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EVALUATION OF INTERSTITIAL LUNG DISEASES USING HIGH-RESOLUTION COMPUTED TOMOGRAPHY

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ABSTRACT

A wide spectrum of pulmonary conditions known as interstitial lung diseases (ILDs) have been defined by fibrosis and inflammation of the lung interstitium, which impairs gas exchange. To enhance results and direct treatment, an early and precise diagnosis is essential. By providing unmatched resolution in imaging patterns, permitting accurate disease characterization, and lowering the need for invasive procedures like biopsies, High-Resolution Computed Tomography (HRCT) has completely changed the diagnosis and treatment of ILD.

Materials and Methods

For four months, a cross-sectional analytical investigation was carried out at the Islamabad Diagnostic Center's Radiology Department in Faisalabad. The study included 100 patients (22–86 years old) with symptoms indicative of ILD, such as dry cough, shortness of breath, and haemoptysis. HRCT was performed using a Toshiba 128-slice scanner with 1mm thickness settings, capturing fine-grained images for evaluation

Results

HRCT demonstrated high diagnostic accuracy, detecting patchy ground-glass opacity in 66% of cases, pleural effusion in 30%, lung consolidation in 35%, and parenchymal abnormalities in 9%. The imaging enabled subtype differentiation, with idiopathic pulmonary fibrosis (IPF) being the most frequently identified condition. HRCT outperformed chest radiographs in detecting subtle abnormalities, reducing the reliance on invasive procedures. Additionally, HRCT facilitated disease monitoring and provided prognostic insights, further underscoring its utility in clinical practice.

Conclusion

HRCT has established itself as the gold standard in the diagnosis and monitoring of ILDs. Its ability to detect fine imaging patterns, differentiate subtypes, and provide prognostic information makes it an indispensable tool in modern pulmonary medicine. By offering a non-invasive and comprehensive approach, HRCT significantly enhances diagnostic accuracy, reduces the need for invasive biopsies, and supports tailored treatment strategies, ultimately improving patient care.

Keywords: *Interstitial Lung Diseases (ILDs), High-Resolution Computed Tomography (HRCT), Idiopathic Pulmonary Fibrosis (IPF), Ground-glass opacity, Parenchymal abnormalities, Consolidation, Pleural Effusion*

INTRODUCTION

Numerous disorders affecting the interstitium the thin, lace-like tissue that supports the alveoli and facilitates gas exchange are together referred to as interstitial lung disease (ILD). Imaging can show that the interstitium thickens in ILD as a result of inflammation, scarring, or edema[1].

While some types of interstitial lung disease are chronic and incurable, others are transient. The following are a few kinds of interstitial lung disease are interstitial pneumonia: The lung's interstitium may get infected by bacteria, viruses, or fungus. The most frequent cause is a bacteria known as mycoplasma pneumonia. Idiopathic pulmonary fibrosis is a chronic, progressive form of interstitial fibrosis, or scarring. We have no idea what triggered it. Interstitial pneumonitis that is not specific: An autoimmune condition (such as rheumatoid arthritis or scleroderma) that often coexists with interstitial lung disease. Hypersensitivity pneumonitis: Interstitial lung illness known as hypersensitivity pneumonitis is brought on by persistent inhalation of dust or other irritants. Cryptogenic organizing pneumonia (COP): An interstitial lung disease that resembles pneumonia but doesn't involve an infection. Bronchiolitis obliterans with organising pneumonia (BOOP) is another name for COP. Acute Interstitial pneumonitis: An abrupt, severe interstitial lung disease that frequently necessitates life support is known as acute interstitial pneumonitis. Desquamative Interstitial pneumonitis: Smoking is a contributing factor in the interstitial lung illness known as desquamative interstitial pneumonitis. Sarcoidosis: An illness that causes interstitial lung disease, enlarged lymph nodes, and occasionally involvement of the heart, skin, nerves, or eyes. Asbestosis: Exposure to asbestos induces interstitial lung disease[1].

