Volume : 5 | Issue : 6 | June 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

High Resolution Computed Tomography (Hrct) Study in Infectious Lung Diseases

Medical Science

KEYWORDS : Centrilobular, consolidation, high resolution computed tomography, interstitial, lobular, and multifocal.

*** Dr. Dharm Raj Meena MD**	Associate Professor. Department of Radiodiagnosis. Govt. Medical College, Kota. Rajasthan. India. 324005. * Corresponding Author
Dr. Sumitra Guar	Ex. Resident. Department of Radiodiagnosis. Govt. Medical College, Kota. Rajasthan. India. 324005.
Dr. Anand Prakash Verma MD	Ex. Head of Department. Radiodiagnosis. Govt. Medical College, Kota. Rajasthan. India. 324005.
Dr. Sangeeta Saxena MD	Head of Department Radiodiagnosis. Govt. Medical College, Kota. Rajasthan. India. 324005.
Dr. Hashvardhan Khokhar MD	Assistant Professor, Department of Radiodiagnosis. Govt. Medical College, Kota. Rajasthan. India. 324005.

ABSTRACT

Background: The present study concluded that high resolution computed tomography is an invaluable tool in defining the imaging features of lower respiratory tract infection and characterization of the disease based on various pattern as well as early detection of subtle pathological changes in lung by high resolution computed tomography. Aim & Objective: 1. To detect and characterize HRCT patterns of various lower respiratory tract infections. 2. To develop an approach to differential diagnosis of lower respiratory tract infections based on HRCT pattern and distribution, with clinically correlated patient. 3. To recognize and differentiate infective from non-infective cause of lower respiratory tract disease. Setting and Design: This prospective study was conducted at department of radiodiagnosis, govt. medical college and associated group of hospitals, from December 2011 to December 2012 in association with department of medicine and paediatrics. Material and method: The study group included a total of 55 patients with suspected clinical diagnosis of lower respiratory tract infection presenting in department of medicine and paediatrics. The diagnosis was established based on the clinical profile, laboratory investigations and imaging findings. Observations and Results: Fifty five patients with clinically suspected diagnosis of lower respiratory tract infection underwent plain radiography of the chest followed by computed tomography. Of the 55 patients evaluated 50 patients were finally proven to have lower respiratory tract infection while 2 patients had a normal HRCT and 2 patients had old Koch's chest with no HRCT sign of active disease and one patient had interstitial lung disease. Conclusion and Interpretation: In our study chest radiograph was positive in 47 out of 50 cases of LRTI infection. Consolidation, multifocal lobular and confluent together, formed the most common pattern of LRTI seen in 74 % of the positive cases. It was more commonly seen in bacterial infections12/15 (80%). On HRCT consolidation, lobar & multifocal type together, formed the most common pattern of LRTI. The second most common HRCT pattern was presence of centrilobular nodules.

INTRODUCTION:

Acute lower respiratory tract infection are persistent and pervasive health problem, they cause greater burden of disease worldwide than the HIV infection, malaria, cancer or heart attack[1]

Lower respiratory tract infection describes a range of symptoms and signs, varying in severity from non-pneumonic LRTI in the young healthy adult through to pneumonia or life-threatening exacerbation in a patient with severe disabling chronic obstructive pulmonary disease (COPD) [2].

Lower respiratory tract infection) is often endogenous caused by microbes in the patient's normal flora. In a known or suspected case of Lower respiratory tract infection, the plain chest radiograph, sputum smear and culture remain initial method of evaluation.

The current gold standard for this distinction has been chest radiography[3, 4]

Chest radiography has, been used for decades to identify pneumonia in patients suffering from acute lower respiratory tract infection. Chest radiography is still recommended as standard reference method for confirming the diagnosis of pneumonia, however due to significant inter-observer variability in radiograph interpretation, its reliability is limited. The true prevalence of infiltrative disease in LRTI is more than 1.5 fold compared to seen at chest radiography Thus spiral computed tomography and High Resolution Computed Tomography play an important role in detection of LRTI.[5]

Although Computed Tomography (CT) is not recommended for initial evaluation of patient with pneumonia, it is a valuable adjuvant to conventional radiography in a patient with no revealing or non diagnostic imaging finding.[6]

Conventional CT of chest provide a two dimensional representation of a three dimensional cross sectional slice of lung. Although it allows assessment of the entire chest, it has limited ability to demonstrate fine parenchymal details.

HRCT is currently the best imaging modality for evaluation of lower respiratory tract infections, especially small airway disease. It provides fine interstitial details and may detect subtle pneumonias sooner than other techniques. It is capable of imaging the lung parenchyma with excellent spatial resolution and provides fine anatomical details similar to that seen in gross pathological specimen.[7]

HRCT is most useful modality for imaging of small airway disease. Direct sign of small airway disease that appear on HRCT scan are the result of changes in the airway wall or lumen .Abnormal small airway can be seen as tubular, nodular, or branching linear structure on HRCT scan. In-

direct sign of small airway disease result from changes in lung parenchyma distal to the diseased small airway and include air trapping, sub segmental atelectesis, centrilobular emphysema, and air space nodule in diverse inflammatory and infectious processes.[11]

Computed tomography and High resolution computed tomography is more sensitive than plain radiography in detecting the endobronchial spread of TB, a finding that indicates the presence of activity. HRCT is helpful in the differential diagnosis of tuberculosis from other lung disease, in the distinction of active from inactive TB, in determining the degree of smear positivity and assessing antituberculous treatment efficiency

Although chest radiography remains crucial in the evaluation of childhood respiratory infections, computed tomography has a role in specific instances. High resolution computed tomography (HRCT) offers several advantages over chest radiography due to its exquisite demonstration of pulmonary architecture without superimposition of overlying structures. Broadly, HRCT allows a better assessment of the type, distribution and severity of parenchymal abnormality than is possible on the plain radiograph.

