Original Article **Open Access**

Diagnostic Accuracy of Chest X-Ray for the Diagnosis of Interstitial Lung Disease Keeping High Resolution Computed Tomography (HRCT) as Gold Standard

Nosheen Sadiq, Ammara Iftikhar, Muhammad Usman Khan, Hussain Rashid Ehsan, Naveed Hussain

ABSTRACT

Objective: To determine diagnostic accuracy of chest x-ray for the diagnosis of interstitial lung disease keeping high resolution computed tomography as gold standard.

Study design and setting: Comparative cross sectional study, Department of Radiology PNS Shifa Karachi

Methodology: Study done over the period of 1 year and two months. 160 Patients were included by using non-probability consecutive sampling all underwent CXR and HRCT chest. Sample size was calculated using sensitivity and specificity calculator for sample size with expected sensitivity of 80%[7], expected specificity of 82.98%[7]and expected prevalence of 76%[7]

Results: In this 160 patients were included by using non probability sampling. Among all 116(72.50%) were males while 44 (27.50%) were females. Sensitivity (SE),specificity, positive predictive value (PPV) negative predictive value(NPV) and diagnostic accuracy of CXR vs HRCT in cases of ILD was 88.89%, 87.50%, 88.89%, 87.50% and 88.24% respectively.

Conclusion: Chest x-ray has high diagnostic accuracy and simultaneously readily available and cost effective modality, therefore it can be effectively used as alternative to HRCT.

Key words: Chest x-ray, interstitial lung disease, high resolution computed tomography

How to cite this Article:
Sadiq N, Iftikhar A, Khan MA, Ehsan HR, Hussain N. Diagnostic Accuracy of Chest X-Ray for the Diagnosis of Interstitial Lung Disease Keeping High Resolution Computed Tomography (HRCT) as Gold Standard. J Bahria Uni Med Dental Coll. 2024;14(1):61-4 DOI: https://doi.org/10.51985 /JBUMDC202291

INTRODUCTION:

In the realm of diagnostic imaging, evaluation of interstitial lung disease stands as pivotal challenge Interstitial lung disease is a group of heterogenous disorders affecting the epithelial cells of the alveoli, basement membrane, endothelial cells of the pulmonary capillaries, perivascular and lymphoid cells.[1] Diseases of connective tissue is a group of interstitial lung disorder which can invade the surrounding vessels and parenchyma posing a great threat to the life of patients.[1] Smoking remains a high risk factor in causing respiratory illness damaging the airways, pleura and parenchyma which requires a multidisciplinary approach to prompt diagnosis and effective treatment.[3] ILD is seen in all age groups, developmental or genetic causes may result in pulmonary manifestations leading to ILD in the pediatric age group.[4] Amidst the various imaging modalities available, the chest X-ray emerges as fundamental tool widely employed in initial assessment. Chest Xray was a useful tool previously for the diagnosis of pulmonary pathology until the use of Computed tomography which helped to view the gross structure of the lung. Using high-resolution tomographic technique pathologies of the pulmonary system were detected at an earlier stage with prompt commencement of treatment and better outcomes.

Pathologies of the pulmonary interstitium can affect the lung parenchyma in multiple ways resulting in different patterns on histopathology assessment. These patterns can range from simple reticular to nodular or reticulonodular

Nosheen Sadiq *(Corresponding Author)*
Consultant Radiologist, Department of Radiology
Combined Military Hospital Thal
Email: nosheenpak@gmail.com

Ammara Iftikhar
Consultant Radiologist, Department of Radiology
Pakistan Air Force, Mianwali
Email: ammara.awan@live.com

Muhammad Usman Khan
Consultant, Department of Radiology
PNS Shifa Hospital, Karachi
Email: usmank1032@yahoo.com

Hussain Rashid Ehsan
Consultant, Department of Radiology
Combined Military Hospital Peshawar
Email: hussainrashidehsan@gmail.com

Naveed Hussain
Resident, Department of Radiology
PNS Shifa Hospital Karachi
Email: dr.naveed25@gamil.com

Received: 23-06-2023
Accepted: 18-12-2023

pattern involving different segments of the lungs. This involvement can manifest in several ways clinically and radiologically making the diagnosis a complicated deal.[4] Computed tomography has played an inferior role as compared to high resolution computed tomography. When CT was used it was able to diagnose and assess the distribution and severity of the disease however when CT negative patients with suspicion of having a disease underwent HRCT, it could identify the disease, site, and extent of the lesion. This helped to narrow down the diagnosis and advocated commencement of earlier treatment. Furthermore, this helped in biopsy procedures and was useful to assess the response to treatment.[5] This signifies the superior role of HRCT as compared to simple CT in diagnosis, treatment and monitoring response to treatment in patients suffering from interstitial lung disease.