Breathlessness is the most prevalent sign of all types of interstitial lung disease. Breathlessness affects almost everyone with interstitial lung disease, and it may worsen over time. The following are other indicators of interstitial lung disease: A cough that is typically dry and ineffective, Loss of weight (usually in those with BOOP or COP), fatigue and chest discomfort. Most often, people with interstitial lung disease visit a doctor because they are worried about coughing or shortness of breath. Lung imaging tests are typically performed to determine the issue. A simple chest X-ray is the first diagnostic performed on the majority of patients who have a respiratory problem. Chest X-ray pictures of people with interstitial lung disease may show little lines in the lungs. A CT scanner uses several chest X-rays to provide detailed images of the lungs and surrounding structures. A CT scan is the method most commonly used to identify interstitial lung disease. If interstitial lung disease is identified, specific CT scanner settings can improve the images. This enhances the CT scan's ability to identify interstitial lung disease. A person sits in an enclosed plastic booth and breathes through a tube. Lung capacity may be decreased in people with interstitial lung disease. They could also be less able to circulate oxygen from their lungs into their bloodstream. Lung biopsy: In many cases, the only method to identify the type of interstitial lung disease an individual has is to take lung tissue for microscopic examination. A lung biopsy, which is a collection of lung tissue, can be done in an array of methods: Bronchoscopy: A procedure where an endoscope is pushed into the respiratory tract through the mouth or nose. The endoscope has tiny instruments that can collect lung tissue samples. Video-assisted thoracoscopic surgery (VATS): A surgeon can sample many regions of lung tissue through video-assisted thoracoscopic surgery by using instruments that are placed through tiny incisions. Open lung biopsy (thoracotomy): Sometimes obtaining a lung sample requires standard surgery that involves a big incision in the chest[2].

High-resolution computational tomography (HRCT) is a diagnostic procedure that uses a typical computed tomographic scanner to evaluate lung health[3]. The patient may not lie supine, but imaging parameters such as inhalation and expiration are chosen to maximize spatial resolution. HRCT only shows 10% of the lungs since it employs narrow slices that are 10–40 mm apart. It is therefore inappropriate for assessing lung cancer or other localized lung conditions. Because of their tiny sections and high resolution algorithm, HRCT pictures with excessive noise might lead to a misinterpretation of the soft tissues of the mediastinum. Due to the strong contrast of the lung and the inadequate method for identifying soft tissues and arteries, intravenous contrasts are not employed[4]. Interstitial lung diseases like pulmonary fibrosis and broader lung ailments like bronchiectasis and emphysema are assessed using high resolution computed tomography (HRCT). Routine check-ups frequently recommend it, but it can be difficult for inexperienced people to see significant abnormalities on chest x-rays. Assessment of interstitial lung disease patterns, such as reticular marks, consolidation, nodules, and their anatomical distribution, is made simpler by HRCT's superior spatial and contrast resolution[5].

MATERIALS AND METHODS

A cross-sectional study with 100 participants was carried out at the Islamabad Diagnostic Center's Radiology Department in Faisalabad. A Toshiba 128-slice Alexion CT scanner with a 400 mA current and a 120 kV tube voltage was employed in the investigation. Images were acquired using a 10 mm slice thickness and intervals, and the lung and mediastinal windows were reconstructed with a 2 mm thickness and interval. Patients were placed in a supine position for the scan, and in order to take pictures from the bases of the lungs to the apices, inspiratory breath-holding was necessary. An approach for reconstruction with a high spatial resolution was used.

RESULTS

In results of this study one hundred patients participated in the cross-sectional study, which was carried out in the radiology department of the Islamabad Diagnostic Center in Faisalabad.

Gender of the patients

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	45	45.0	45.0	45.0
	Female	55	55.0	55.0	100.0
	Total	100	100.0	100.0	

Table 1

In (Table 1) a questionnaire was used for each patient, which was filled out on the basis of history of sign & symptoms and image findings. Out of 100 patients there were 45 males and 55 females.