The HRCT technique is use of thin sections and image reconstruction with a high spatial frequency algorithm. Although standard CT usually provides an adequately detailed image of the lung parenchyma, high resolution CT provides fine interstitial details and may detect subtle pneumonias sooner than do other techniques. HRCT is particularly useful in immunocompromised patients, in whom infection can quickly overwhelm the depressed immune system. Lower respiratory tract infections show various pattern on HRCT including ground glass opacity, discrete consolidation, confluent consolidation, airspace nodule peri-bronchovascular thickening, tree-in-bud pattern, free pleural fluid and septal thickening.

An expiratory mosaic pattern can also be noted in nearly 20% patients reflecting a coexisting small airway obstruction. [5, 12]

Small airway diseases manifest on HRCT as mosaic lung attenuation and centrilobular nodular opacities. Infective causes such as endobronchial tuberculosis, mycobacterium avium complex, airway aspergillus infection, respiratory syncytial virus, cytomegalovirus etc. exhibit a centrilobular nodular or "tree-in-bud" pattern.

The smallest airway normally visible using HRCT have diameter of approximately 2 mm and a wall thickness of 0.2 to 0.3 mm so bronchioles as small as 2 mm may be seen on HRCT however intralobular bronchi which are less than 1 mm in diameter with wall thickness 0.1 mm cannot be seen on High resolution computed tomography. Thus visibility of intralobular bronchi represents a disease state.

The CT findings of LRTI are nonspecific but a specific diagnosis can be made when findings are correlated with the patient history, clinical information and associated CT findings.

The study undertaken is an effort to define the various HRCT patterns of lower respiratory tract infection, characterstic of specific infective pathologies and their differentiation

MATERIAL AND METHOD:

Present study was conducted in Department of Radiodiagnosis, Govt. Medical College and Associated groups of Hospitals, Kota, from December 2011 to December 2012 in association with Departments of Medicine and Paediatrics.

The study group included a total of 55 patient with suspected clinical diagnosis of lower respiratory tract infection presenting in department of medicine and paediatrics All the patient were evaluated along the following lines and findings were recorded on separate performa

1. Clinical assessment:

A detailed history was elicited from each patient that included relevant symptoms, past history, relevant family history and smoking habits. Findings of general and systemic examination were noted in each patient.

2. Laboratory investigation

Relevant laboratory investigations including blood and sputum examination were recorded in each case.

3. Radiological evaluation

(a) Plain radiography:

Standard posterior-anterior radiograph / anterior-posterior radiograph were obtained in all cases. Radiographs were evaluated to detect the involvement of both lung fields by the infective process. The following features were noted:

Zonal distribution of the disease — upper, middle, lower or diffuse Involvement.

Predominant pattern of disease — reticular, nodular, reticulonodular alveolar opacities, cystic lesion and / or bronchiectatic change.

Volume of lung fields.

Presence of pleural effusion / thickening.

Presence / Absence of lymphadenopathy.

Associated abnormality like the presence of cardiomegaly and mediastinal

(b) Computed Tomography of the Chest:

Non contrast / Contrast enhanced spiral axial computed tomographic scans of the chest were obtained in each patient on the Siemens Somatom Sensation 40 slice and GE Bright Speed 16 slice spiral CT scanner as per condition of patient. Patients were instructed to come after overnight fasting on the day of examination. Images were obtained using helical data acquisition with 6 mm section using a pitch of 1-1.5 mm in a caudocranial direction after giving bolus intravenous contrast agent ml/ kg of iodinated contrast. Non ionic contrast was used wherever indicated. Patients were asked to inspire fully and hold their breath while the data acquisition was completed. Images were evaluated on both mediastinal and lung window settings.

(c) High Resolution Computed Tomography Scans:

High resolution sequential axial scans of the chest with 1mm collimation at a scan interval of 15-20 mm in full inspiration were obtained in each patient. The following aspect of lung parenchyma were evaluated

Large bronchi and vessel

Volume : 5 | Issue : 6 | June 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

Secondary pulmonary lobule

Interlobular Septae

Centrilobular region and core structure

Lobular parenchyma

Pulmonary acinus

Lung interstitium

Axial

Peripheral

Intralobular

Associated findings

The following feature of lung involvement by the lower respiratory tract infection process was evaluated.

Zonal distribution of the disease

Predominant pattern disease - reticular, nodular, reticulonodular alveolar opacities cystic lesion /bronchiectatic changes.

Bronchiolar disease with centrilobular nodules and tree-in-bud pattern

Volume of lung fields

Presence and type of septal thickening

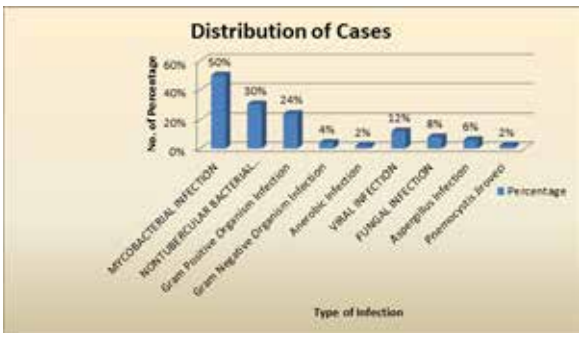
Presence and distribution of honey combing a findings-traction bronchiectasis and conglomerate fibrosis.

OBSERVATIONS AND RESULTS:

Fifty five patients with clinically suspected diagnosis of lower respiratory tract infection underwent plain radiography of the chest followed by computed tomography. Of the 55 patients evaluated 50 patients were finally proven to have lower respiratory tract infection while 2 patients had a normal HRCT and 2 patients had old K chest with no HRCT sign of active disease and one patient had interstitial lung disease.

