

## ROLE OF HRCT IN ASSESSMENT OF LUNG DISEASES

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## INTRODUCTION

HRCT is currently the best modality for evaluation of large and small airways disease and diffuse interstitial lung diseases thus improving the diagnostic accuracy and specificity.<sup>[1]</sup> HRCT is more sensitive in differentiating normal from abnormal lung parenchyma. It can also characterize diseases into interstitial, airway, and airspace processes. It is more sensitive in detecting abnormalities, providing better information and a more accurate differentiation between different pathologies than the chest radiograph and conventional CT. All these reasons explain the increasing use of this technique in the investigation and evaluation of many lung disorders.

**KEYWORDS:** High Resolution CT scan, Interstitial lung disease, secondary pulmonary nodule, various lung conditions.

## AIMS AND OBJECTIVES

1. Patients with respiratory symptoms with normal or equivocal chest X-ray or conventional CT will be subjected to HRCT to characterize them.
2. To correlate HRCT findings with histopathological/cytological examinations wherever possible.

## MATERIALS AND METHODS

**Study Design:** Prospective study.

## Patient Selection Criteria

- 1) Diffusely abnormal chest radiograph without a diagnosis.
- 2) Patients with breathing difficulty with abnormal pulmonary function test and normal/abnormal chest radiograph.
- 3) Symptomatic patients with disease not characterized on conventional CT thorax.
- 4) High risk group for early detection of carcinoma lung/metastases.

## Patient Exclusion Criteria

- 1) Patients in acute respiratory distress.
- 2) Uncooperative patients.
- 3) Patients on some life support system not fit to be transported to CT room.

## Machine Specification

- 1) Plain Radiography was done in 1000mA X-ray machine (Model-Siemens Axiom Iconos R200).

- 2) CT Scan (Model- Siemens Somatom Emotion).

## Setting

- The study was conducted in the Department of Radiodiagnosis, Tata Main Hospital, Jamshedpur for a period of 16 months.
- The study group included a total of **47 patients** with respiratory problems presenting in the Department of Medicine.

## OBSERVATIONS

Forty seven (47) patients of different age groups with various respiratory symptoms underwent plain radiography of the chest followed by CT examination. The diagnosis was established based on clinical profile, laboratory investigations including histopathological examinations, imaging features and response to treatment.

Of the 47 patients evaluated, 45 patients were found to have pulmonary pathology while 2 patients had normal HRCT scan. Of the 45 patients, the chest radiographs were normal in 12 cases and equivocal in rest of the cases. They were finally characterized by HRCT examinations. These cases were:-

**Table I: Additional Cases Detected In Computed Tomography.**

Diseases	No. of Cases
Interstitial lung diseases	
• Hypersensitivity Pneumonitis	1
• Connective tissue disorder(SLE)	1
• Asbestosis	1
Pulmonary Koch's	3
Solitary Pulmonary Nodule	2
Bronchiectasis	3
Metastases	1
<b>Total</b>	<b>12</b>

Thus, we were able to detect 12 additional cases out of 45 (26.66%).

**Table II: Distribution Of Cases In The Study Group (n=45).**

DISEASES	NUMBER	% (approx.)
Interstitial lung diseases(ILDs)	17	38%
• Idiopathic Pulmonary Fibrosis (IPF)		
• Connective Tissue Disorders (CTD)	10	22%
-Rheumatoid arthritis	1	2.2%
-SLE	1	2.2%
-Goodpasture's Syndrome	1	2.2%
• Asbestosis	2	4.4%
• Sarcoidosis	1	2.2%
• Hypersensitivity Pneumonitis	1	2.2%
Tuberculosis	15	33%
• Active	10	22%
• Inactive	5	11%
Solitary Pulmonary Nodule(SPN)	6	13%
• Benign	2	4.5%
• Malignant	4	8.8%
Bronchiectasis	3	6.6%
Metastases	2	4.5%
Bronchioloalveolar Carcinoma(BAC)	1	2.2%
Allergic Bronchopulmonary Aspergillosis (ABPA)	1	2.2%

**Table-III: age and Sex Distribution Of Different Diseases (n=45).**

DISEASES	0-10		11-20		21-30		31-40		41-50		51-60		>61	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
ILDs														
• IPF	-	-	-	-	-	-	-	-	1	1	2	2	3	1
• CTD	-	-	-	-	-	-	-	-	1	2	-	-	-	-
• Asbestosis	-	-	-	-	-	-	-	-	-	-	-	-	1	1
• Sarcoidosis	-	-	-	-	-	-	-	-	-	1	-	-	-	-
• H.Pneumonitis	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Koch's	-	-	1	-	1	-	1	2	1	2	2	1	3	1
SPN														
• Benign	-	-	-	-	-	-	-	-	1	-	1	-	-	-
• Malignant	-	-	-	-	-	-	-	-	1	-	2	1	-	-
Bronchiectasis	-	-	-	-	-	-	-	-	1	1	1	-	-	-
Metastases	-	-	-	-	-	1	-	-	-	-	-	1	-	-
BAC	-	-	-	-	-	-	-	-	-	-	-	-	1	-
ABPA	-	-	-	-	-	-	-	-	-	1	-	-	-	-