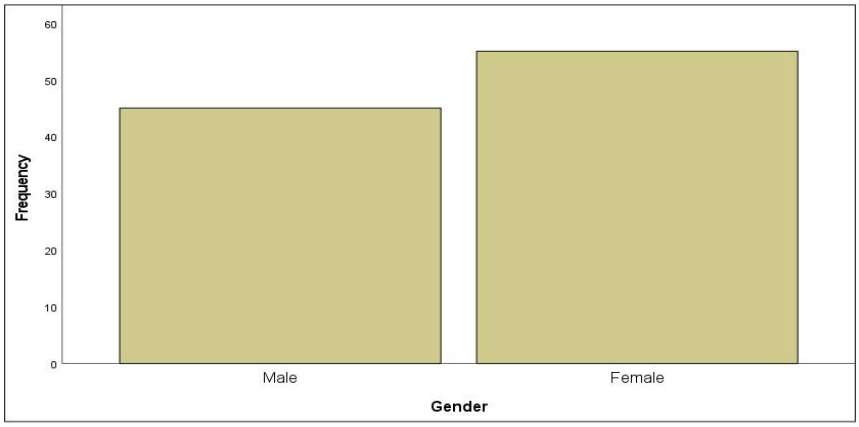

Figure 1

The (Figure 1) shown that in this study, 100 patients were examined, of whom 45% were men and 55% were women.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age of the patients undergoing diagnosis	100	22	86	58.18	15.582
Valid N	100				

Table 2

In (Table 2) shown patients from various age groups were included in the study; the minimum age was 22, and the maximum age was 86. Thus, 58.18 ± 15.18 years was the mean age.

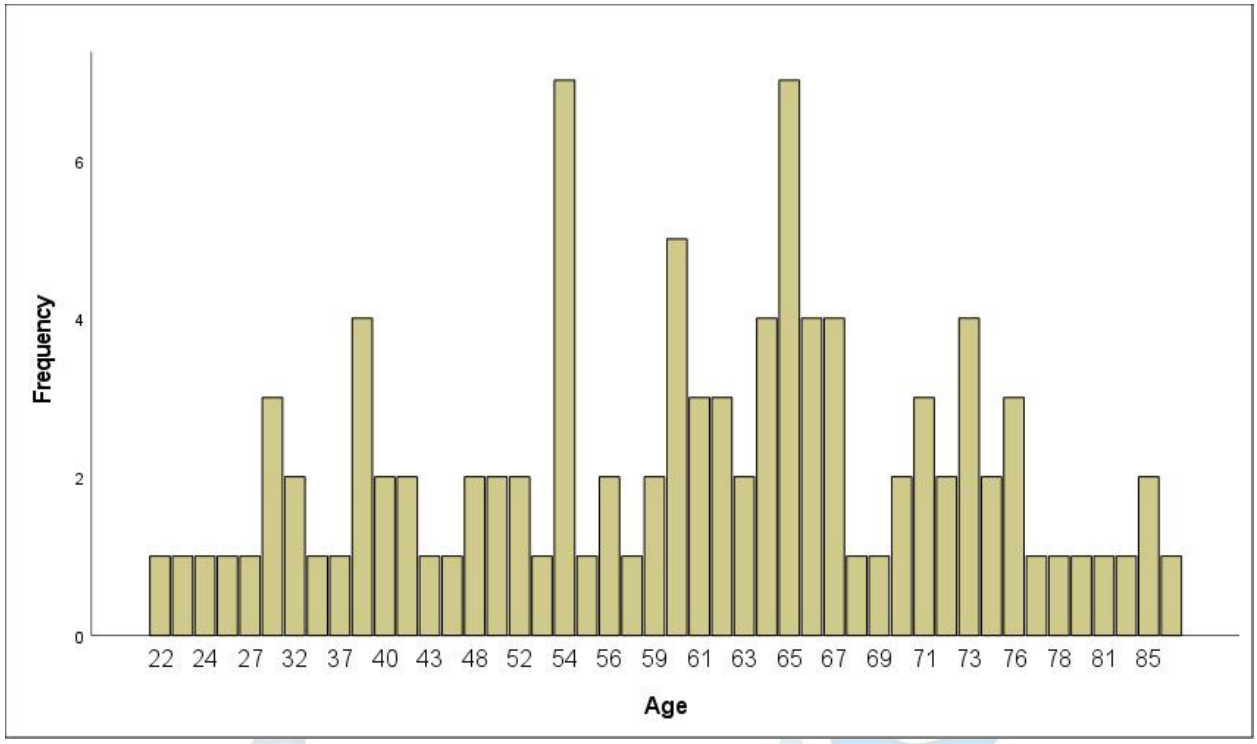

Figure 2

In (Figure 2) frequency graph (with respect to age) for the patients, under study is given.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Presence of dry cough symptom in patients	100	1	2	1.54	.501
Valid N	100				

Table 3

In (Table 3) among 100 patients, Dry cough was present in almost half of the patients with mean value of 1.54 and standard deviation of 0.501.