Table 1: Distribution of cases (n=50)

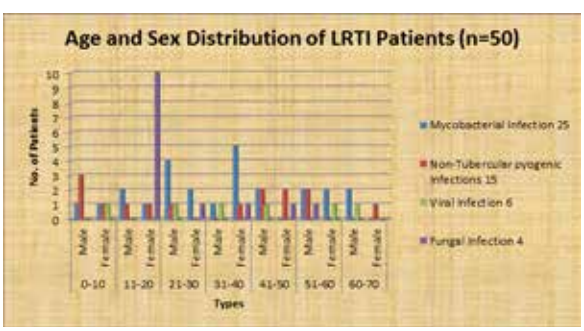
Type of Infection	Number	Percentage
MYCOBACTERIAL INFECTION	25	50%
NONTUBERCULAR BACTERIAL INFECTION	15	30%
Gram Positive Organism Infection	12	24%
Gram Negative Organism Infection	2	4%
Anaerobic Infection	1	2%
VIRAL INFECTION	6	12%
FUNGAL INFECTION	4	8%
Aspergillus Infection	3	6%
Pnemocystis Jiroveci	1	2%



Mycobacterial infection formed the largest group with 25 out of 50 cases constituting approximately 50 % of the total patient group

Table 2: Age and Sex distribution of LRTI Patients (n= 50)

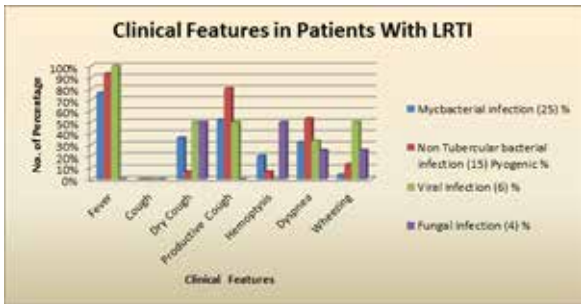
Types	0-10		11-20		21-30		31-40		41-50		51-60		60-70	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Mycobacterial Infection 25	1	1	2	1	4	2	1	5	2	-	2	2	2	-
Non-Tubercular pyogenic Infections 15	3	1	1	1	1	-	-	1	2	2	2	-	-	1
Viral Infection 6	-	1	-	-	1	-	1	-	1	-	-	1	1	-
Fungal Infection 4	-	-	-	-	-	1	-	1	-	1	1	-	-	-



Approximately thirty six percent of the patient were in the age group of 21-40 yrs

TABLE 3
CLINICAL FEATURE IN PATIENT WITH LRTI (N=50)

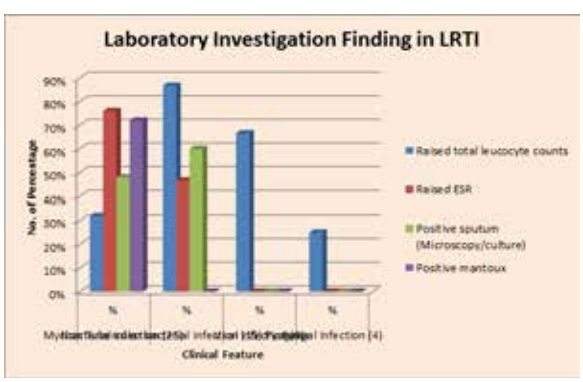
Clinical Feature	Mycobacterial infection (25)		Non Tubercular bacterial infection (15) Pyogenic		Viral Infection (6)		Fungal Infection (4)	
	No	%	No	%	No	%	No	%
Fever	19	76%	14	93%	6	100%	0	0%
Cough	0	0%	0	0%	0	0%	0	0%
Dry Cough	9	36%	1	7%	3	50%	2	50%
Productive Cough	13	52%	11	80%	3	50%	0	0%
Haemoptysis	5	20%	1	7%	0	0%	2	50%
Dyspnoea	8	32%	8	53%	2	33%	1	25%
Wheezing	1	4%	2	13%	3	50%	1	25%



Cough was the most common presentation seen in association with all type of infection

Table 4
LABORATORY INVESTIGATION FINDING IN LRTI (n=50)

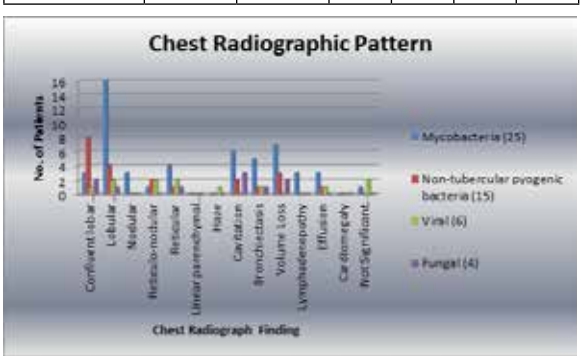
Clinical Feature	Mycbacterial infection (25)		Non Tubercular bacterial infection (15) Pyogenic		Viral Infection (6)		Fungal Infection (4)	
	No	%	No	%	No	%	No	%
Raised total leucocyte counts	8	32%	13	87%	4	67%	1	25%
Raised ESR	19	76%	7	47%	0	0%	0	0%
Positive sputum (Microscopy/ culture)	12	48%	9	60%	0	0%	0	0%
Positive Monteux	18	72%	0	0%	0	0%	0	0%
Other	HIV+2	0%	0	0%	0	0%	1 Serology	0%



Raised total leucocytes counts were seen in 26/50 of patients (52%)

Table 5
CHEST RADIOGRAPHIC PATTERN

Chest Radiograph Finding	Mycobacteria (25)	Non-tubercular pyogenic bacteria (15)	Viral (6)	Fungal (4)	No	%
Predominant Pattern						
Confluent lobar Consolidation	3	8	1	2	14	28
Lobular Consolidation	16	4	2	1	23	46
Nodular	3	0	0	0	3	6
Reticulonodular	1	2	2	0	5	10
Reticular	4	1	2	1	8	16
Linear parenchymal band	0	0	0	0	0	0
Haze	0	0	1	0	1	2
Cavitation	6	2	0	3	11	22
Bronchiectasis	5	1	1	1	8	16
Volume Loss	7	3	0	2	12	24
Lymphadenopathy	3	0	0	0	3	6
Effusion	3	1	1	0	5	10
Cardiomegaly	0	0	0	0	0	0
Not Significant abnormality	1	0	2	0	0	0



***Many patients show multiple findings on chest x ray**

Consolidation is the most common pattern of LRTI, multifocal lobular and confluent type together seen in 37 patient comprising 74% of positive cases. It was more commonly seen in bacterial infection.

