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Diagnostic Utility of High Resolution Computed Radiography & Chest Radiography in Assessing Disease Activity in Chronic Lung Disease

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Abstract
HRCT uses high spatial resolution of lung parenchyma, using thin collimation, high-spatial frequency reconstruction algorithm, increased kVp and mA settings.. Alterations in anatomy can be identified at level of secondary pulmonary lobule which can be diagnostic, although nonspecific. High-resolution CT scanning is helpful in identifying patients who have significant lung disease despite a normal chest radiograph. The aim of our present study is to summarize clinical usefulness of HRCT in patients with Chronic Lung Disease, and suggest specific indications based on a review of literature. The clinical value of HRCT is assessed in terms of its ability to detect diffuse chronic lung disease, confirm or refute presence of abnormality when chest radiograph is normal and its ability to determine optimal site of lung biopsy
Keywords: *HRCT, GGO, Fibrosis.*

INTRODUCTION

"Chronic Lung Disease is arbitrarily defined as lasting for more than 2 weeks or 1 month."[1] Although chest radiography is useful and inexpensive method for examining patients who have diffuse lung disease, it has well known limitations. Findings on the radiograph are often normal in symptomatic patients with pathology-ically proved diffuse lung disease,they seldom allow a confident diagnosis, and they correlate poorly with clinical and functional impairment. Approximately 10 % of patients who eventually prove to have infiltrative lung disease have a normal plain radiograph at presentation. [2,3] Mathieson[5] reported considerable superiority for HRCT over chest radiography. HRCT can show abnormalities in patients who have normal findings and because it provides accurate assessment of pattern and distribution of lung disease, it allows confident diagnoses in patients who have normal or non-specific findings in conventional radiography. HRCT techniques are capable of imaging lung with excellent spatial resolution, providing anatomic detail similar to that available from gross pathologic specimens or lung slices. HRCT can demonstrate the normal to abnormal lung interstitium and morphologic characteristics of both localized and diffuse

parenchymal abnormalities; and hence superior to plain radiographs and conventional CT.

AIMS & OBJECTIVES

The aim of our present study is to summarize clinical usefulness of HRCT in patients with Chronic Lung Disease, and suggest specific indications based on a review of literature. The clinical value of HRCT is assessed in terms of its ability to detect diffuse chronic lung disease, confirm or refute presence of abnormality when chest radiograph is normal; and its ability to determine the optimal type and site of lung biopsy

MATERIALS & METHODS

A retrospective study was conducted on 50 patients underwent HRCT & chest radiograph in our hospital. All patients who fulfilled the following clinical criteria were taken into consideration. (1) Progressive increase in shortness of breath on exertion or at rest not responding to treatment more than 2 weeks to one month. (2)Paroxysmal non-productive cough of long duration. (3)Fine dry end-inspiratory crackles posteriorly at lower chest. (4)Positive occupational history. (5)Abnormal chest radiograph. (6)Abnormal pulmonary function tests. Chest radiograph and CT scan were performed on the same day for each patient. All scans were obtained using SEIMENS SOMATOM EMOTION 16 SLICE CT SCANNER. The following HRCT protocols were used: Scan orientation -craniocaudal, patient position- supine (prone scans done wherever necessary), collimation -1.5mm, scan time - 1 sec, 120 kvp, 150 mA, 512x512 matrix , wl- -600, ww- 1500, no contrast, bone reconstruction algorithm, spacing at 5 preselected levels - (apices, aortic arch, hilar,infrahilar,1cm above right dome of diaphragm),full inspiration (expiratory scan done in cases where small airway disease was suspected) The CT scans were analyzed for type, size, and extent of small opacities, presence or absence of reticular pattern, reticulonodular shadowing, ground glass shadowing ,mosaic perfusion, traction bronchiectasis, honeycombcysts, septal lines. The distribution of abnormalities were classified as being either predominantly upper or lower zone; as being central, diffuse, posterior, or peripheral.; as having either predominantly peribronchovasular, or subpleural or distribution or as being randomly distributed . These findings were then interpreted on the basis of previously published data on radiographic and HRCT findings.