Figure 3

In (Figure 3) shown that frequency graph for the presence of dry cough in the patients. It can be seen that 46% patients had dry cough symptoms present in them.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Symptoms of shortness of breath	100	1	2	1.27	.446
Valid N	100				

Table 4

The (Table 4) versatility was found in the presenting patients as far as shortness of breath is concerned, with the mean value of 1.27 and standard deviation of .446, shortness of breath was frequently found.

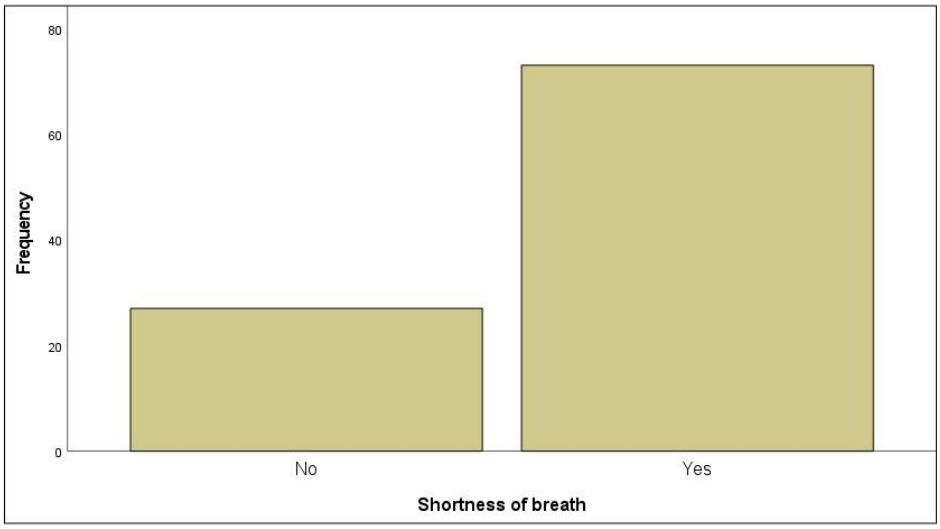

Figure 4

In(Figure 4) frequency graph for the presence of symptoms of Shortness of Breath (SOB) is given. It can be seen that mostly patients were presented with SOB. According to this study 73% patients can with the history of SOB.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Symptoms of Chest pain	100	1	2	1.83	.378
Valid N	100				

Table 5

In (Table 5) shown similarly, for the chest pain, among 100 patients, mean value was 1.83 and standard deviation of 0.378.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Symptoms of Hemoptysis	100	1	2	1.85	.359
Valid N	100				

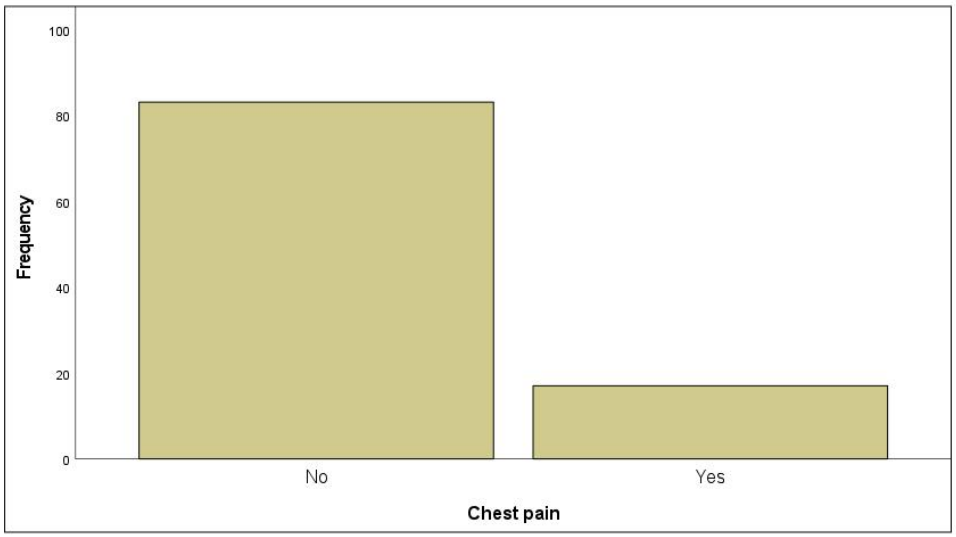

Figure 5

In (Figure 5) frequency graph for patients presenting with the history of chest Pain is given. It can be seen that only 17% patients came with the history of chest Pain.

