RESEARCH PAPER

Role Of Hrct In Early Detection And Severity Assessment Of Interstitial Lung Disease (Ild)

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ABSTRACT

Background:Interstitial lung disease (ILD) comprises a heterogeneous group of pulmonary disorders characterized by inflammation and fibrosis of the lung interstitium, leading to progressive respiratory impairment. Early detection and accurate assessment of disease severity are crucial for timely management. High-Resolution Computed Tomography (HRCT) has emerged as a valuable imaging modality for identifying subtle interstitial changes and evaluating the extent of lung involvement.

Aim:To evaluate the role of HRCT in the early detection and severity assessment of interstitial lung disease.

Materials and Methods:This prospective observational study was conducted in the Department of Radiodiagnosis at Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana, Haryana, India, over a period of six months. A total of 80 patients clinically suspected of ILD underwent HRCT chest examination. Demographic data, clinical presentation, HRCT imaging patterns, and severity grading were recorded and analyzed using appropriate statistical methods.

Results:The majority of patients belonged to the 51–60 years age group (27.5%), with a slight male predominance (57.5%). Dyspnea (77.5%) and chronic cough (68.7%) were the most common presenting symptoms. HRCT findings revealed ground-glass opacities (32.5%) as the most frequent pattern, followed by reticular opacities (22.5%), honeycombing (17.5%), and traction bronchiectasis (15.0%). Based on HRCT severity scoring, moderate disease was observed in 42.5% of patients.

Conclusion:HRCT plays a crucial role in the early detection and severity assessment of ILD. It provides detailed visualization of lung parenchymal changes, helps identify characteristic imaging patterns, and assists in determining the extent of disease, thereby facilitating accurate diagnosis and better clinical management.

Keywords: Interstitial Lung Disease, HRCT, Ground Glass Opacity, Pulmonary Fibrosis, Reticular Pattern, Severity Assessment.

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INTRODUCTION

Interstitial lung disease (ILD) represents a heterogeneous group of pulmonary disorders characterized by varying degrees of inflammation and fibrosis affecting the lung interstitium, alveoli, and small airways. These conditions often lead to progressive impairment of gas exchange, reduced lung compliance, and eventual respiratory failure if not diagnosed and managed early. ILD encompasses a wide spectrum of diseases including idiopathic pulmonary fibrosis (IPF), hypersensitivity pneumonitis, sarcoidosis, connective tissue disease–associated ILD, and occupational lung diseases such as asbestosis and silicosis. Although the etiologies differ, the pathological hallmark of most ILDs involves chronic inflammation followed by irreversible fibrosis of the pulmonary interstitium. Early detection of these pathological changes is crucial because timely intervention may slow disease progression, improve patient quality of life, and reduce morbidity and mortality [1,2].

Traditionally, the evaluation of suspected ILD relied on clinical assessment, pulmonary function tests, chest radiography, and occasionally lung biopsy. However, chest radiography has limited sensitivity in detecting early interstitial abnormalities, particularly in the initial stages when structural lung changes are subtle. Many patients may have normal or non-specific chest X-ray findings despite having significant early interstitial involvement. Consequently, reliance solely on conventional radiography may delay diagnosis and treatment. In recent decades, High-Resolution Computed Tomography (HRCT) of the chest has emerged as a pivotal imaging modality for the evaluation of diffuse parenchymal lung diseases, offering superior spatial resolution and the ability to visualize fine anatomical details of the pulmonary interstitium [3,4].

HRCT uses thin-section imaging and high-spatial-frequency reconstruction algorithms, allowing detailed

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visualization of lung parenchyma and interstitial structures. This technique enables the identification of characteristic imaging patterns such as ground-glass opacities, reticular abnormalities, honeycombing, traction bronchiectasis, and nodular infiltrates. These patterns not only facilitate early detection of ILD but also assist in differentiating among various subtypes of interstitial lung diseases. For example, the presence of a usual interstitial pneumonia (UIP) pattern on HRCT strongly suggests idiopathic pulmonary fibrosis, while centrilobular nodules and mosaic attenuation may indicate hypersensitivity pneumonitis. Such radiological patterns often correlate closely with histopathological findings, thereby reducing the need for invasive procedures like surgical lung biopsy in many patients [5,6].