Results

Our study comprised of 50 patients (54%male, 46% female) with age range from 10-80 years (mean age-45.42 years)

TABLE I : Chest radiograph vs HRCT

Total no of patients with normal chest radiography	8	16%
Total no of patients with abnormal chest radiography	42	84 %
Total no of patients with normal CXR and abnormal HRCT	8	16%
Total no of patients with abnormal CXR and abnormal HRCT	42	84%
Total no of patients abnormal CXR and normal HRCT	NIL	NIL

Eight cases which appeared normal on chest radiographs were detected as abnormal on HRCT whereas all cases abnormal on chest radiograph were also abnormal on HRCT.

TABLE II: Disease Incidence

DISEASE	NO OF PATIENTS	PERCENTAGE
Idiopathic pulmonary fibrosis	9	18%
Pulmonary tuberculosis	20	40%
Pneumocystis carinii pneumonia	3	6%
Alveolar microlithiasis	4	8%
End stage lung disease	1	2%
Histiocytosis x	1	2%
Boop	2	4%
Lung metastases	3	6%
Lymphangitis carcinomatosa	2	4%

Diffuse alveolitis	1	2%
ARDS	1	2%
Rheumatoid arthritis	2	4%
Sarcoidosis	1	2%
Total	50	

Tuberculosis followed by idiopathic pulmonary fibrosis were most common diseases in our study .Isolated cases of end stage lung disease, histiocytosis X,sarcoidosis, rheumatoid arhtritis and diffuse alveolits were also identified. One case of familial alveolar microlithiasis was also present. Three cases of pneumocystis carini pneumonia in immunocompromised patients were also identified.

TABLE III: Demographic Data

Disease → / Character	PTB N=20	IPF N=9	HIV/ PCP N=3	ALVEOLAR MICROLITHIASIS N=4	ESLD N=1	HISTICYTOSIS N=1	BOOP N=2	LUNG METASTASES N=3	LYMPHANGITIS CARCINOMATOSA N=2	DIFFUSE ALVEOLITIS N=1	ARDS N=1	SARCOIDOSIS N=1	RHEUMATOID ARTHRITIS N=2
Sex male	14 (70%)	6(66.6%)	0	1	1	1	2(100%)	-	1(50%)	1	-	-	-
Female	6(30%)	3(33.3%)	3(100%)	3	-	-	-	3(100%)	1(50%)	-	1	1	2
Median age	46 yrs	48 yrs	37 yrs	27 yrs	70 yrs	55yrs	45yrs	48 yrs	67yrs	48yrs	35yrs	35yrs	57yrs
Non smoker	9 (30%)	7(77.7%)	3(100%)	4(100%)	-	-	-	3(100%)	1(50%)	-	1	1	2
Smoker	14 (70%)	2(22.2%)	0	-	1	1	2(100%)	-	1 (50%)	1	-	-	-
No smoking data	-	-	-	-	-	-	-	-	-	-	-	-	-

Prevalence of pulmonary tuberculosis was high in male smoker with mean age of 46 yrs.Prevalence of idiopathic pulmonary fibrosis was high in male nonsmokers with mean age of 48 yrs.Alveolar microlithiasis was found to affect younger age groups and was slightly common in females.End stage lung disease and lymphangitis carcinomatosa tend to affect older age groups.

TABLE IV : Quantification Of Groundglass Opacification And Fibrosis IN IPF

FEATURE / CASE ↓	INTENSITY OF GGO RANGE (1-3)	EXTENT OF GGO RANGE (1-4)	EXTENT OF FIBROSIS RANGE (1-4)	COARSENESS OF FIBROSIS (0-15)	TRACTION BRONCHIECTASIS RANGE (0-10)	SEVE SEVERITY OF GGO GGO RANGE (2-7)	SEVERITY OF GGO
CASE1	2.4	2	2	8	4	4.4	Moderate-severe
CASE2	2	3.2	1	2	0	5.2	Moderate-severe
CASE3	2	1	2	10	7	3	Mild
CASE4	2	1.4	1	5	0	3.4	Mild
CASE5	2.2	3.2	1.6	5	4	5.4	Moderate-severe
CASE6	2.4	2	2	8	4	4.4	Moderate severe
CASE7	2	2	2	9	4	4	Mild
CASE8	1	2	1	5	0	3	Mild
CASE9	1	1	2	10	7	2	Mild

TABLE IV A : Intensity Of GGO

INTENSITY	NO .OF PATIENTS
Low	2(22%)
Moderate	4(45%)
Severe	3(33%)

Table :IV B. Extent Of Ground Glass Opacification :