Table 6

In (Table 6) among the 100 patients included in the study, haemoptysis was one of very few sign & symptom was present in patients with the mean value of 1.85 and standard deviation .359.

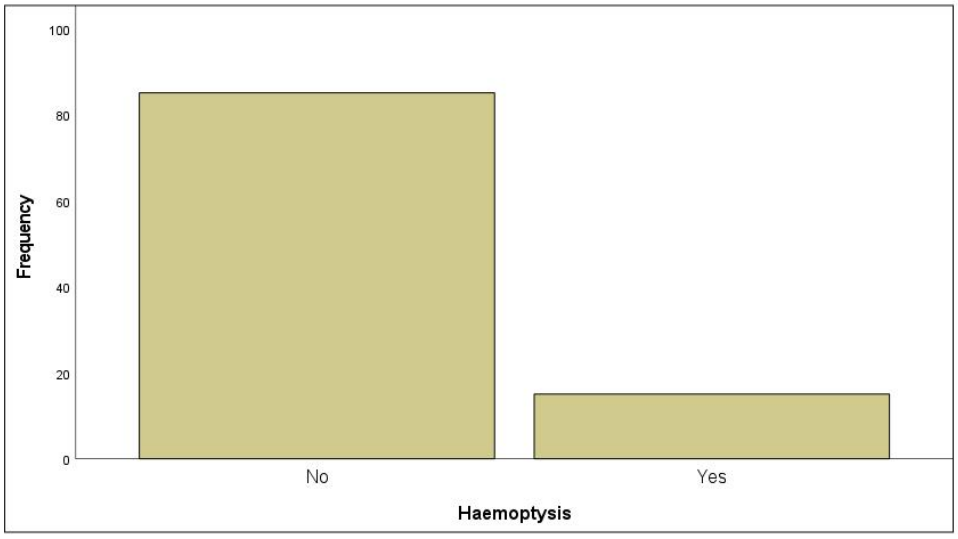

Figure 6

In (Figure 6) frequency table for the patients with sign and symptoms of haemoptysis is given. It can be seen that only 15% patients came with the history of haemoptysis.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Findings of Patchy ground glass pattern	100	1	2	1.34	.476
Valid N	100				

Table 7

In (Table 7) among the 100 patients participated in the study, standard deviation was decided to find between the above mentioned variables. The mean and standard deviation for the Patchy Ground Glass Pattern are 1.34 and 0.476, respectively.