- 28/45 (62%) of patients were in the age group of 41-60 years.
- 26/45 patients i.e. 58% were males while 19/45 patients i.e.42% were females.
- The largest group in the study group i.e. interstitial lung diseases was found to be concentrated in the age group of 41-60 years and above.
- The second most common group of Pulmonary Koch's was found to be almost evenly distributed between 11-60 years.
- Metastases showed no obvious age predilection.

**Table-IV: Different Clinical Features In Patients (n=45).**

Clinical Features	Fever	Cough*			Dysp-nea	Wheez- ing	Clubb- ing	Chest Pain	
		D	P	H					
ILDs (n=17)	No	2	4	1	1	15	5	8	11
	%	12%	24%	6%	6%	<b>88%</b>	29%	47%	<b>64%</b>
Koch's (n=15)	No	12	3	8	3	4	1	-	2
	%	<b>80%</b>	<b>20%</b>	<b>54%</b>	<b>20%</b>	27%	7%	-	13%
SPNs (n=6)	No	2	1	2	2	-	-	-	-
	%	33%	16%	33%	33%	-	-	-	-
Bronchiectasis (n=3)	No	1	-	1	2	-	2	-	-
	%	33%	-	33%	66%	-	66%	-	-
Metas- tases (n=2)	No	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-
BAC (n=1)	No	1	-	-	1	1	-	-	-
	%	100%	-	-	100%	100%	-	-	-
ABPA (n=1)	No	-	1	-	-	1	1	-	-
	%	-	100%	-	-	100%	100%	-	-

\*D=Dry cough, P=Productive cough, H=Haemoptysis

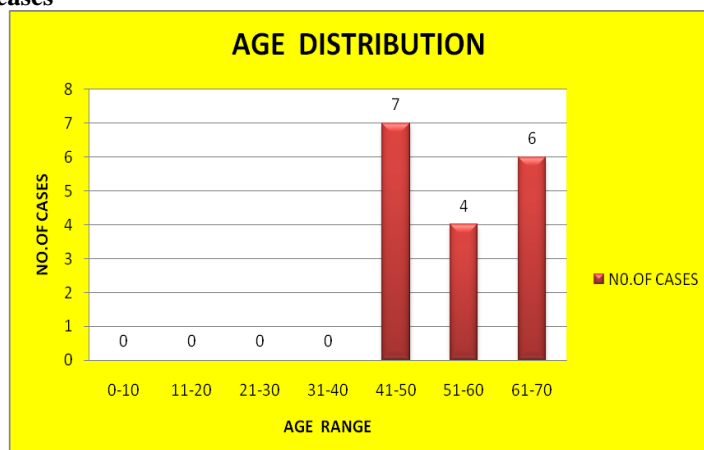
Many patients showed multiple clinical symptoms.

- Fever and Cough were the most common presentation seen in association with infectious disorder (Koch's, focal pneumonitis, ABPA).Fever and productive cough were seen in 80% and 54% of Koch's patient respectively. Dry cough was seen in 20% of Koch's patients.
- Haemoptysis was seen in 9/45(20%) cases. The predominant cause was tuberculosis 3/9(33.33%) and bronchiectasis (post tubercular) 2/9(22.2%).
- Dyspnoea (88%) followed by chest pain (64%) were the predominant symptoms in patients of interstitial lung diseases.
- Patients with pulmonary metastases 2/45(4.4%) were asymptomatic at presentation. CT/HRCT was performed as a routine evaluation.

**Table V: Lab. Investigation Findings In Various Diseases (n=45).**

Lab parameters	Raised TLC	Raised ESR	Positive Sputum (micro/Culture)	Others
ILDs	2	2	-	p-ANCA+(1), RF+(1),reduced platelet(1),CD8+(1)
Koch's	6	10	10	-
SPNs	3	4	-	-
Bronchiectasis	2	2	2	-
Metastases	1	2	-	-
BAC	-	1	-	-
ABPA	1	1	1	Eos+, IgE+

- Raised Total Leukocyte count was seen in 15/45 patients=33.33%
- Raised ESR was seen in 22/45 patients i.e.49%. Raised ESR was seen in 10/15(67%) Koch's patients.
- Sputum examinations was positive in 10/15(66.66%) cases of tuberculosis.
- Sputum culture of the patient of ABPA showed fungal growth.