EXTENT	PERCENTAGE
<25 %	2(22%)
25-50%	5(55.6%)
50-75%	2(22%)
>75%	-

TABLE IV C : Severity Of Ground Glass Opacification :

GGO severity	Present study	RemyJardin etal
Mild	5(55.6%)	46%
Moderate to severe	4(44.4%)	54%

TABLE IVD : Grading Of Opacification:

GRADE	PERCENTAGE
I	55%
II	44%
III	1%

TABLE V Findings In Sputum Postive And Sputum Negative Tuberculosis:

Total no of cases = 20
Total no of sputum (+) cases = 11(55%)
Total no of sputum (-) cases = 9(45%)

Feature	Active(n=11)	Inctive (N=9)	overall
Tree-in-bud opacity	10(90.9%)	8(88%)	90%
Centrilobular nodules	8(72.%)	6(66.7%)	70%
Ildefined nodules	5(45.5%)	5(55.5%)	50%
Cavitation	7(63.6%)	6(66.7%	65%
Lobar consolidation	9(82%)	3(33.3%)	50%
Septal thickening	1(9%)	3(33.3%)	20%
Groundglass opacity	8(72.7%)	1(11%)	45%
Linear scar	7(63.6%)	7(77.7%)	70%
Pleural thickening	3(27.3%)	7(77.7%	50%
Adenopathy	1(9%)	-	5%
Total	11(55%)	9(45%)	100%

Prevalence of groundglass opacity ,lobar consolidation , tree-in-bud opacities, centrilobular nodules was more in active tuberculosis compared to inactive tuberculsosis.Similarly prevalence of linear scar ,interlobular irregular septal thickening ,pleural thickening was higher in patients with inactive tuberculsosis.

TABLE VI Summary Of Findings In Hiv (+) Patients With Pnemocystis Carinii Pneumonia Infection :

Total number of HIV (+) patients =3
Total number of patients with abnormal radiographs =2(66.6%)
Total number of patients with normal radiographs =1(33.3%)
Total number of patients with positive HRCT findings =3(100%)

Feature	No of patients	Percent
Bilaterality	3	100%
Diffuse involvement	3	100%
Nodules	1	33.3%
Consolidation	2	66.6%
Groundglass opacity	3	100%
Thin walled cysts	1	33.3%
Pleural thickening	-	-
Adenopathy	-	-
Pneumothorax	-	-

Bilateral diffuse pattern of ground glass opacity was the common finding in HIV patients .

DISCUSSION

Only very few studies regarding diagnostic accuracy of chest radiograph and CT have been published. Matheison et al[5] reported that in 118 patients with chronic diffuse infiltrative lung disease interobserver variation was minimal and interobserver agreement was more accurate using HRCT than interpretation using chest radiograph. They subsequently recommended that CT scanning should preceed lung biopsy in all patients.Similarly in other three studies , utilizing 48 selected patients with chronic DILD (Bergin et al), 140 consecutive patients with chronic DILD (Grenier et al), and 86 patients with chronic DILD mixed with normal subjects (Padley et al) HRCT was determined to be superior to conventional radiograph in the diagnosis of chronic DILD.

HRCT VERSUS CHEST RADIOGRAPH : (TABLE I)

Felson[4] showed that prediction of microscopic distribution from plain radiograph pattern is unreliable. Even when chest radiograph shows definite evidence of diffuse lung disease Mccloud

has pointed that "the chest radiograph is often nonspecific and rarely diagnostic". This is due to the fact that there is superimpostion of structures on lungs leading to observation which is further compounded by presence of pleural thickening. In our study plain radiography was normal in 8 (16%) of patients. Epler etal[2] and Gaenslen & Carrington etal[3] concluded that approximately 10 % of patients who eventually prove to have interstitial lung disease have a normal plain radiograph at presentation.In our study HRCT was abnormal in all 8 patients who had a normal chest radiograph. In no case was HRCT felt to be normal when the chest radiograph was described as abnormal. Padley etal[8] reported that out of 18 chest radiographs erroneously called normal , 11 were described as abnormal on HRCT(62%).They also reported that in no case was HRCT felt to be normal when the chest radiograph was described as normal. Thus in our study the role of HRCT in face of equivocal chest radiograph has been confirmed. Matheison etal[5] concluded that correct diagnosis was made in 77% of chest radiography and 93% of CT scan reading ($p<0.001$).