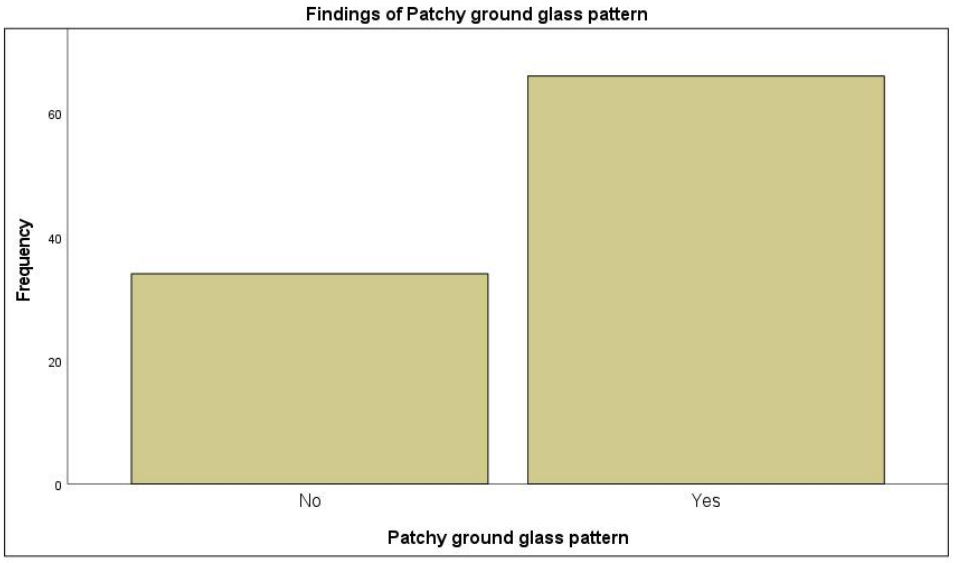

Figure 7

In (Figure 7) frequency graph for Patchy Ground Glass Pattern findings is given. It was seen that 65% patients were diagnosed with the presence of Patch Ground Glass Pattern.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pleural Effusion	100	1	2	1.70	.461
Valid N	100				

Table 8

In (Table 8) as far as pleural effusion is concerned, the mean value is 1.70 and standard deviation is 0.461.

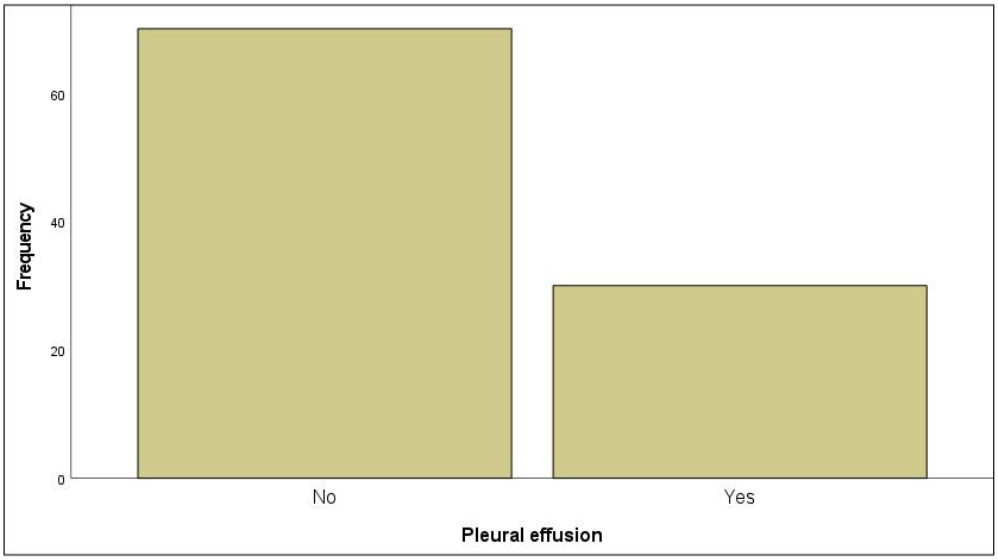

Figure 8

In (Figure 8) the frequency graph for Pleural effusion is given. It can be seen that 29% patients were diagnosed with the presence of Pleural Effusion.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Findings of Parenchymal Abnormality	100	1	2	1.91	.288
Valid N	100				

Table 5.9

In (Table 5.9) another important variable that decides the diagnosis of ILD is the presence of parenchymal abnormalities with the mean value of 1.91 and standard deviation of 0.288.