**(I) Interstitial Lung Diseases****Graph-1: Showing Age Distribution Of Ild Patients (n=17).**

• Patients with interstitial lung diseases were concentrated in the age group of 41-70 years.

Females (n) =4(40.00%)

Male: Female ratio=6:4 or 1.5:1

Avg. age of male patients-58.60 years

Avg. age of female patients-57.75 years

**(A) Idiopathic Pulmonary Fibrosis (n=10)**

Males (n) = 6(60.00%)

**Table-VI HRCT Findings In Idiopathic Pulmonary Fibrosis (n=10).**

HRCT PATTERN*	NUMBER	PERCENTAGE
Peribronchovascular thickening	4	40
Septal thickening		
Interlobular	3	30
Intralobular	9	90
Groundglass opacity	2	20
Tree-in-bud appearance	0	0
Honey combing	9	90
Mosaic attenuation	1	1
Centrilobular emphysema	4	40
Bronchiectasis	9	90
Fibrosis	9	90
Predominant zone		
-UL	3	30
-ML	5	50
-LL	8	80
Peripheral distribution	10	100
Associated findings:		
Lymphadenopathy	3	30
Pleural thickening	7	70

\*Many patients showed multiple findings on HRCT.

- All the cases showed peripheral distribution of lesions (100%) predominantly involving the lower lobe (80%). Three patients (30%) showed no zonal predominance and involved all the zones to an equal extent.
- Evidences of intralobular septal thickening and fibro-bronchiectatic changes leading to architectural distortion were seen in 90% cases.
- Honeycombing was seen in 90% cases. It was bilateral but asymmetrical in all the cases.

- Pleural thickening was seen in seven patients (70%).
- Mediastinal lymphadenopathy was detected only in three patient (30%).
- Interlobular septal thickening and ground glass opacity were relatively infrequent findings present in 30% and 20% of the cases respectively.
- Tree-in-bud appearance was not seen in any cases.

**(B) Other Interstitial Lung Diseases****Table-VII: Showing Hrcr Pattern In Other Ilds.**

HRCT PATTERN*	ILD IN CTD (n=3)	ASBESTOSIS(n=2)	SARCOID-OSIS (n=1)**	HP (n=1)
PBV Thick'ng	1(33.3%)	1(50%)	1(100%)	-
SeptalThick'ng				
Interlobular	2(66.66%)	2(100%)	1(100%)	-
Intralobular	1(33.33%)	-	-	-
GGO	3 (100%)	-	-	1(100%)
Honey- combing	-	2(100%)	-	-
Br'tasis	-	1(50%)	-	-
Fibrosis	2(66.6%)	1(50%)	-	-
Zone				
-UL	3	-	1	
-ML	3	-	-	1(100%)
-LL	3	2(100%)	1	1(100%)
Additional Features	Reticulation (2)(66.6%)	Pleural Calcification (1)(50%), Reticulation (1)(50%)	Perilymphatic nodules	

\*Many patients showed multiple findings on HRCT.

\*\*Diagnosis confirmed histopathologically.

**Abbreviations**

HP=Hypersensitivity pneumonitis

PBV= Peribronchovascular thickening

CTD=Connective tissue disorders

GGO=Ground glass opacities

Br'tasis= Bronchiectasis.

**(II) Tuberculosis (n=15)**

Males (n) = 9(60.00%)

Females (n) = 6(40.00%)

Male: Female ratio = 9:6 or 1.5:1

Avg. age of Male patients - 48.8 years

Avg. age of Female patients - 49.8 years

Active cases (AFB+) =10

Inactive cases (AFB-) =5

**Table VIII: Table Showing Age Distribution Of Koch's Patients (n=15).**

Age in years	No.of patients	Percentage
0-10	0	0%
11-20	1	6.6%
21-30	1	6.6%
31-40	3	20%
41-50	3	20%
51-60	3	20%
61-70	2	13.3%
71-80	2	13.3%

- The patients were uniformly distributed in the age group of 11-80 years.
- Maximum number of patients was found in the age group of 31-60 years comprising 60% (9/15) of the total number of cases.
- No cases were seen in the age group of 0-10 years.