Reticular pattern seen in viral infection ie 2 out of 6 cases (33%) in comparison to bacterial infection in which it was only seen in 5 cases out of 40 cases.(12%)

Nodular pattern seen in Mycobacterial infection

Cavitations were seen in association with Mycobacterial and fungal infection.

Lymphadenopathy seen in 3 out of 50 cases (6%), in association with Mycobacterial infection

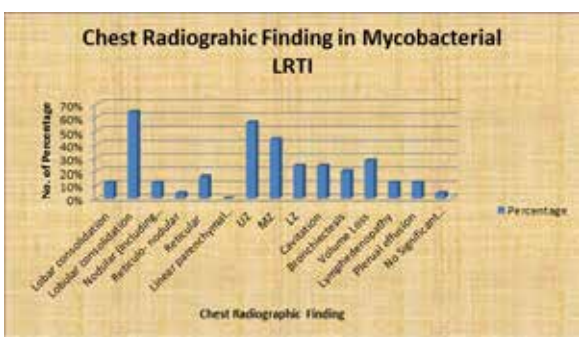
Three LRTI patients, one of mycobacterium and two of viral etiology, had normal chest radiograph, these patient however, showed abnormality on HRCT scan.

Table 6
Chest Radiographic finding in Mycobacterial in LRTI

Chest Radiographic Finding	No. of Patients	Percentage
Predominant Pattern		
Lobar consolidation	3	12
Lobular consolidation	16	64

Volume : 5 | Issue : 6 | June 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

Nodular (Including miliary)	3	12
Reticulo- nodular	1	4
Reticular	4	16
Linear parenchymal bands	0	0
Predominant Pattern		
UZ	14	56
MZ	11	44
LZ	6	24
Cavitation	5	24
Bronchiectasis	5	20
Volume Loss	7	28
Lymphadenopathy	3	12
Pleural effusion	3	12
No Significant abnormality	1	4



***Many patients showed multiple findings on chest radiograph**

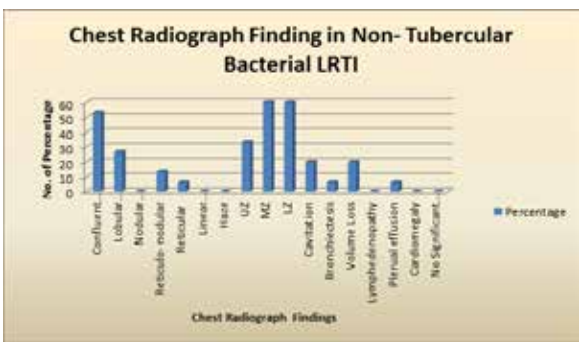
Multiple lobular consolidations, was the most common chest radiographic pattern observed, seen in 16 out of 25 cases (64%) of Mycobacterial infection.

Upper zone was the most common zone of involvement, seen in 14 out of 25 cases (56%).

Reticular/reticulonodular/nodular pattern was seen in 8 patients out of 25 cases (24%).

Table 7
Chest Radiograph Findings in Non- Tubercular Bacterial LRTI (15)

Chest Radiographic Finding	No. of Patients	Percentage
Predominant Pattern		
Confluent Consolidation	8	53.3
Lobular Consolidation	4	26.6
Nodular (Including miliary)	0	0
Reticulo- nodular	2	13.3
Reticular	1	6.6
Linear parenchymal bands	0	0
Haze	0	0
Predominant Pattern		
UZ	5	33.3
MZ	9	60
LZ	9	60
Cavitation	3	20
Bronchiectasis	1	6.6
Volume Loss	3	20
Lymphadenopathy	0	0
Pleural effusion	1	6.6
Cardiomegaly	0	0
No Significant abnormality	0	0



***Many patient show multiple findings on chest radiograph.**

Lobar consolidation and multifocal lobular consolidation together constituted 80 % (12/15) patients with pyogenic LRTI, of which lobar consolidation was seen in8/15 cases (53.3%)

Second most common pattern was reticulonodular seen in 2 out of 15 patient

Middle and lower zone were most common zone of involvement seen in pyogenic bacterial infection in 9/15 cases

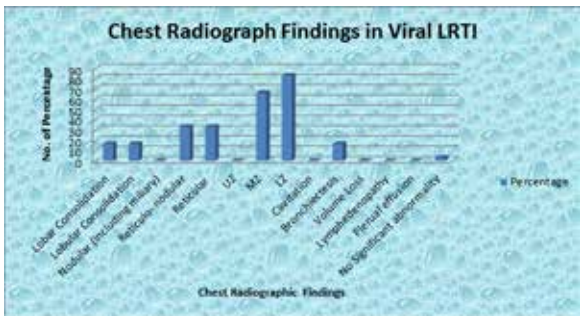
Volume loss observed in 3out of 15 cases (20%)

Cavitations was seen in 3/15 cases (20%)

Table 8
Chest Radiograph Finding in Viral LRTI (6)

Chest Radiographic Finding	No. of Patients	Percentage
Predominant Pattern		
Lobar Consolidation	1	16.66
Lobular Consolidation	1	16.66
Nodular (Including miliary)	0	0
Reticulo- nodular	2	33.33
Reticular	2	33.33
Predominant Pattern		
UZ	0	0
MZ	4	66.66
LZ	5	83.33

Cavitation	0	0
Bronchiectasis	1	16.6
Volume Loss	0	0
Lymphadenopathy	0	0
Pleural effusion	0	0
No Significant abnormality	2	3.3



Many patients showed multiple findings on chest radiograph.