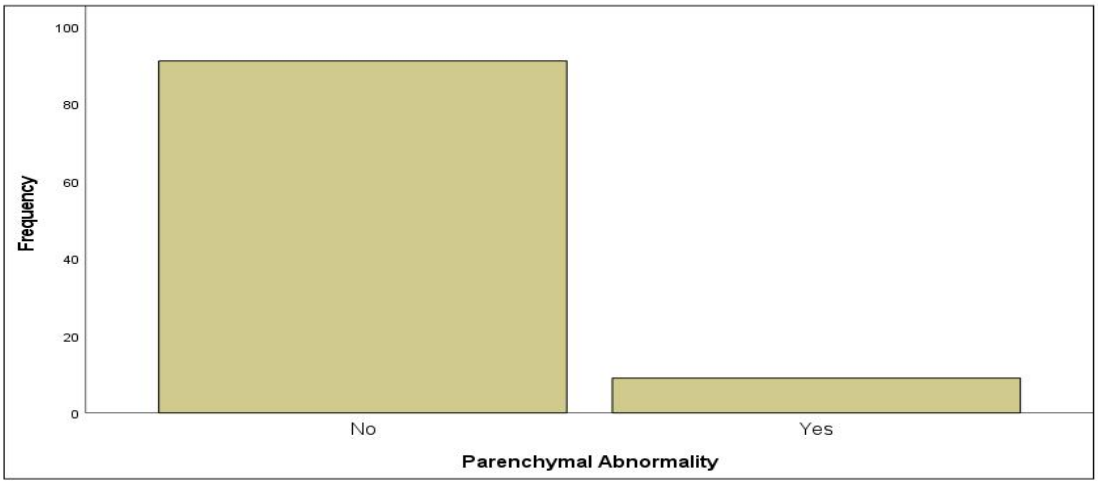

Figure 5.9

In (figure 5.9) the frequency graph for the findings of Parenchymal Abnormalities is given. It can be seen that only 9% patients were diagnosed with Parenchymal abnormalities.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Findings of Consolidation	100	1	2	1.65	.479
Valid N	100				

Table 10

In (Table 10) lung consolidation is primarily seen on chest X-rays, but it was also taken into account in HRCT chest. In the case of consolidation, the standard deviation was 0.479 and the mean was 1.65.

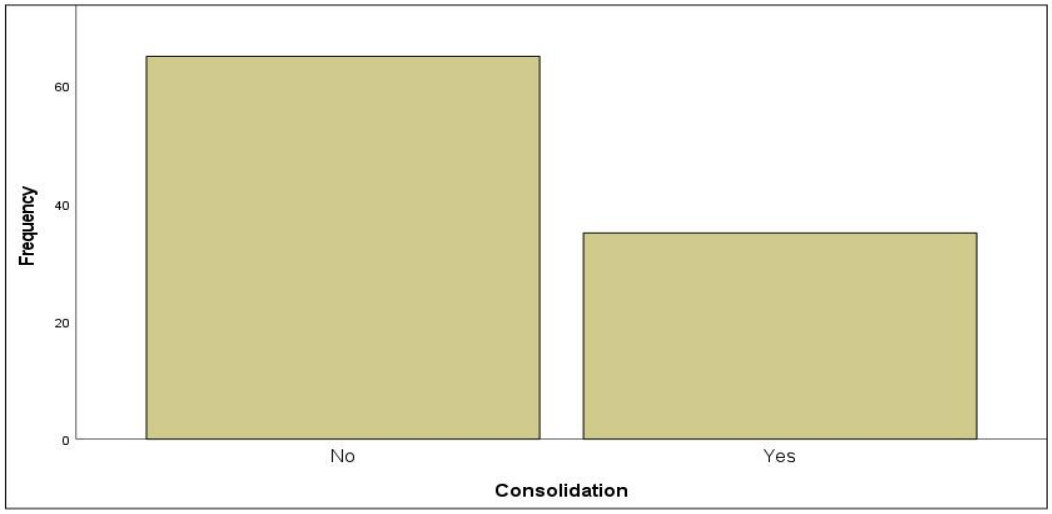

Figure 10

In (Figure 10) the frequency graph for patient diagnosed with consolidation is given. It can be seen that 35% patients were diagnosed with findings of consolidation.

