculosis and radiation therapy. [5, 6] Another important pathophysiological association of ILD that has surfaced in the recent times is with infection of the Sars-CoV-2 corona virus (COVID-19) which wreaked havoc across the globe in 2019/20 in the form of a pandemic. [7]

Diagnosis of ILD is a multi-step process in which patients who present with characteristic clinical features of "3Cs (crackles, cough and clubbing)" undergo a series of tests. There are several test in this regard including autoimmune/rheumatology antibodies blood panel, pulmonary function test, histopathological assessment of the diseased lung parenchyma by lung biopsy but of the most definitive non-invasive and highly accurate test in this regard is high resolution computed tomography (HRCT) scan of the chest. [8, 9] However, in Pakistan, availability of advanced diagnostic tests (like HRCT) for effectively diagnosing ILD is mainly concentrated in the teaching or tertiary health care hospitals while most secondary care and periphery hospitals are equipped with chest X-ray (CXR) which is also considered to be useful in this regard. Present study focused on determining the diagnostic accuracy of CXR to diagnose ILD keeping HRCT as gold standard so that it can be assessed that can CXR be a reliable tool to diagnose ILD and refer them to a higher

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facility. This may help in significantly reducing the referral burden on already burdened tertiary care hospitals and also provide useful insight regarding this cheaper and easily available investigation to diagnose ILD.

MATERIAL AND METHODS

This validation study was conducted at "Radiology department of Islamabad Diagnostic Center, Islamabad from 21st June to 21st December 2024" after taking institutional ethical approval. For calculation of sample size WHO sample size calculator and following formula was used:

$$n = \frac{z^2_{1-\alpha/2} P(1-P)}{d^2}$$

For calculation following parameters were utilized; confidence level of 95%, absolute precision of 8% and anticipated accuracy of CXR to diagnose ILD of 81.02%. [10] This gave a sample size of 92.

Adult patients who were aged 18 years or above, both male and female, who presented with high clinical suspicion of ILD who were referred for radiology scans to radiology department were included in the study. High clinical suspicion was defined as combination of history of unexplained persistent shortness of breath and dry cough for six weeks or more along with presence of nail clubbing and fine inspiratory crackles on clinical examination. Patients with previous history of chemotherapy or radiotherapy, known history of asthma, COPD, pleural diseases, pneumonia, bronchogenic carcinoma, tuberculosis, cystic fibrosis or alpha-1 antitrypsin deficiency were excluded from the study.

Patients were selected consecutively using non-probability sampling technique. Baseline characteristics including age, gender and duration of symptoms were documented. All these patients then underwent CXR and HRCT chest to determine diagnosis of ILD. A patients was labelled to have ILD on CXR in case of presence of reticulonodular opacities along with or without presence of septal lines, areas of volume loss and honeycombing. On HRCT, ILD was diagnosed by presence of characteristics radiological features including honeycombing, linear reticular opacities, ground glass opacities, nodular opacities, and inter- & itra-lobular septal thickening. [11]

Based on the findings of both the investigations "true positive (TP), true negative (TN), false positive (FP) and false negative (FN)" cases were identified. Cases were labelled as TP in case of presence of ILD both on CXR and HRCT chest, TN in case of absence of ILD both on CXR and HRCT chest, FP in case of presence of ILD on CXR but not on HRCT chest and FN in case of absence of ILD on CXR but present on HRCT chest. Based on this "sensitivity (SN), specificity (SP), positive predictive value (PPV), negative predictive value (NPV) and accuracy" of CXR to diagnose ILD were calculated keeping HRCT as gold standard.

Data was analyzed by using Statistical Package for Social Sciences (SPSS) version 20.00. Normality of data was checked by Shapiro-Wilk test which showed that both age and duration of symptoms were not distributed normally and so were represented using median (IQR). Qualitative data (gender, presence of ILD on CXR and HRCT) was represented by using percentage and frequency. 2x2 contingency tables were drawn to calculate diagnostic accuracy parameters of CXR to diagnose ILD.