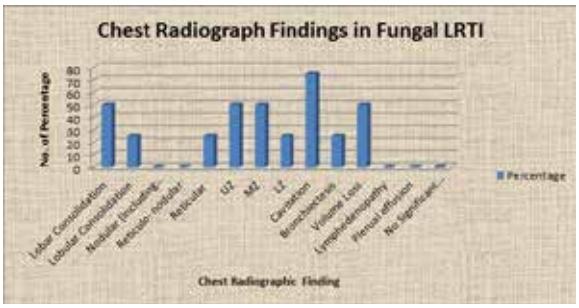
Reticulonodular and reticular were seen in with equal frequency ,each seen in 33% of patient (2 cases) with viral LRTI

Multifocal lobular and lobar consolidation was seen in one case each.

Cavitations, volume loss and Lymphadenopathy were not seen in any of the cases

Table 9
Chest Radiograph Findings in Fungal LRTI (4)

Chest Radiographic Finding	No. of Patients	Percentage
Predominant Pattern		
Lobar Consolidation	2	50
Lobular Consolidation	1	25
Nodular (Including miliary)	0	0
Reticulo- nodular	0	0
Reticular	1	25
Predominant Pattern		
UZ	2	50
MZ	2	50
LZ	1	25
Cavitation	3	75
Bronchiectasis	1	25
Volume Loss	2	50
Lymphadenopathy	0	0
Pleural effusion	0	0
No Significant abnormality	0	0



***Patient had old tubercular cavities.**

Confluent lobar and lobular Consolidation were the most common radiographic pattern observed ,seen in 3 out of 4 cases together constitute 75% of total patients with fungal infection.

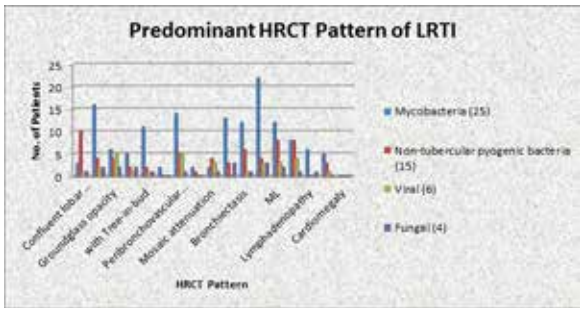
Upper and mid zone involvement was equally common seen in 3 out of 4 cases (75%) of fungal infection.

Volume loss was seen in 2 cases out of 4 cases (50%).

Table 10
Predominant HRCT Pattern of LRTI (25)

HRCT Pattern	No	%	Mycobacteria (25)	Non-tubercular pyogenic bacteria (15)	Viral (6)	Fungal (4)
Confluent lobar Consolidation	15	30	3	10	1	1
Multifocal lobular consolidation	24	46	16	4	2	2
Ground glass opacity	17	34	6	4	5	2
Centrilobular nodules without Tree-in- bud	10	20	5	2	1	2
with Tree-in-bud	15	30	11	2	1	1
Miliary nodules	2	4	2	0	0	0
Peribronchovascular thickening	24	48	14	5	5	1
Septal thickening	3	6	2	1	0	0
Mosaic attenuation	10	20	2	4	3	1
Cavitation	19	38	13	3	0	3
Bronchiectasis	20	40	12	6	1	1
UL	35	70	22	4	3	3
ML	26	50	12	8	3	2
LL	22	44	8	8	4	1
Lymphadenopathy	7	14	6	0	0	1
Pleural effusion	9	18	5	3	1	0
Cardiomegaly	0	0	0	0	0	0

Volume : 5 | Issue : 6 | June 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48



****Patient was a case of ILD with severe viral pneumonia**

*Many patients show multiple findings on HRCT

Multifocal, lobular consolidation together with confluent lobar consolidation formed the most common pattern of LRTI seen in 39 patients comprising 78 %of the positive cases.

Lobar consolidation was more common in pyogenic infection seen in 10/15 patients (66.6%) as compared to tubercular infection in which it was noted in 3/25 cases (12%)

Second most common HRCT pattern was presence of centrilobular nodule seen in 25/50 cases (50%) with associated tree in bud seen in more than half of these patients. (15/25 patients)

Centrilobular nodules were commonly seen in Mycobacterial 16 out of 25 cases (64%) and fungal infection 2 out of 4 cases(50%) in comparison to pyogenic infection in which it was noted in 4 cases out of 15 cases(26.6%).

Concomitant presence of lobular consolidation and centrilobular nodules, was most commonly seen with Mycobacterial infection seen in 11/25 cases(44%) in comparison of pyogenic infection in which the above combination was seen in only 2/15 cases(13.3%).

Miliary nodules were observed in association with Mycobacterial infection in 2/50 cases (4%)

Bronchiectasis and peri bronchovascular thickening were observed in 20/50 cases (40%) and 24/50 cases (48%) respectively.

Largest LRTI group associated with bronchiectasis was Mycobacterial infection with 12 out of 25 cases (48%)

Mosaic attenuation most commonly seen in 3/6 cases (50%) of viral infection. Few patients of pyogenic infection 4/15 cases (26.6%)

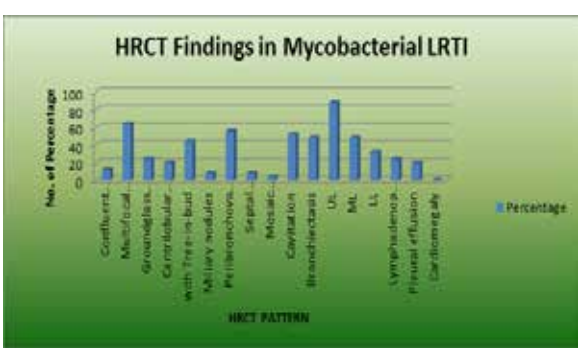
Lymphadenopathy was observed in 6 cases of Mycobacterial infection

Pleural effusion was most commonly associated with Mycobacterial LRTI seen in 5/25 cases

In comparison to chest radiograph HRCT detected bronchiectasis, lymphadenopathy and pleural effusion in 12, 4 and 4 additional cases respectively.