In addition to aiding diagnosis, HRCT plays a significant role in assessing disease severity and extent. Quantitative and semi-quantitative HRCT scoring systems have been developed to estimate the degree of lung involvement by evaluating the distribution and proportion of abnormal lung patterns. These scoring systems help clinicians determine disease progression, guide treatment decisions, and monitor response to therapy over time. Studies have shown that HRCT findings correlate well with pulmonary function parameters such as forced vital capacity (FVC) and diffusing capacity for carbon monoxide (DLCO), which are important indicators of disease severity in ILD patients [7].

Another important advantage of HRCT is its ability to detect ILD at a preclinical or early stage, particularly in patients with risk factors such as autoimmune disorders, occupational exposures, or familial predisposition. Early identification of interstitial changes can prompt closer monitoring and early therapeutic intervention, potentially preventing irreversible fibrotic remodeling. Furthermore, HRCT provides valuable information about disease distribution, such as basal versus upper lobe predominance and peripheral versus central involvement, which is essential for accurate diagnosis and prognostication [8].

In recent years, HRCT has also become an integral component of multidisciplinary evaluation involving pulmonologists, radiologists, and pathologists for the diagnosis of ILD. International guidelines emphasize the importance of HRCT patterns in establishing a confident diagnosis of conditions like idiopathic pulmonary fibrosis without the need for biopsy when typical imaging features are present. Therefore, HRCT not only enhances diagnostic accuracy but also reduces procedural risks associated with invasive diagnostic techniques [9].

Given its high sensitivity and specificity in detecting subtle interstitial abnormalities, HRCT has become the imaging modality of choice for the evaluation of suspected ILD. It provides comprehensive information regarding disease presence, pattern, extent, and severity, making it indispensable in both clinical practice and research settings. Understanding the role of HRCT in the early detection and severity assessment of ILD is essential for improving diagnostic precision and optimizing patient management strategies [10].

The aim of this study is to evaluate the role of High-Resolution Computed Tomography (HRCT) in the early detection of Interstitial Lung Disease (ILD). The objectives include assessing HRCT patterns, determining the extent and severity of lung involvement, and correlating HRCT findings with clinical presentation to improve diagnostic accuracy and disease assessment.

MATERIALS AND METHODS

Study Design: Hospital-based prospective observational study.

Study Duration: 6 months.

Study Sample Size: 80 patients suspected of having interstitial lung disease (ILD).

Study Department: Department of RadioDiagnosis.

Study Place: Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana, Haryana, India.

Study Population: Patients clinically suspected of ILD and referred for HRCT chest evaluation.

Inclusion Criteria: Patients presenting with symptoms such as chronic cough, dyspnea, or suspected ILD on clinical or radiographic assessment.

Exclusion Criteria: Patients with acute pulmonary infections, severe motion artifacts during CT imaging, or those unwilling to participate.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS software version 27.0 (SPSS Inc., Chicago, IL, USA) and GraphPad Prism version 5. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The unpaired t-test was used to compare continuous variables between independent groups, and the paired t-test was applied for within-group comparisons. Categorical variables were analyzed using the Chi-square test or Fisher's exact test as appropriate. A p-value of <0.05 was considered statistically significant.

RESULT

Table 1. Age Distribution of Study Participants

Age Group (Years)	Number of Patients	Percentage (%)	p value
21–30	8	10	**0.041**
31–40	12	15	
41–50	20	25	
51–60	22	27.5	
>60	18	22.5	
Total	**80**	**100**	

Table 2. Gender Distribution of Patients

Gender	Number of Patients	Percentage (%)	p value
Male	46	57.5	**0.048**

Female	34	42.5	
Total	**80**	**100**	

Table 3. Clinical Presentation of Patients

Clinical Symptom	Number of Patients	Percentage (%)	p value
Dyspnea	62	77.5	
Chronic Cough	55	68.7	
Fatigue	28	35	**0.032**
Chest Pain	14	17.5	
Weight Loss	11	13.7	

Table 4. HRCT Patterns Observed in ILD Patients

HRCT Pattern	Number of Patients	Percentage (%)	p value
Ground Glass Opacity	26	32.5	
Reticular Opacities	18	22.5	
Honeycombing	14	17.5	
Traction Bronchiectasis	12	15	**0.021**
Mixed Pattern	10	12.5	
Total	**80**	**100**	