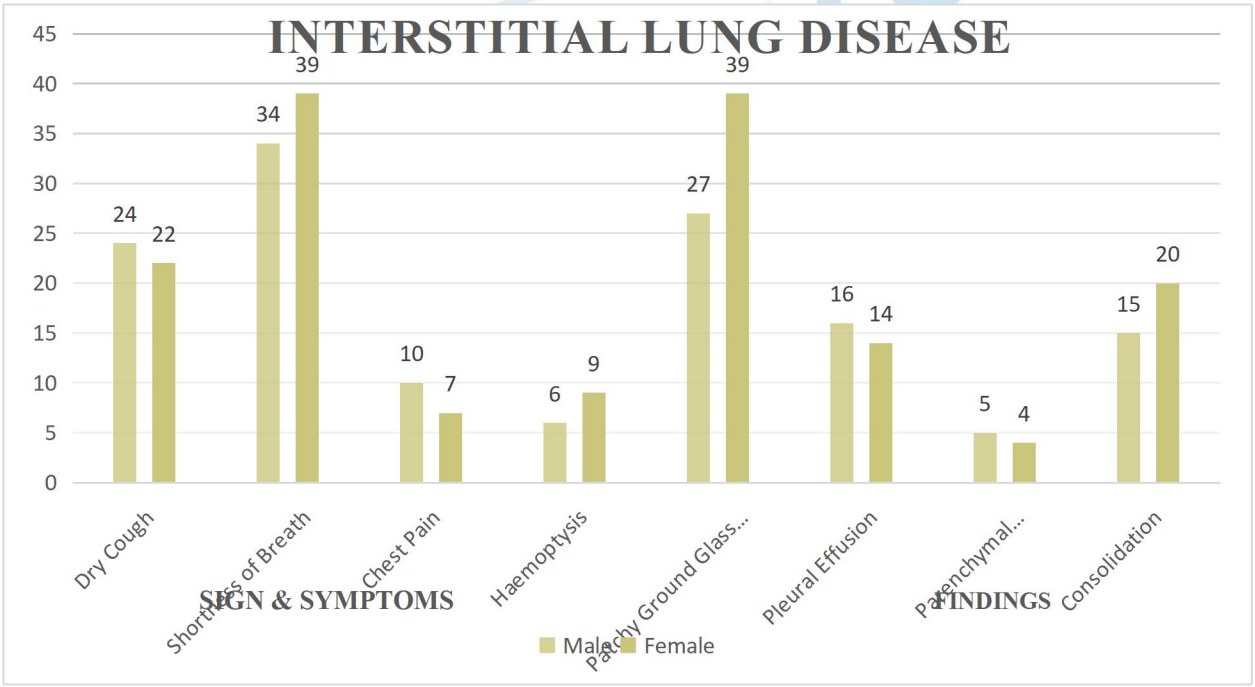

Figure 11

DISCUSSION

This study significantly and uniquely advances our knowledge of and use of high-resolution computed tomography (HRCT) in the diagnosis, tracking, and treatment of interstitial lung diseases (ILDs). Although previous studies have demonstrated the diagnostic accuracy of HRCT, this work contributes to the field by quantifying certain imaging patterns, like the frequency of patchy ground-glass opacities, and offering a thorough analysis to differentiate between different ILD subtypes. It emphasizes how HRCT is unmatched in detecting distinctive characteristics like fibrosis, honeycombing, and faint ground-glass opacities, providing information that goes beyond conventional imaging interpretations. The results support the importance of HRCT in reducing the need for invasive diagnostic techniques such surgical lung biopsies, which is

consistent with studies by Mridul Ayush et al. and Michael B. Sneider et al. This study expands on the findings of Mridul Ayush et al. by exploring the distribution and prevalence of certain ILD patterns, providing a more sophisticated understanding of the onset and course of the illness. This study emphasizes HRCT's dynamic function in tracking disease development, assessing therapy responses, and estimating clinical outcomes, in contrast to many other studies that mainly concentrate on its diagnostic or prognostic capacities. Additionally, it highlights how HRCT may be used in concert with laboratory results and clinical evaluations, proving its worth as a thorough, non-invasive diagnostic method. In addition to improving diagnosis accuracy, this integrated approach makes early intervention and customized treatment plans easier. This work greatly advances our understanding of HRCT's potential in managing ILD by offering a thorough quantitative evaluation of the imaging patterns and investigating their relationship to clinical outcomes. In the end, it establishes HRCT as a fundamental component in the non-invasive assessment of interstitial lung disorders and opens the door for better clinical procedures.

CONCLUSION

Interstitial lung disorders (ILDs) can now be diagnosed and treated with the help of High-Resolution Computed Tomography (HRCT). In 66% of cases, it is excellent at detecting important imaging patterns such patchy ground glass patterns. With its unmatched diagnostic accuracy, HRCT also successfully detects lung consolidation (35%), parenchymal abnormalities (9%), and pleural effusion (30%). Its capacity to distinguish between ILD subtypes, including idiopathic pulmonary fibrosis (IPF), while directing focused treatment plans and minimizing the need for intrusive tests like biopsies, is especially remarkable. HRCT is better to traditional imaging methods because it plays a substantial role in prognosis and disease monitoring beyond diagnosis. This study confirms the critical role HRCT plays in guaranteeing an accurate, non-invasive, and thorough approach to the assessment and treatment of ILD

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