QUANTIFICATION OF GROUNDGLASS OPACIFICATION (Tables IV,IV-A,B,C)

Out of 9 cases of IPF diagnosed in our study, 22%, 45% and 33% had low , moderate &severe GGO intensity scores respectively. The extent of GGO involvement was <25% involvement in 22% of cases, 25-50%involvemnt in 55.6% of cases and 50-75%involvement in 22% of cases.In a study by Remy Jardin etal[6] out of 37 patients diagnosed as IPF 40%, 45%,and14% had low, moderate, and severe GGO intensity scores respectively. The extent of GGO involvement in their study was <25% involvement in 10.8%;25-50% involvement in 35%;50-75% in 16%; >75% involvement in 40% of cases. Remy Jardin et al[6] evaluated the importance of scoring of groundglass opacification and fibrosis in chronic diffuse infiltrative lung disease. A mild groundglass opacification was defined as GGO score <4 and moderate - severe groundglass opacification was defined as GGO severity score >4. In our study 55.6% had mild GGO severity score and 44.4% had moderate –severe GGO severity score. These results are comparable to the above study by Remy Jardin et al who showed that 46 % had mild GGO and 54% had moderate – severe GGO.

QUANTIFICATION OF FIBROSIS

In our study 75 % of cases with IPF who had severe GGO scores also had a severe overall coarseness of fibrosis score. The prevalence of traction bronchiectasis was also high in these patients (75%). Remy Jardin et al[6] observed a trend towards onset or increase in honeycoombing and traction bronchiectasis in patients with most severe GGO profusion score at initial CT evaluation. According to Westcott et al in patients with IPF the presence of bronchiectasis doesnot necessarily imply the presence of primary bronchial disease . In general there was a direct relationship between the severity of fibrosis and presence &severity of bronchiectasis. In our study there was a direct relationship between the coarseness of fibrosis scores and traction bronc-hiectasis. The extent of traction bronchiectasis was higher in patients who had a severe coarseness of fibrosis score, high GGO severity score. Patients with low GGO intensity, extent scores , had also low GGO severity scores,low coarseness of fibrosis scores.

HRCT & IPF : (Table-IVD)

HRCT was found to be more sensitive in detecting disease activity and prognosis in patients with Idiopathic pulmonary fibrosis. In our study out of 9 cases of IPF 55% had grade I parenchymal opacification, 44% had grade II parenchymal opacififcation, and 1% had grade III parenchymal opacification. Bilateral lower zone involvement was present in virtually all patients(100%). In a study by Leung etal[7] out of 15 patients with IPF 8 patients had gradeI opacfication(53%), 6 patients had grade II opacification (40%) and only one had grade III opacifiaction (6.6%).Grade II and Grade III disease indicated high grade. Bilateral involvement was present in 8 out 15 patients

(54%). Lower zone involvement occurred in 10 patients (77%). Most common pattern of involvment was bilateral and diffuse present in all patients. In our study out of 9 patients with Idiopathic pulmonary fibrosis who had predominantly GGO showed mild-moderate symptomatic improvement on treatment with steroids and patients who had predominantly fibrosis and traction bronchiectasis showed little response to treatment. Wells etal[10] divided CT findings in IPF into three groups-groupI predominantly GGO, group II mixed GGO and reticular opacities, group III predominantly reticular opacities. Response to therapy was significantly greater in patients who had predominantly GGO and greater in group II than group III. Groundglass opacification indicated reversible and potentially treatable disease whereas fibrosis and traction bronchiectasis indicate irreversible disease.

HRCT AND PULMONARY TUBERCULOSIS : (Table-V**)**

In our study 20 cases of pulmonary tuberculosis were identified. Out of these tree-in-bud opacities were present in 90%;centrilobular nodules in 70%,poorly defined nodules 50 %;cavitation 65%.Tree-in-bud pattern was most common pattern observed.Im etal[9] showed the high frequency of HRCT finding of endobronchial spread of infection in postprimary tuberculosis. In post primary tuberculosis tree-in-bud opacities were seen in 92%;centrilobular nodules in 67%;bronchial wall thickening in 50-73%;poorly defined nodules in 42%cavitation in 58%. With this they concluded that tree-in-bud opacities were most common and earliest manifestation of bronchogenic dissemination. In our study 11 cases were sputum positive and 9 cases were sputum negative. Prevalence of various findings in active tuberculosis were groundglass opacification-72%,tree-in-bud 90.9%, lobar consolidation –82%, centrilobular nodules-72.7%,interlobular septal thickening-9%,linear scar –63%.