**Table-IX (A): Table Showing Hrcr Findings In Pulmonary Koch's (n=15).**

Hrcr pattern*	Number	Percentage
Confluent lobar consolidation	2	13.33%
Multifocal lobular consolidation	4	26.66%
Groundglass opacity	2	13.33%
Centrilobular nodules	4	26.66%
Without Tree-in-bud	7	46.66%
With Tree-in-bud		
Miliary nodules	1	6.66%
Peribronchovascular thickening	4	26.66%
Cavitation	8	53.33%
Septal thickening	4	26.66%
Mosaic attenuation	2	13.33%
Bronchiectasis	5	33.33%
Predominant zone		

-UL	13	86.66%
-ML	9	60%
-LL	4	26.66%
Associated findings		
Lymphadenopathy	5	33.33%
Pleural Effusion	4	26.66%

\*Many patients have multiple findings on HRCT

- Centrilobular nodule formed the most common pattern seen in 11/15(73.33%) cases with tree-in-bud appearance in 7/15(46.66%) and without tree-in-bud appearance seen in (26.66%) cases.
- The next most common HRCT pattern was cavitation seen in 8/15(53.33%) while bronchiectasis was seen in 5/15(33.33%)cases
- Multifocal lobular consolidation was seen in 4/15(26.66%) patients.
- Upper lobe involvement was most common seen in 13/15(86.66%) patients.
- Multifocal lobular consolidation, peribronchovascular thickening, septal thickening were also common findings, each seen in 4/15(26.66%) patients.
- Pleural effusion was seen in 4/15(26.66%) of patients & lymphadenopathy in 5/15(33.33%) patients.

**Table-IX (B): Hrct Features In Active Koch's Cases [AFB +] (n=10).**

HRCT FEATURES	Number	Percentage
Centrilobular nodules	9	90%
Consolidation	6	60%

- Centrilobular nodules and consolidation were seen in 90% and 60% of active cases respectively.

### (III) Solitary Pulmonary Nodule (n=6)

**Table-X: Hrct Findings In Solitary Pulmonary Nodule Of Lung.**

HRCT FEATURES	BENIGN (n=2)	MALIGNANT (n=4)
Contour/Margins		
Smooth	1(50%)	-
Irregular	1(50%)	4(100%)
Attenuation		
Homogeneous	2(100%)	-
Heterogeneous	-	4(100%)
Internal morphology		
Calcifications	1(100%)	-

- In the present study, 6 cases of solitary pulmonary nodule were evaluated. All the malignant nodules (100%) were irregular in outline and had heterogeneous attenuation.
- Benign nodules were homogenous in attenuation but smooth in outline in 1/2 (50%) cases. The other case showed irregular outlines 1/2 (50%).
- All the cases were confirmed by FNAC.

### (IV) Bronchiectasis (n=3).

In the present study, 3 cases of isolated cases of bronchiectasis were detected by HRCT, which were unexplained in plain radiograph. 2 cases (66.66%) presented with haemoptysis, while 1 case (33.33%) had purulent sputum {Table-IV}.

### (V) Metastases (n=2)

Age=21yr & 55yr.

Female=2

Asymptomatic presentation.

Chest X-ray- clear lung fields-1 case (50%).

Soft opacities in lower zones-1 case (50%).

HRCT examination-Smooth well defined nodules-2cases (100%).

Lymphadenopathy-2 cases (100%).

### (VI) Bronchioloalveolar Carcinoma (n=1)

Male= 71 years.

Symptoms- fever, haemoptysis, dyspnoea and weight loss.

Chest X- ray-poorly marginated, consolidative opacity.

HRCT examination-

- Diffuse consolidation with air bronchograms.
- Ill defined centrilobular nodules.
- Predominant zone-right middle and lower lung lobes.
- No pleural effusion or lymphadenopathy.

FNAC was performed and the diagnosis was confirmed cytologically.

### (VII) Allergic Bronchopulmonary Aspergillosis (n=1)

Female=44years

Symptoms- cough, wheezing, dyspnoea & H/O asthma.

Chest X ray- showed non-specific irregular opacities in right upper zone radiating from the hila.

#### HRCT examination

- Central bronchiectasis.
- Distribution bilateral upper zone /middle zone/lower zone.
- Mucus plugging giving 'gloved-finger' or branching opacities.

#### (A) Statistical Analysis In Case Of Active Tuberculosis

In present study, considering centrilobular nodules as the marker of activity.

HRCT Dx	AFB+	AFB-	Total
Positive for TB	9	2	11
Negative for TB	1	3	4
	10	5	15

$$\text{Sensitivity} = \frac{9}{9+1} \times 100 = \frac{9}{10} \times 100 = 90\%$$

$$\text{Specificity} = \frac{3}{2+3} \times 100 = \frac{3}{5} \times 100 = 60\%$$

$$\text{Positive Predictive Value} = \frac{9}{9+2} \times 100 = \frac{9}{11} \times 100 = 82\%$$

$$\text{Negative Predictive Value} = \frac{3}{1+3} \times 100 = \frac{3}{4} \times 100 = 75\%$$

$$\text{Accuracy} = \frac{9+3}{9+2+1+3} \times 100 = \frac{12}{15} \times 100 = 80\%$$

#### (B) Statistical Analysis In Case Of Solitary Pulmonary Nodules

In the present study, considering spiculations as the marker of malignancy.