RESULTS

Study sample was 92 patients. Median age of patients was 52.00 (69.00 – 35.00) years. There were 35 (38.00%) male participants while remaining 57 (62.00%) participants were female. Median duration of symptoms was 9.00 (14.00 – 7.00) weeks. These baseline characteristics are summarized below in Table-I:

Table I

Baseline characteristics of study participants (n = 92)

Characteristics	Median (IQR); n (%)
Median age	52.00 (69.00 – 35.00) years
Gender	
Male	35 (38.00%)
Female	57 (62.00%)
Median duration of symptoms	9.00 (14.00 – 7.00) weeks

The frequency of patients found to have ILD on CXR was 58 (63.00%) while number of patients who were found to have ILD on HRCT chest was 67 (72.83%). A total of 45 (48.91%) patients were found to have ILD both on CXR and chest HRCT **[TP]** while those with ILD on CXR but not on chest HRCT were 13 (14.13%) **[FP].** Similarly, patients who did not have ILD on CXR but had positive chest HRCT were 22 (23.91%) **[FN]** while those who neither had ILD on CXR nor on chest HRCT were 12 (13.04%) **[TN].** Based on these following 2 x 2 contingency table was drawn, Table-II:

Table II

2x2 Contingency table of TP, TN, FP and FN cases (n = 92)

	ILD on chest HRCT	No ILD on chest HRCT
ILD on CXR	45 **(TP)**	13 **(FP)**
No ILD on CXR	22 **(FN)**	12 **(TN)**

Based on the formulas, it was found that "sensitivity (SN), specificity (SP), accuracy, positive predictive value (PPV) and negative predictive value (NPV)" of CXR to diagnose ILD with chest HRCT being the gold standard were 67.16%, 48.00%, 61.96%, 77.59% and 35.29%, respectively. This is tabulated below in Table-III:

Table III

Diagnostic parameters of CXR in diagnosis of ILD keeping HRCT as gold standard (n = 92)

Parameter	Value
Sensitivity (TP/TP+FN) x 100	67.16%
Specificity (TN/FP+TN) x 100	48.00%
Accuracy (TP+TN/TP+TN+FP+FN) x 100	61.96%
PPV (TP/TP+FP) x 100	77.59%
NPV (TN/FN+TN) x 100	35.29%

DISCUSSION

ILD has recently been a pulmonary morbidity of focus after the world has seen corona virus pandemic in which a large number of patients developed this condition a part of long term sequelae of COVID-19. [12, 13] However, ILD has existed long before COVID pandemic. [14] Since COVID affected population on a very large scale, the possibility of spread of ILD across all the regions of country has even rose

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further thereby increasing the requirements of diagnostic facilities. Present study thus focused on assessing the diagnostic ability of a highly accessible, cheap and reproducible investigation which is CXR for diagnosis of ILD.

In this study, average age of the patients was fifty two years placing themin the older age group. This was congruent with the findings of multiple studies stating that older age is a major risk factor for developing ILD and eventual fibrosis of the lung parenchyma. [15, 16] Based on gender, it was observed in present study that majority of patients suspected of having ILD were female. This higher prevalence of interstitial lung disease in women can be attributed to higher chances of women to have connective tissue disorders as well as autoimmune disorders. [17, 18] Contrarily, results of multiple studies reported higher prevalence of ILD among the male population. [19, 20]

In terms of diagnostic ability, it was found that "sensitivity, specificity, accuracy, PPV and NPV" of CXR to diagnose ILD with chest HRCT being the gold standard were 67.16%, 48.00%, 61.96%, 77.59% and 35.29%, respectively. Compared to this, Afzal et al. [10] reported values for these parameters at 80%, 82.98%, 81.02%, 90% and 68.42% which were higher as compared to present study. In another study conducted by Sadiq et al. [21] with similar aim, these values were found to be at 88.89%, 87.50%, 88.24%, 88.89% and 87.50% which were much higher than being observed in current study. Comparable to the findings of current study, Anwar et al. [22] found diagnostic accuracy parameters of CXR for ILD diagnosis to be 76%, 84%, 78.6%, 86.3% and 76.7%. In one study conducted by Akram et al. [23], although the diagnostic accuracy and sensitivity of CXR for ILD diagnosis were similar to present study at 65.5% and 61.66% but its specificity was only 20% which was much lower as compared to present study.

Present study shows that X-ray of the chest which is the most easily accessible radiological investigation in general can be a very useful in making diagnosis of ILD while keeping chest HRCT as gold standard. Findings of CXR can be used as a reliable tool to make or rule out a provisional diagnosis of ILD before referring these patients to a specialized care center. Limited sample size, single study center and conductance of study at an advanced diagnostic facility center were few limitations of study.

CONCLUSION

X-ray of the chest is a useful non-invasive and cheap radiological investigation that can be used for diagnosis of ILD with a moderate degree of accuracy of 61.96%.

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