Table 5. HRCT Severity Score Distribution

Severity Grade	Number of Patients	Percentage (%)	p value
Mild	24	30	
Moderate	34	42.5	**0.037**
Severe	22	27.5	
Total	**80**	**100**	

Figure: 1. Clinical Presentation of Patients

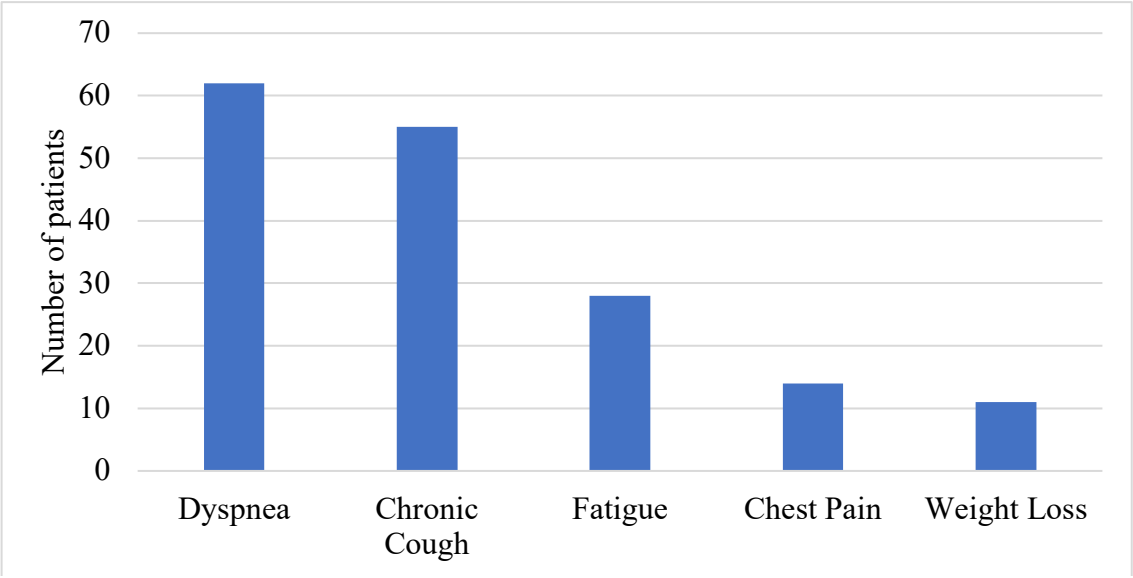

Figure: 2.HRCT Patterns Observed in ILD Patients

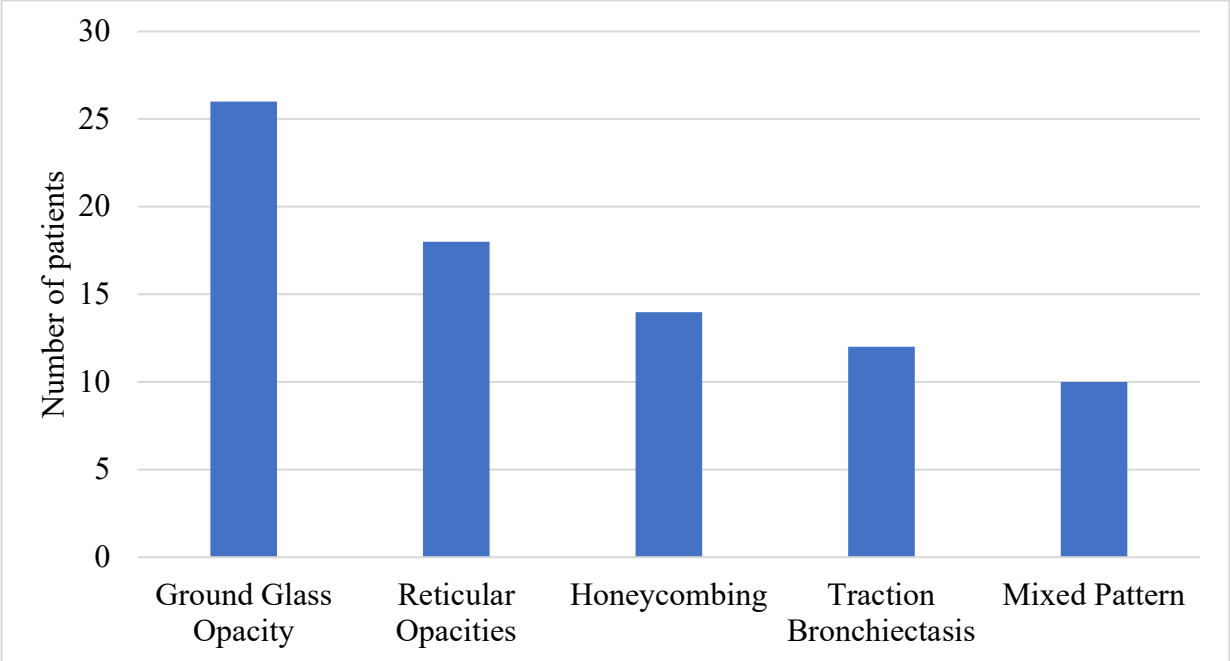

Table 1. Age Distribution of Study Participants

The present study included 80 patients with suspected interstitial lung disease. The majority of patients were in the age group of 51–60 years, comprising 22 patients (27.5%), followed by 41–50 years with 20 patients (25.0%) and >60 years with 18 patients (22.5%). The 31–40 years age group accounted for 12 patients (15.0%), while the least number of patients were in the 21–30 years age group with 8 patients (10.0%). The distribution of patients across age groups showed a statistically significant difference ($p = 0.041$), indicating that ILD was more commonly observed in middle-aged and elderly individuals.

Table 2. Gender Distribution of Patients

Among the 80 patients included in the study, 46 patients (57.5%) were males, whereas 34 patients (42.5%) were females. This indicates a slightly higher prevalence of interstitial lung disease among male patients compared to female patients in the present study population. The difference in gender distribution was found to be statistically significant ($p = 0.048$), suggesting a male predominance in the occurrence of ILD among the study participants.

Table 3. Clinical Presentation of Patients

The most common presenting symptom among patients was dyspnea, reported in 62 patients (77.5%), followed by chronic cough in 55 patients (68.7%). Fatigue was observed in 28 patients (35.0%), while chest pain was reported by 14 patients (17.5%). Weight loss was the least common symptom, seen in 11 patients (13.7%). The distribution of clinical symptoms among the study participants was found to be statistically significant ($p = 0.032$), highlighting dyspnea and chronic cough as the predominant clinical manifestations in patients with interstitial lung disease.

Table 4. HRCT Patterns Observed in ILD Patients