Table 11
HRCT FINDINGS IN MYCOBACTERIAL LRTI (25)

HRCT Pattern	No. of Patients	Percentage
Confluent lobar Consolidation	3	12
Multifocal lobular consolidation	16	64
Ground glass opacity	6	24
Centrilobular nodules without Tree- in- bud	5	20
with Tree-in-bud	11	44
Miliary nodules	2	8
Peribronchovascular thickening	14	56
Septal thickening	2	8
Mosaic attenuation	1	4
Cavitation	13	52
Bronchiectasis	12	48
UL	22	88
ML	12	48
LL	8	32
Lymphadenopathy	6	24
Pleural effusion	5	20
Cardiomegaly	0	0



Many patients show multiple findings on HRCT

Multifocal lobular consolidation was most common pattern seen in 16/25 cases (64%).

Upper lobe involvement was most common, seen in 22/25 cases (88%)

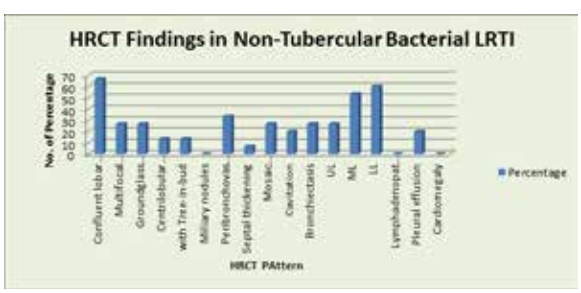
Second most HRCT pattern was presence of centrilobular nodules with or without tree in bud, seen in16/25 cases (64%).

Centrilobular nodules were associated with tree in bud in 11/25 cases (44%)

Peribronchovascular thickening and bronchiectasis were also common findings seen in 14 cases (56%) and 12(48%) patients of Mycobacterial infection respectively.

Table 12
HRCT Findings in Non-Tubercular Bacterial LRTI (15)

HRCT Pattern	Pyogenic Bacteria (15)	
	No. of Patients	Percentage
Confluent lobar Consolidation	10	66.67
Multifocal lobular consolidation	4	26.67
Ground glass opacity	4	26.67
Centrilobular nodules without Tree- in- bud	2	13.33
with Tree-in-bud	2	13.33
Miliary nodules	0	0
Peribronchovascular thickening	5	33.33
Septal thickening	1	6.67
Mosaic attenuation	4	26.67
Cavitation	3	20
Bronchiectasis	4	26.67
UL	4	26.67
ML	8	53.33
LL	9	60
Lymphadenopathy	0	0
Pleural effusion	3	20
Cardiomegaly	0	0



Many patients show multiple findings on HRCT

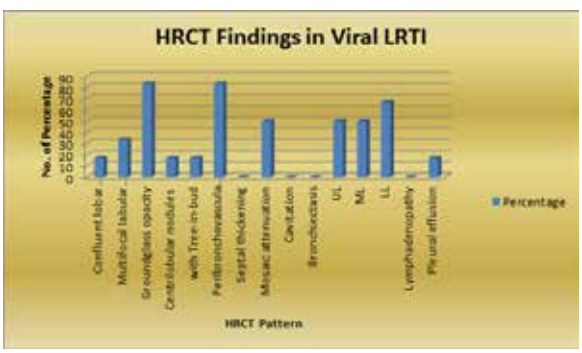
Consolidation, lobar or multifocal type were seen in 14/15 cases of pyogenic LRTI, and found most common pattern comprising 93.3 of total cases.

Lower lobes were most commonly involved seen in 9 out of 15 cases.

Second most common HRCT pattern was presence of bronchiectasis seen in 4 cases out of 15 cases. (26.6%).

Table 13
HRCT Findings in Viral LRTI (6)

HRCT Pattern	No. of Patients	Percentage
Confluent lobar Consolidation	1	16.66
Multifocal lobular consolidation	2	33.33
Ground glass opacity	5	83.33
Centrilobular nodules	1	16.67
with Tree-in-bud	1	16.67
Peribronchovascular thickening	5	83.33
Septal thickening	0	0
Mosaic attenuation	3	50
Cavitation	0	0
Bronchiectasis	0	0
UL	3	50
ML	3	50
LL	4	66.67
Lymphadenopathy	0	0
Pleural effusion	1	16.67



Most common HRCT pattern observed with viral lower respiratory tract infections were seen ground glass opacity and peribronchovascular thickening, each seen in 5 cases out of 6 patients (83.3%)

Lower lobe involvement was most commonly observed seen in 4out of 6 cases of viral infection.

Mosaic attenuation seen in 3/6 patients (50%)

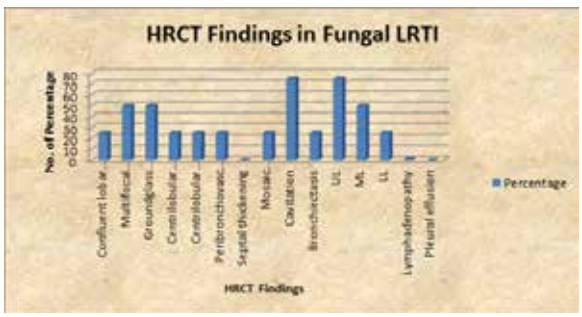
Multifocal lobular consolidation seen in 2 /6 cases (33.3%) of viral infection.