Prevalence of various findings in inactive tuberculosis were groundglass opacification –11%,tree-in-bud opacties –88%, lobar consoliation-33.3%,centrilobular nodules-66.7%,interlobular septal thickening-33%,linear scar-77%. Hatipoglu and coworkers[11] compared HRCT findings in 32 patients who had active and inactive pulmonary tuberculosis. Tree-in-bud opacities (71%) nodules(69%) consolidation(44%) centrilobular opacities (91%) were identified in patients with active disease. They concluded that centrilobular opacities, tree-in-bud opacities are the most useful findings to differentiate active from inactive disease. The prevalence of linear scar ,irregular interlobular septal thickening was higher in patients with inactive tuberculosis.

ROLE OF HRCT IN AIDS PATIENTS: (Table-VI**)**

In our study HRCT detected intrathoracic disease in 100% of patients who were HIV positive. These results are comparable to study by Hartmann etal[12] which showed that HRCT detected intrathoracic disease in 99% of patients who were HIV positive. In our study three HIV positive patients in whom persistent hypoxemia was present in 2 cases had pneumocystis carini pneumonia infection. Plain radiographs were abnormal in 2 cases (66%) and revealed diffuse hazy opacification of lung parenchyma bilaterally. HRCT was abnormal in above all cases (100%sensitivity). Diffuse bilateral inviolvemnt was most common pattern involved seen in 100% of cases. The most common finding was groundglass opacification seen in all patients followed by diffuse patchy consolidation(66%).Thin walled cysts were seen in 1 patient(33%).Hartman etal[12] studied 24 patients who had pneumocystis carinii pneumonia infection. CT findings incuded GGO in 92%, consolidation in 38%,cystic change in 33%,pleural effusion in 17% and lymphadeno-pathy in 25%.Kang et al[15] reported a sensitivity of 90% for chest radiography and 96% for CT in detecting intrathoracic complications of AIDS. In our study HRCT effectively detected GGO in all three AIDS patients indicating presence of pneumocystis carinii pneumonia infection and this finding correlated well with hypoxemic status of the

individual. Hartman etal[12] stated that the finding of GGO on HRCT in patients with AIDS , particularly those with hypoxemia,is virtually diagnostic of pneumocystis carinii pneumonia infection. Grueden etal[13] documented that especially in AIDS patients who have equivocal radiographs HRCT plays an important role by excluding presence of GGO thus excluding presence of pneumocystis carinii infection. (100% sensitivity, 89% specificity). In AIDS patients , who have suspected pneumocystis carinii pneumonia infection and normal or equivocal chest radiograph, senstivity of HRCT has been shown to be 100% in making diagnosis whereas specificity was shown to be 89%[13] In our study the sensitivity of HRCT in detecting pneumocystis carinii pneumonia in AIDS patients was 100%.

ISOLATED CASES

In our study only one case of Histiocytosis X with grade I parenchymal opacification was identified. Thin walled cystic changes was present in both lung fields predominantly located in upper and mid zones. Right pneumothorax was also present. Moore etal[14] showed that cystic changes and nodules were the predominant HRCT findings in Histiocytosis X, usually thin walled cysts are present. They showed that these patients were prone to pneumothorax.In our study only one case(2%) of endstage lung disease was identified. Gaensler and Carrington[3] identified a prevalence of 3.4% for endstage lung disease in 502 patients indicating severe lung fibrosis.Few isolated cases of sarcoidosis, lymphangitis carcino-matosa, histiocytosis rheumatoid arthritis, BOOP were also detected in our study.

Our study had two main limitations. First it included a small number of cases. Second in all patients diagnosis was based on clinical, radiography and HRCT findings rather than biopsy.

CONCLUSION

In conclusion this study confirms superiority of HRCT over routine chest radiography for obtaining specific diagnosis in patients with chronic lung disease. We recommend clinical evaluation, conventional radiography and HRCT examination as integral part of appropriate initial evaluation of patients with chronic lung disease. In patients in whom CT doesnot provide diagnostic information HRCT can help direct the surgeon to optimal site of biopsy. In patients with chronic lung disease correlation of pathologic specimen with HRCT study gives best overall estimate of disease pattern and distribution.

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