High-resolution computed tomography (HRCT) findings revealed that ground-glass opacity was the most frequently observed pattern, present in 26 patients (32.5%). This was followed by reticular opacities in 18 patients (22.5%), honeycombing in 14 patients (17.5%), and traction bronchiectasis in 12 patients (15.0%). A mixed pattern of interstitial changes was identified in 10 patients (12.5%). The variation in HRCT patterns among the study population was statistically significant ($p = 0.021$), indicating that HRCT is effective in identifying different radiological patterns associated with interstitial lung disease.

Table 5. HRCT Severity Score Distribution

Based on HRCT severity assessment, 34 patients (42.5%) were categorized as having moderate disease, representing the largest proportion of the study population. Mild disease was observed in 24 patients (30.0%), while severe disease was noted in 22 patients (27.5%). The distribution of disease severity among patients was found to be statistically significant ($p = 0.037$). These findings suggest that HRCT plays an important role not only in the detection of ILD but also in evaluating the extent and severity of lung involvement.

DISCUSSION

In the present study, the majority of patients with interstitial lung disease (ILD) were observed in the 51–60 years age group (27.5%), followed by the 41–50 years age group (25.0%), indicating that ILD is more prevalent in middle-aged and elderly individuals. Similar findings were reported by Sverzellati et al., who observed that the incidence of ILD increases with advancing age, with the majority of cases occurring after the fifth decade of life [11]. Likewise, King et al. reported that idiopathic pulmonary fibrosis and other fibrotic ILDs predominantly affect individuals older than 50 years, supporting the age distribution seen in the present study [12]. The age-related increase in ILD prevalence may be attributed to cumulative environmental exposure, progressive decline in pulmonary repair mechanisms, and age-associated immune alterations. These findings emphasize the importance of careful radiological evaluation

in older patients presenting with respiratory symptoms suggestive of diffuse lung disease.