Table 14
HRCT Findings in Fungal LRTI (4)

HRCT Pattern	No. of Patients	Percentage
Confluent lobar Consolidation	1	25
Multifocal lobular consolidation	2	50
Ground glass opacity	2	50
Centrilobular nodules	1	25
Centrilobular nodules with Tree-in-bud	1	25
Peribronchovascular thickening	1	25
Septal thickening	0	0
Mosaic attenuation	1	25

Volume : 5 | Issue : 6 | June 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

Cavitation	3	75
Bronchiectasis	1	25
UL	3	75
ML	2	50
LL	1	25
Lymphadenopathy	1	1
Pleural effusion	0	0



Most common HRCT pattern observed with fungal infection were centrilobular nodule and ground glass opacity seen in 2/4 cases (50%)

Lobar and multifocal lobular consolidation seen in 1/4cases and 2/4 cases respectively

Upper lobe involvement was most commonly seen in 3out of 4 cases (75%)

DISCUSSION:

The present study was undertaken to detect and characterize high resolution computed tomography patterns of lower respiratory tract infections (LRTI) in our hospital. Fifty five patients with clinical suspicion of LRTI and referred for chest computed tomography were included in the study.

Fifty out of 55 patients showed features suggestive of lower respiratory tract infection on HRCT. The diagnosis was established based on the clinical profile, laboratory investigations and imaging findings.

Etiological agent:

Mycobacterial infection appear as the largest etiological group in our study consisted of 25/50 cases (50 %). Non-tubercular bacterial infection was the second largest group in this study comprising of 15 cases (30%) Viral and fungal LRTI was seen in 6 (12%) and 4 (10%) patients respectively.

Our findings are similar to those of Sherwani et al (2005)13 who also reported tuberculosis as the most common etiology among infectious causes of opacities on chest radiograph followed by pyogenic infections.

Our findings are differ from the survey of community-acquired pneumonia in adults in British hospitals[14] and another study by Grillner et al (1990) [15] they report pyogenic bacterial infection as the most important and common cause of LRTI. The above studies reflect commoner occurrence of pyogenic infections in comparison to tuberculosis in western world.

CLINICAL SPECTRUM:

No obvious age predilection was noted among any of the etiological groups of LRTI. There was slight male predominance in the present study with male patients constituting 56% of the total positive cases.

Present study shows age and sex distribution similar to a study conducted at S.K. Sharma et al (2004)[16] and Leroy et al (1999)[17] in which no obvious age predilection was found in tubercular and pyogenic infections respectively.

Fever and cough were the most common clinical symptoms of LRTI irrespective of etiology, seen in 39 cases out of 50 (78%) and 42 cases out of 50 cases (84%) of patients respectively in our study.

Our findings are similar to those of Philippart (2006)[18] 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 etiology.

Wheezing was seen in 50% (3/6 cases) of patients of viral infections in our study as opposed to 7.5% (3/40) of bacterial infections. These findings are in agreement with those of Michelow et al (2004)[19] who also reported wheezing to be commoner with viral and atypical infections.

Hemoptysis was seen in 8 cases out of 50 cases. Among these, the most common cause of hemoptysis was mycobacterial infection 5/8 cases (62.5%). These findings were similar to that of Stebbings et al (1999)[20] who reported pulmonary tuberculosis and post-tuberculous bronchiectasis as the most common causes of haemoptysis.

In the present study raised total leucocyte count was the most common but nonspecific laboratory abnormality, seen in 52% of patients.

These findings are similar to those of Michelow et al (2004) 19 who also observed that the type of infection was not related to total leucocyte count.

Sputum examination in our study was positive in 48% (12/25) patients with mycobacterial infection and 60% (11/15) of pyogenic infection.

Our findings are similar to a study at AIIMS DOTS centre in which they found that sputum positive cases constitute 46.23% of total cases of pulmonary tuberculosis and Sabira et al (1999)21 who found that sputum samples were accurate in only 52.3 percent of patients with community acquired pneumonia (CAP).

CHEST RADIOGRPHIC FINDINGS:

In our study chest radiograph was positive in 47 out of 50 cases of LRTI infection. Consolidation, multifocal lobular and confluent together, formed the most common pattern of LRTI seen in 74 % of the positive cases. It was more commonly seen in bacterial infections12/15 (80%). Reticular pattern was more commonly with viral LRTI ,seen in (2/6) 33% in comparison to bacterial infections in which it was seen in only 5/40 (12.5%) of patients. Nodular pattern was observed. in association with mycobacterial infections 3/25 (12%). Cavitation was seen in association with mycobacterial, pyogenic and fungal infections. Lymphadenopathy was seen in 3 patients, all of whom had mycobacterial infection and pleural effusion was seen in 4 patients 3 of mycobacterial, and one of pyogenic etiology.

Multifocal lobular consolidation was the most common chest radiographic patterns observed in mycobacterium Infection, seen in 64% of patients with involvement of upper zone in 56% of patients. In 19/25 (76%) of cases a varying combination of upper zone and middle zone involvement was seen.

Nodular pattern, including miliary nodules, was seen in 3/25 12% of patients of pulmonary tuberculosis while volume loss and bronchiectasis were also common occurring observed in 7/25 (27%) and 5/25 (20%) patients of mycobacterial infection.

Cavitation and lymphadenopathy were seen in 6/25 (24%) & 3/25 (12 %) patients of the mycobacterial infections respectively. Our findings were similar to those observed by Tarver et al (2005)[22] who reported upper lobe involvement in 85% of patients and associated lymphadenopathy in 10% of patients and cavitations in 20 % of patients. Eighty percent of cavities were located in the apical and posterior segment of the upper lobe. Nodular opacities were seen in 20 %.of patients with mycobacterial infection.