HRCT Dx	Malignant	Benign	Total
Positive	4	1	5
Negative	0	1	1
	4	2	6

$$\text{Sensitivity} = \frac{4}{4+0} \times 100 = \frac{4}{4} \times 100 = 100\%$$

$$\text{Specificity} = \frac{1}{1+1} \times 100 = \frac{1}{2} \times 100 = 50\%$$

$$\text{Positive Predictive Value} = \frac{4}{4+1} \times 100 = \frac{4}{5} \times 100 = 80\%$$

$$\text{Negative Predictive Value} = \frac{1}{1+0} \times 100 = \frac{1}{1} \times 100 = 100\%$$

$$\text{Accuracy} = \frac{4+1}{4+1+0+1} \times 100 = \frac{5}{6} \times 100 = 83.33\%$$

#### DISCUSSION

The present study was undertaken to detect and characterize high resolution computed tomography (HRCT) patterns of various lung diseases in our hospital. Our study included 47 patients who were initially evaluated by clinician in chest OPD or indoor and who had chest radiograph with normal or equivocal pulmonary pathology.

In our study **12 additional cases** (26.6%) {Table-I} were identified on HRCT which were normal in plain radiograph. **Syrjala et al. (1998)** reported 55.3% of additional cases of community acquired pneumonia on HRCT not identified on chest radiograph.<sup>[2]</sup> The relatively lower percentage of additional cases detected on HRCT in present study could be due to the fact that the patients presented relatively late with a large number of patients having a positive radiograph at the time of presentation.

**Interstitial lung diseases** formed the most common group where disease characterization was done followed by **tubercular infections** {Table-II}. This is in agreement to **Athol U. Wells (2003)** who studied optimal diagnostic use of HRCT in diffuse lung disease as the most important indication.<sup>[3]</sup>

Our findings were also similar to those of **Sherwani et al. (2005)** who reported tuberculosis as the most common etiology among infectious causes of opacities on chest radiograph followed by pyogenic infections.<sup>[4]</sup>

#### Clinical Spectrum

The study included 58% males and 42% females. This indicates that males were more prone for pulmonary pathology.

Patients of **Idiopathic Pulmonary Fibrosis (IPF) and other Interstitial Lung Diseases (ILDs)** most commonly presented between 40 and 70 years of age {Table-III} with male predominance. The average age of IPF patients were 58.17 yrs. This is comparable to the study of **Lynch et al. (1980)** in which the average age of presentation is 58.3 years.<sup>[5]</sup> In **tubercular infections** no obvious age predilection was noted {Table-III&VIII} with male outnumbering females. Present study showed

age and sex distribution similar to a study conducted at **AIIMS DOTS centre (2004)** in which no obvious age predilection was found in tubercular and pyogenic infections.<sup>[6]</sup> Similarly, patient with **metastases** showed no obvious age predilection. The age of **Bronchioloalveolar carcinoma** patient corresponds to the literature,<sup>[7]</sup> i.e. presenting in 6<sup>th</sup> to 7<sup>th</sup> decade.

Each patient presented with one or more symptoms {Table-IV, Graph-IV}. However, both patients (100%) of pulmonary metastases were asymptomatic constituting 4.4% (2/45) of study group. This is similar to the study of **Morgan-Parkes JH (1995)** where 80-95% patients were asymptomatic.<sup>[8]</sup>

In **ILD** patients {Table-IV} **dyspnoea and chest pain** were the most predominant symptoms seen in 88% & 64% patients respectively in our study. **Clubbing** was seen in 47% patients at presentation. **Cough** (usually dry) was seen in 24% cases. Pulmonary function testing (PFT) demonstrated a restrictive defect in all the **ILD** patients, however PFT was not performed in 1 patient due to acute presentation. The routine laboratory evaluation of a patient suspected of having **IPF** was not helpful except to "rule out" other causes of diffuse parenchymal lung disease. These findings were similar to the study conducted by **Reynolds HY (1998)**.<sup>[9]</sup>

In **Koch's** patients, **fever and cough** were the most common clinical symptoms seen in 80% and 94% of patients respectively in our study {Table-IV}. Our findings are similar to those of **Philippart (2006)** who stated that **LRTI** is suggested by clinical signs i.e. cough and sputum associated with fever. However, clinical as well as radiographic signs cannot reliably identify the aetiology.<sup>[10]</sup>