Vizioli L, et al showed the sensitivity of 48% and specificity of 91% of chest X-ray with a superior role of HRCT in diagnosing pathologies of interstitium as compared to CXR.[6]

There is paucity of data on this subject in our local population. The review of different studies have showed variability in results; therefore, their results cannot be generalized on all populations. If my study results come in favor of Chest X-ray as a good diagnostic tool than it will be very useful to utilize this tool in settings where HRCT is not available as in peripheral health care centers.

METHODOLOGY:

This was a cross sectional study, which was done at the Department of Radiology, PNS Shifa Karachi in a period of one year and two months. Sample size was calculated using sensitivity and specificity calculator for sample size with expected sensitivity of 80%[7], expected specificity of 82.98%[7], expected prevalence of 76%[7]. With an interval of confidence as 95%, expected precision of sensitivity and specificity of 10% each the total sample size calculated was 160.

Inclusion criteria: Individuals of age 20-70 years, male or female with the presence of dyspnea on physical examination, cough 3-6 weeks on medical history, fatigue 4-6 weeks, weight loss (=4.5 kilograms or 5% of normal body weight = 3 months without knowing the reason) were included in the study group.

Exclusion criteria: Patients with pregnancy on medical record, history of pulmonary tuberculosis, history of pneumonia in last 3 months, patients with CCF/ IHD were excluded from the study groups.

Consent and IRC: Approval was obtained from the hospital ethics' committee and research department. (ERC/2022/Radio/25). All patients fulfilling the inclusion criteria and presenting to the department of radiology PNS Shifa Karachi were enrolled. Patients were counselled and procedure was explained to them, including the effects of radiation, followed by a written informed consent duly signed by them. Base line demographic information of patients (age, gender, duration of complain) were taken.

Chest X ray and HRCT was done for each patient. HRCT was conducted as per our institutional protocol using a magnified resolution for better vision of the underlying lesion. From the apex till the base of the lungs narrow slice each of 1mm was taken to visualize all parts of the lung. Images with high spatial resolution were taken with a resulting scan taken at full inspiration and a better view of the lung segments while patients remained supine. CXR and HRCT were reported by two different radiologists each having more than 10 years of experience. Radiologists reporting HRCT was blind to findings of CXR and vice versa. Using Performa, the findings of both the chest x-ray and HRCT were recorded.

Subjects were divided into two groups:20 to 45 and 46-70 yrs. Subjects were also divide into two groups according to duration of symptom < = 6wks and >6wks

Using Statistical software (SPSS-23) the recorded data was analyzed. Quantitative variables and were analyzed by using mean values and standard deviation while qualitative variables were analyzed by frequencies and percentages of the variables. For computing the diagnostic accuracy of CXR and HRCT variables were used to calculate sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy. Using Receiver operator characteristic curve ratio of likelihood was calculated.

RESULTS:

A total of 160 patients were included in the study with age ranging from were 20-to 70 years. Mean age of subjects was 46.91 ± 10.16yrs. Sixty eight patient were between 20-

		HRCT +ve	HRCT -ve
X-Ray	+ve	True positive (a)	False positive (b)
	-ve	False negative (c)	True negative (d)

45 years of age and ninety two were above 46 years. Males were greater than females with a ratio of 2.6:1 with a total no of 116 (72.50%) males. Value of mean for the duration of symptoms seen in these patients was 6.89 ± 1.76 weeks. Mean weight of patients was 77.41 ± 8.99 kg.

All patients underwent CXR and HRCT. All CXR were analyzed for features suggestive of ILD; 84 patients were reported positive. Out of these 84 patients, only 71 patients were confirmed as ILD on HRCT while 13 had negative results.

Total number of patients with negative results on CXR was 76. Among these 62 were confirmed as negative on HRCT as well.However, 14 cases had at least 1 finding consistent with interstitial lung disease (as shown in Table 1). Using these values, the diagnostic accuracy of CXR was calculated

when HRCT was kept as gold standard with a result of significant p-value <0.05(Table 1).

Stratification of diagnostic accuracy with respect to duration of symptoms is shown in Table 2 and Table 3.

Stratification of diagnostic accuracy according to age also done. For age group 20-45years a sensitivity of 88.89%, specificity of 87.50%, positive predictive value of 88.89%, negative predictive value of 87.50%, diagnostic Accuracy of 88.24% was calculated.

For age group 46 -70years a sensitivity of 86.97%, specificity of 79.49%, positive predictive value of 85.19%, negative predictive value of 81.58%, diagnostic Accuracy of 83.70% was calculated.