Regarding gender distribution, the present study demonstrated a male predominance (57.5%) compared to females (42.5%). This observation is consistent with the findings of Navaratnam et al., who reported a higher prevalence of ILD among males, particularly in idiopathic pulmonary fibrosis and occupational lung diseases [13]. Similarly, Raghu et al. documented that male gender is frequently associated with a higher incidence of fibrotic interstitial lung diseases, which may be related to increased exposure to environmental and occupational risk factors such as dust, smoking, and industrial pollutants [14]. The results of the present study therefore align with previous literature indicating a modest male predominance in ILD patients.

In terms of clinical presentation, dyspnea (77.5%) and chronic cough (68.7%) were the most common symptoms among the study population. These findings are comparable to the observations of Antoniou et al., who reported dyspnea and persistent dry cough as the predominant symptoms in patients with diffuse parenchymal lung diseases [15]. Similarly, Cottin and Cordier found that progressive exertional dyspnea and chronic cough were the most frequent presenting complaints in ILD, often leading to further imaging evaluation with HRCT [16]. The predominance of these symptoms can be explained by progressive fibrosis and interstitial inflammation, which impair gas exchange and reduce lung compliance. Early identification of these symptoms combined with HRCT evaluation may facilitate earlier diagnosis and management.

With respect to HRCT imaging patterns, the most frequent finding in the present study was ground-glass opacity (32.5%), followed by reticular opacities (22.5%), honeycombing (17.5%), and traction bronchiectasis (15.0%). Comparable observations were reported by Hansell et al., who highlighted ground-glass opacities and reticular abnormalities as common HRCT findings in various forms of interstitial lung disease [17]. Additionally, Lynch et al. reported that ground-glass opacities often represent early inflammatory changes, whereas honeycombing and traction bronchiectasis are indicators of established pulmonary fibrosis [18]. The identification of these radiological patterns plays a crucial role in differentiating between various ILD subtypes and in guiding clinical decision-making.

The severity assessment using HRCT in the present study revealed that moderate disease (42.5%) was the most common category, followed by mild disease (30.0%) and severe disease (27.5%). Similar results were observed by Wells et al., who demonstrated that HRCT scoring systems correlate well with pulmonary function impairment and can reliably assess the extent of fibrotic involvement in ILD [19]. Furthermore, Sverzellati and colleagues emphasized that HRCT-based severity grading provides valuable prognostic information and helps in monitoring disease progression and treatment response [20]. These findings reinforce the importance of HRCT not only for early detection but also for evaluating disease severity and guiding management strategies.

Overall, the findings of the present study are consistent with previously published literature, demonstrating that HRCT plays a crucial role in the early detection, characterization, and severity assessment of interstitial lung disease. The ability of HRCT to identify subtle interstitial abnormalities, define characteristic imaging patterns, and estimate the extent of lung involvement makes it an indispensable tool in the diagnostic evaluation and clinical management of ILD patients.

CONCLUSION

The present study highlights the significant role of High-Resolution Computed Tomography (HRCT) in the early detection and severity assessment of interstitial lung disease (ILD). The findings demonstrated that ILD was more commonly observed in middle-aged and elderly individuals with a slight male predominance. Dyspnea and chronic cough were identified as the most frequent clinical presentations among the patients. HRCT evaluation revealed characteristic radiological patterns, with ground-glass opacities and reticular changes being the most commonly observed findings. Additionally, HRCT proved valuable in determining the extent and severity of lung involvement, with the majority of patients showing moderate disease severity. The ability of HRCT to detect subtle interstitial changes, differentiate various radiological patterns, and assess disease progression makes it an indispensable imaging modality in the evaluation of ILD. Therefore, HRCT plays a crucial role in facilitating early diagnosis, guiding clinical management, and improving overall patient outcomes in individuals suspected of having interstitial lung disease.

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