The most common cause of **haemoptysis** was mycobacterial infection and post tubercular bronchiectasis which constituted 5/9 (55.55%) cases {Table-IV}. These findings were similar to **Stebbing et al. (1999)** who reported post-tubercular bronchiectasis and pulmonary tuberculosis as the most common cause of haemoptysis.<sup>[11]</sup>

In the present study **raised total leukocyte** count was the common but nonspecific laboratory abnormality, seen in 33.33% patients {Table-V}. These findings were similar to those of **Michelow et al. (2004)** who also observed that the type of infection was not related to total leukocyte count.<sup>[12]</sup>

**Sputum examination** in our study was positive in 10/15(66.67%) patients with mycobacterial infection. Our findings were quite similar to a study at **AIIMS DOTS centre (2004)** in which they found that sputum positive cases constituted 46.23% of total cases of pulmonary tuberculosis.<sup>[6]</sup>

### HRCT Patterns

In our present study, **Idiopathic Pulmonary Fibrosis** was the most common Interstitial lung disease comprising of 59% cases (10/17) corresponding to the study of **Johnston I D et al.(1997)**<sup>[13]</sup> The diagnosis was based on the criteria proposed by **ATS/ERS (2002)**<sup>[14]</sup> Histological confirmation by CT guided biopsy was not done in our setup due to high risk of pneumothorax.

In our study, lower lobe predominance was seen in 80% & peripheral, subpleural (peripheral) predominance in 100% of the cases {Table- VI} as compared to 81% & 91% respectively by **Lynch et al.(2005)** (108). 3 patients (30%) showed no zonal predominance and involved all the zones to an equal extent.

The predominant HRCT features in our study leading to architectural distortion were fibrobronchiectatic changes (90% cases) and intralobular septal thickening (90% cases) which is comparable to a previous study,<sup>[15]</sup> where traction bronchiectasis was seen in 85% cases. Interlobular septal thickening was seen in only three patients (30%), a relatively infrequent finding comparable to the previous study.<sup>[14]</sup>

Pleural thickening was seen in 7 patients (70%).

In our study, ground glass opacities was seen in only 20% of the cases and in these patients it was not a predominant finding. This is possibly because of our study population being in advanced stage of the disease.

In our study, honeycombing was seen in 90% of cases which is almost similar to 88% as seen in the study by **Lynch et al.(2005)**.<sup>[16]</sup> In 90% patients, honeycombing was bilateral however it was asymmetrical in all the patients. This does not correspond to the study by **Iwai K (1994)** where it was symmetrical.<sup>[15]</sup>

In our study, mediastinal lymphadenopathy (LAP) was detected only in 3 patients (30%) which is inconsistent with the study of **Niimi H et al. (1996)** where LAP was seen in 70% cases.<sup>[17]</sup>

In the present study, 3 cases of **ILD in collagen vascular disorders**, one each of Rheumatoid arthritis, SLE and Goodpasture's syndrome were seen. The SLE and Rheumatoid arthritis patients were known cases while the patient with Goodpasture's syndrome was newly diagnosed by renal biopsy. All the three patients (100%) presented with symptoms of dyspnoea. In addition patient with Goodpasture's syndrome presented with haemoptysis. HRCT features {Table-VII} well corroborates with the literature.<sup>[18,19]</sup> Features of fibrosis like septal thickening (inter & intralobular) (66.66%), peribronchovascular thickening (33.33%) and reticulations (66.66%) were predominant in patients of SLE and RA. However, bronchiectasis & subpleural honeycombing which were predominant features of Idiopathic Pulmonary Fibrosis (IPF) were not seen in any



of these cases. Ground glass opacities were a consistent finding in all the 3 (100%) patients indicating active pathology. In the patient of Goodpasture's syndrome who presented with acute onset of severe dyspnoea, HRCT showed ground glass opacities without any evidence of fibrosis. This represented active disease as evidenced by quick response to therapy with cyclophosphamide.

Similar to the study of **Tanaka et al. (2004)**, in our study, the pathological pattern associated with all the 3 (100%) cases were of nonspecific interstitial pneumonia (NSIP). On HRCT examination, here ground glass opacities predominated in contrast to patients of idiopathic pulmonary fibrosis where honey combing pattern of usual interstitial pneumonia (UIP) was seen.