DISCUSSION:

Interstitial lung diseases are complex diseases that affects the pulmonary system by invading the anatomical structure of the lungs damaging the parenchyma along with the vessels and the areas of the gas exchange, compromising the respiratory mechanics.[2] The widespread involvement of the lungs is expressed in a variety of ways clinically, anatomically,

Table-1: Diagnostic accuracy of chest X-ray

	HRCT positive	HRCT negative	P-value
Chest X-ray (positive)	71 **(TP)**	13**(FP)**	**<0.05**
Chest X-ray (negative)	14 **(FN)**	62 **(TN)**	

Table 2: Results based on duration of symptoms <6 weeks (n=68)

	HRCT positive	HRCT negative	P-value
Chest X-ray (positive)	32 **(TP)**	05 **(FP)**	**<0.05**
Chest X-ray (negative)	05 **(FN)**	26 **(TN)**	

Table 3: Results based on duration of symptoms >6 weeks (n=92)

	HRCT positive	HRCT negative	P-value
Chest X-ray (positive)	46	07	**<0.05**
Chest X-ray (negative)	06	33	

and physiologically with distinct and multiple presentation on radiological imaging. The usual triggers are infections, drugs, environmental toxins, or idiopathic causes. The causative agent greatly affects the prognosis of the disease leading to either resolution or further damage to the lungs.[4] Diagnosis of the condition at an early stage using a high degree of suspicion, detailed history, and a sequence of investigations with concomitant imaging is the mainstay of earlier recognition and prompt treatment of the disease.[5]

Radiological picture in such diseases play a pivotal role in diagnosing and detecting the stage of the disease. Chest X-ray is noninvasive cost effective technique and easily available as compared to high resolution computed tomography which is expensive and available at a few setups only. Exposure to radiations using HRCT can affect the general health of these patients as compared to chest Xray.[6]

CXR is a low-cost procedure and available at the peripheral set-ups playing an important role in the diagnosis of ILD and excluding other pathologies of the lungs. However comparing the diagnostic accuracy of both the procedures reveal a superior role of HRCT as compared to CXR and is considered a gold standard technique in the assessment of ILD.[8]

In our study, 160 patients underwent CXR and HRCT. Patients with positive CXR findings were analyzed out of which 84 patients came out positive. Among these 84 patients only 71 patients were found positive on HRCT while the rest 13 had negative results on HRCT. Total number of patients with negative results on CXR were 76, out of which only 62 were negative on HRCT as well and the rest 14 were positive on HRCT. Comparable results were seen in the study conducted by Gupta S et al in which HRCT detected 100% patients with Interstitial Lung disease.[5]

The study conducted by Troy LK et al also revealed that HRCT could detect the disease earlier in the course, thus decreasing the mortality and morbidity.9 Furthermore, quantitative indices in HRCT can be useful to evaluate the prognosis of the disease which was demonstrated by Torrisi, Sebastiano Emanuele et al in their study.14 Chest Digital Tomosynthesis was another modality that detected Pulmonary pathology more accurately as compared to CXR in the study done by Kruamak et al.[18]

The availability of chest x-ray as compared to HRCT makes the former a diagnostic modality of choice in most of the hospitals however the gold standard is HRCT for accurate diagnosis and staging of the disease.

CONCLUSION:

Our study concludes a high diagnostic accuracy of Chest Xray and since this technique is cost effective and readily available at the low resource peripheral set-up, it can be used as an alternative to the expensive modality of HRCT for the diagnosis of interstitial lung disease. Cases with a high index of suspicion however can undergo HRCT for a confirmatory diagnosis.

Authors Contribution:
Nosheen Sadiq: Conception, design, analysis and interpretation of data
Ammara Iftikhar: Conception, design, analysis and interpretation of data
Muhammad Usman Khan: Conception, design, analysis and interpretation of data
Hussain Rashid Ehsan: Conception, design, analysis and interpretation of data
Naveed Hussain: Conception, design, analysis and interpretation of data

REFERENCES:

1. Shao T, Shi X, Yang S, et al. Interstitial Lung Disease in Connective Tissue Disease: A Common Lesion with Heterogeneous Mechanisms and Treatment Considerations. Front Immunol. 2021; 12:684699. doi: 10.3389/fimmu. 2021. 684699.
2. Yildirim, Fatma et al. "Comparison of clinical courses and mortality of connective tissue disease-associated interstitial pneumonias and chronic fibrosing idiopathic interstitial pneumonias." The Kaohsiung journal of medical sciences vol. 35,6 (2019): 365-372. https://doi.org/10.1002/kjm2.12066
3. Dawod YT, Cook NE, Graham WB, et al. Smoking-Associated Interstitial Lung Disease: Update and Review. Expert Rev Respir Med 2020; 14: 825–834. DOI: 10.1080/17476348 .2020.1766971
4. Griese M. (2018). Chronic interstitial lung disease in children. European respiratory review: an official journal of the European Respiratory Society, 27(147), 170100.
5. Gupta S, Ilyas M, Gupta V, Dev G. High resolution computed tomography in the evaluation of interstitial lung diseases: imaging perspective revisited with review of literature. Int J Med Res Rev. 2017;5(04):412-20. DOI: 10.1183/16000617 .0100-2017
6. 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. doi: 10.1159/000452225.
7. Afzal F, Raza S, Shafique M. Diagnostic accuracy of x-ray chest in interstitial lung disease as confirmed by high resolution computed tomography (HRCT) chest. Pak Armed Forces Med J. 2017;67(4):593-8. https://www.pafmj.org/index. php/ PAFMJ /article/view/699
8. Desai SR, Prosch H, Galvin JR. Plain Film and HRCT Diagnosis of Interstitial Lung Disease. 2019 Feb 20. In: Hodler J, Kubik-Huch RA, von Schulthess GK, editors. Diseases of the Chest, Breast, Heart and Vessels 2019-2022: Diagnostic and Interventional Imaging [Internet]. Cham (CH): Springer; 2019. DOI: 10.1007/978-3-030-11149-6_4
9. Troy LK, Hetzel J. Lung cryobiopsy and interstitial lung disease: What is its role in the era of multidisciplinary meetings and antifibrotics? Respirology. 2020 Sep;25(9):987-996. DOI: 10.1111/resp.13822
10. Ley, S et al. "Low dose computed tomography of the lung for detection and grading of interstitial lung disease: A systematic simulation study." Pulmonology vol. 27,1 (2021): 14-25 https://doi.org/10.1016/j.pulmoe.2020.06.004
11. Park, Beomhee et al. "Lung Segmentation on HRCT and Volumetric CT for Diffuse Interstitial Lung Disease Using Deep Convolutional Neural Networks." Journal of digital imaging vol. 32,6 (2019): 1019-1026. doi: 10.1007/s10278-019-00254-8
12. Wang, YuKai et al. "Usefulness of lung ultrasound B-lines in connective tissue disease-associated interstitial lung disease: a literature review." Arthritis research & therapy vol. 19,1 206. 18 Sep. 2017. https://doi.org/10.1186/s13075-017-1409-7
13. Zhou, Boran et al. "Predicting lung mass density of patients with interstitial lung disease and healthy subjects using deep neural network and lung ultrasound surface wave elastography." Journal of the mechanical behavior of biomedical materials vol. 104 (2020): 103682 doi: 10.1016/j.jmbbm.2020.103682
14. Torrisi, Sebastiano Emanuele et al. "Assessment of survival in patients with idiopathic pulmonary fibrosis using quantitative HRCT indexes." Multidisciplinary respiratory medicine vol. 13 43. 1 Dec. 2018. https://doi.org/10.1186/s40248-018-0155-2
15. Jun, SangHoon et al. "Development of a Computer-Aided Differential Diagnosis System to Distinguish Between Usual Interstitial Pneumonia and Non-specific Interstitial Pneumonia Using Texture- and Shape-Based Hierarchical Classifiers on HRCT Images." Journal of digital imaging vol. 31,2 (2018): 235-244. doi: 10.1007/s10278-017-0018-y.
16. Karayama, Masato et al. "Simple method for detecting idiopathic interstitial pneumonias by measuring vertical lung length on chest X-ray." Scientific reports vol. 11,1 7669. 7 Apr. 2021. https://doi.org/10.1038/s41598-021-87452-z
17. Nakagawa, Hiroaki et al. "Quantitative CT analysis of honeycombing area predicts mortality in idiopathic pulmonary fibrosis with definite usual interstitial pneumonia pattern: A retrospective cohort study." PloS one vol. 14,3 e0214278. 21 Mar. 2019. doi: 10.1371/journal.pone.0214278
18. Kruamak T., Edwards R., Cheng S., et al. Accuracy of Digital Tomosynthesis of the Chest in Detection of Interstitial Lung Disease Comparison with Digital Chest Radiography. Comparative Study. J. Comput. Assist. Tomogr. 2019;43;1:109–114. https://doi.org/10.1097/RCT. 00000000-00000780.
19. Ansarie M, Naseem A, Kasmani A, Ahmed R, Azeemuddin M. Profile of interstitial lung diseases in Pakistan, Karachi pulmonolgy clinics registry data-Jan 2012- Aug 2013. Chest. 2014;145(3):241A. http://www.ildpak.com/wp-content/uploads/2019/10/ILDPAK-REPORT-2016-2018.pdf
20. Luca Vizioli; Federica Ciccarese Paola Forti; Anna Maria Chiesa; Integrated Use of Lung Ultrasound and Chest X-Ray in the Detection of Interstitial Lung Disease (2016) 93 (1): 15–22.https://doi.org/10.1159/000452225