In our study, 2 cases (1 male, 1 female) of **asbestosis** were found. The diagnosis was based on the history of asbestos exposure, radiographic findings and abnormal pulmonary function tests as according to the literature. One patient showed evidence of pleural calcification and fibrosis in plain X-ray, while the other had normal X-ray. HRCT findings {Table-VII} showing lower lobe involvement and subpleural location of lesions in 100% cases in our study were comparable to the study of **Akira et al. (2003)** which showed basal predominance of fibrosis in 98% cases. Further the findings of subpleural reticulation in early stage and extensive honeycombing in advanced stage of disease were also similar to their study. However, in contrast to their study where pleural involvement was seen in 83% cases, pleural thickening and calcifications were seen only in 50% (1 case) in our study probably due to small sample study.

HRCT picked up early fibrosis in the periphery of lobules and interlobular septal thickening which was not characterized in conventional CT. Our study was also comparable to the study of **Gevenois PA et al. (1998)**<sup>[20]</sup> where fibrosis was bilateral and symmetrical.

In the present study, 1 case of **Hypersensitivity Pneumonitis** was seen. The patient was a bird fancier, 55 year old male. He presented with complaints of dyspnoea and wheeze for 3 months and had normal chest radiograph. The findings are consistent with the previous study of **Silver et al. (1989)**<sup>[21]</sup> Pulmonary function test showed restrictive pattern. HRCT showed bilateral ground glass opacities (GGO) in both the lung fields involving middle and lower zones. The HRCT findings were similar to the study of **Hansell and Moskovic (1991)**<sup>[22]</sup> However, the second most common finding of poorly defined nodules in their study was not found in our study probably due to just single case study.

In the present study, one case of **sarcoidosis** was detected. The patient was a female, 42 years of age. She presented with dry cough and dyspnoea. Chest radiograph of the patient showed abnormal pulmonary parenchymal opacities in the LUZ. The diagnosis was

supported by histopathological examination as mentioned in the literature.<sup>[23]</sup>

HRCT features in our study {Table-VII} showing smooth well defined nodules in perilymphatic distribution along interlobular septa & fissures and large coalescent nodules predominantly in upper lobe and bilaterally were consistent with previous studies.<sup>[24,25]</sup>

Classical bilateral mediastinal lymphadenopathy was not seen in the present case. Rather axillary lymph nodes were seen which histopathologically showed noncaseating granulomas. This correlated with the study of atypical CT manifestations of sarcoidosis by **Hamper UM et al. (1986)**.<sup>[26]</sup>

In 15 cases of **Pulmonary Koch's**, 7 cases were newly diagnosed while 8 cases had history of tuberculosis in the past. Out of 8, 4 had reactivation of the disease. 10/15 cases were AFB positive.

Centrilobular nodules formed the most common pattern seen in 11/15 (73.33%) of the total cases and 9/10 (90%) of the active cases. In it, tree-in-bud appearance was seen in 7/11 cases {Table-IX (A&B)}. Cavitation was seen in 8/15 (53.33%) cases. Most commonly involved lobe was the upper lobe seen in 13/15 (86.66%) cases. Our findings were consistent with an earlier study conducted by **Hatipoglu et al. (1996)** where centrilobular nodules constituted 91% of active cases.<sup>[26]</sup> Disappearance of these nodules under treatment was found to be a reliable sign of tuberculosis eradication.

Our findings were also in agreement with those of **Poey et al. (1997)**<sup>[28]</sup> who studied the evolutive pattern and signs of activity of tuberculosis using HRCT. Showing similarity to the present study, it confirmed that the area most commonly involved are the apical and posterior segment of the upper lobes as well as the apical segment of the lower lobes with slight preference for right lung. Parenchymal consolidation secondary to replacement of alveolar air by exudates was seen in 6/10 (60%) of the active cases in our study which is in agreement with the above mentioned study where it was seen in 65% of patients with bacteriologically confirmed tuberculosis.

In the present study, 1/15 case (6.66%) {Table-IX(A)} of pulmonary Koch's showed 1-2 mm miliary nodules randomly distributed bilaterally in the upper, middle and lower lobes, in accordance to that described by **OH et al. (1994)**<sup>[29]</sup> However ground glass attenuation and reticular opacities were not seen in our study.

**Traver et al. (2005)** described the presence of bronchiectasis on HRCT scans in 40% of the patients of post primary tuberculosis (30). Similarly our study showed that peribronchovascular thickening and bronchiectasis {Table IX(A)} were seen in 4/15 (26.66%) and 5/15 (33.33%) cases respectively.

Considering, HRCT feature centrilobular nodules as the marker of active tuberculosis the sensitivity was 90%, specificity was 60%, positive predictive value 82%, negative predictive value 75% and accuracy was 80%.

In the present study, 6 cases of **Solitary Pulmonary Nodule (SPN)** were characterised as benign or malignant using HRCT {Table No-X}. All the cases were subjected to CT guided FNAC for cytological confirmation. The malignant nodules (100%) were irregular in outline and showed heterogeneous attenuation. The benign nodules showed homogeneous attenuation (100%), one was smooth in outline (50%) while the other had irregular outline (50%).

In our study, considering **spiculations** as the marker of malignancy, the sensitivity was 100%, specificity was 50%, positive predictive value was 80%, negative predictive value was 100% and accuracy was 83.33%. This was comparable to the study by **Giuseppe Potente et al. (1997)**<sup>[31]</sup> They used 20 HU enhancement by contrast agent as a threshold for positivity of malignancy. Their sensitivity was 100%, specificity was 74%, positive predictive value was 89.5%, negative predictive value was 100%, and accuracy was 92%. The accuracy was lower in our study probably because of small sample size.

In our study 3 isolated cases of **bronchiectasis** were found. One patient presented with cough with purulent sputum while the other two cases presented with haemoptysis. All the patients had history of Koch's in the past. The clinical presentation were consistent with the study of **Stebbins et al. (1999)**<sup>[11]</sup> who reported post tubercular bronchiectasis as the most common cause of haemoptysis in their study. The findings were not seen in plain radiograph. The diagnosis was made on the basis of characteristic CT signs mentioned in the literature.<sup>[32]</sup>

In our study, we detected 2 cases of early **metastatic nodules** on HRCT sections in known cases of carcinoma breast and soft tissue sarcomas. Chest radiograph was normal in one case (50%). HRCT showed pleural based, well circumscribed, smooth margined nodules indicative of haematogenous metastases which corroborates with the study of **Davis SD (1991)**<sup>[33]</sup> In both these cases (100%) metastatic involvement of lymph nodes were seen. These metastases lacked the specific relationship to lobular structures and interlobular septa that are seen in patients of lymphangitis carcinomatosa.

In the present study, only 1 case of **Bronchioloalveolar carcinoma (BAC)** was found. The diagnosis was confirmed by FNAC. The HRCT manifestations in the present study showing presence of diffuse consolidation with air bronchograms and centrilobular nodules do not corroborate with the study of **Lee KS et al. (1997)**<sup>[34]</sup> where the most common presentation was solitary pulmonary nodule/mass. However our study was similar to the study of **Akira et al. (1999)**<sup>[35]</sup> where

consolidation with air bronchograms was the predominant feature in patients of diffuse BAC. The peripheral and lower lobe involvement in our study corresponds to their observations but pleural effusion and lymphadenopathy were not seen in our case.

In the present study, 1 case of **Allergic Bronchopulmonary Aspergillosis (ABPA)** was found. The patient was a 44 year old female asthmatic. The diagnosis was based on a combination of the patient's history, blood test, sputum test and imaging features as mentioned by **Greenberger PA (1997)**<sup>[36]</sup> The sputum culture was positive for fungal growth and increased eosinophils were seen on blood examination.

The chest radiographic findings were non-specific showing irregular opacities radiating from the hila. These were similar to the study by **Mintzer et al. (1978)**<sup>[37]</sup> HRCT findings showed central bronchiectasis with bronchial wall thickening and bronchial occlusion due to mucus plugging similar to those observed by **Panchal N et al (1997)**<sup>[38]</sup> However, all the lobes were involved in our study in contrast to upper lobe involvement in their study.

## CONCLUSION

1. Interstitial lung disease (ILD) formed the most common group where disease characterization was needed. HRCT determines the disease activity and extent of ILD better than chest X-ray. HRCT is superior to plain chest radiograph in the evaluation of early interstitial lung changes and thus helps in discriminating early reversible stage from late irreversible stage.
2. When HRCT and clinical findings are both typical of an individual pulmonary pathology, i.e. 'pathognomonic', it is generally appropriate to institute management based on a confident non-invasive diagnosis.
3. HRCT is helpful in the distinction of active from inactive TB. HRCT is better than plain chest radiograph in identification of the extent of pulmonary TB, especially subtle areas of consolidation, cavitation, bronchogenic and miliary spread. HRCT is recommended for the confirmation of diagnosis and determination of activity when the radiographic findings are normal or inconclusive and tuberculosis is suspected clinically. In countries with high prevalence of tuberculosis, inspite of low specificity, presence of centrilobular nodules favours the possibility of endobronchial spread of tuberculosis. HRCT is a powerful and reliable tool in tuberculosis diagnosis when other means of diagnosing tuberculosis (e.g., culture, BAL or TBLB) are not available or time consuming.
4. HRCT forms a valuable tool in discriminating benign from malignant pathology.

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