Lobar consolidation was the most common chest radiographic pattern observed in pyogenic LRTI in our study, seen in 8 out of 15 of patients (53.3%) while multifocal lobular consolidation was seen in 4 out of 15patients (26.6%) with middle and lower zone being involved in 9/15 60% of cases. Volume loss was observed in 3/15 (20 %) and cavitation was also seen in 3/15 (20%) of the pyogenic bacterial infections.

In comparison a study by Syrjala et al (1998)23 reported, bronchopneumonia in a higher percentage of patients on chest radiography, seen in 61.1% patients of community acquired pneumonia. Higher incidence of lobar consolidation among pyogenic bacterial infection in our study could be related to the fact that patients with lobar consolidation are more moribund and hence have higher probability of been referred for CT examination.

In patients with viral LRTI reticulonodular, and reticular were observed with equal frequency, each seen in 33.3% of patients. Multifocal lobar consolidation seen in 16% cases and lobar consolidation was an uncommon finding seen in only 1 case. Lower zone was involved in 83.3% of patients with viral infections.

Cavitation, volume loss and lymphadenopathy were not seen in any of the cases. One out of 8 cases of viral L.RTI had no abnormality on chest radiograph but showed findings on subsequent HRCT.

Our findings were similar to Kim et al (2002)[24] who reported bilateral linear opacities, parenchymal consolidation and diffuse or patchy haze in viral LRTI.

Lobar consolidation and multifocal lobular consolidation were the most common chest radiographic patterns observed in fungal LRTI, seen in 50% and 40% of patients respectively. Upper and middle zone involvement was equally common, seen in 50% of cases of fungal infections. Bronchiectasis was seen in 1/4 (20 %.)

These findings concur with those of Waite et al (2006)[25] and Tarver et al (2005)[22] who reported reticular pattern involving bilateral middle zones on chest radiograph in cases of pneumocystis jiroveci pneumonia

Two patients of fungal infection showed well defined opacity in cavitatory lesion with air crescent sign. Chest x-ray of them also showed few calcified nodular opacity, this finding is agreement with Franquet et al (2001)[26] who stated that aspergilloma is more common in old tubercular cavities and appear as well defined soft tissue opacity in cavitatory lesion with air crescent sign.

One patient of fungal LRTI with aspergillosis showed volume loss and cavitation on chest radiograph findings which are similar to those reported by Tarver et al (2005) [22] in angio-invasive aspergillus infection with nodules and single and multiple areas of homogenous consolidation and cavitation.

HRCT PATTERN:

Of the 50 patients who showed findings suggestive of LRT1 on HRCT the chest radiograph was normal in 3 patients. These patients were finally diagnosed to be of one bacterial, and two viral etiology, We were, thus, able to diagnose three additional cases of LRTI with HRCT (6%).

Syrjala et al (1998)[23] reported 55.3% of additional cases of CAP on HRCT not identified on chest radiograph.

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 chest radiograph at the time of presentation.

In our study consolidation, lobar & multifocal type together, formed the most common pattern of LRTI seen in 39patients comprising 78 % of the positive cases.

Centrilobular nodules formed the second most common HRCT pattern seen in 25/50 cases (50 %) of patients. Centrilobular nodules were associated with tree-in- bud opacities in more than half of patients. Centrilobular nodules were more commonly seen in mycobacterial 16/25 (64%) and fungal infections 3/4 cases (75%) in comparison to pyogenic infection in which centrilobular nodules were present in only 4/15 cases (26.6%)

Poey et al (1997)[27] had reported similar incidence of centrilobular nodules (65%) in patients with bacteriologically confirmed tuberculosis.

Similar to the findings observed in our study, Tanaka et al (1996)[12] reported air space consolidation, ground-glass attenuation, thickening of the bronchovascular bundle, and mosaic attenuation on HRCT in patients of LRTI Similarly bacterial pneumonia frequently showed air space consolidation with segmental distribution seen in 72.2% of patients. Atypical pneumonia frequently showed centrilobular shadow (64.3%)-, acinar shadow (71.4%), air space consolidation and ground glass attenuation with lobular distribution (57.1 and 85.7%, respectively).

Miliary nodules were observed in association with mycobacterial infections cases (4%). Bronchiectasis and peri-bronchovascular thickening were also common findings, seen in 40 % & 48 % of patients respectively.

Largest LRTI group associated with bronchiectasis was mycobacterial infection 12 out of 25 patients i.e. (48%). In comparison to chest radiograph bronchiectasis was detected in 12 addition cases on HRCT.

Mosaic attenuation was most frequently seen in association with viral infections 3/6 cases (50%). Lymphadenopathy was also observed in 6 /50 patients, all of whom had mycobacterial infection. Hence CT was able to detect 3 additional cases with lymphadenopathy not detected on chest radiograph.

Pleural effusion was detected in 9 patients on CT with 5 additional cases being detected over chest radiograph.

In 25 cases of mycobacterial infection, multifocal lobular consolidation formed the most common pattern, seen in 16/25 cases (64 %) of the total cases. The second most common HRCT pattern was presence of centrilobular nodules seen in16/25 cases (64%) of cases. Centrilobular nodules were associated with tree-in- bud opacities in 11/25 (44 %) of patients. Upper lobe involvement was most common, seen in 22/25 (88 %.)

Our findings are in agreement with those of Poey et al27 who studied evolutive pattern and signs of activity of tuberculosis using HRCT. The study confirmed that the areas most commonly involved are apical and posterior segment of the upper lobes as well as the apical segment of the lower lobes with slight preference for the right lung similar to present study. He reported parenchymal consolidation secondary to replacement of alveolar air by exudates in 65% of patients and centrilobular nodules were found in 65% of patients with bacteriologically confirmed tuberculosis. Disappearance of these nodules under treatment was found to be a reliable sign of tuberculosis eradication.

Similar to the above study, our study showed presence of centrilobular nodules in 64% patients of tuberculosis.

Our findings however differ from those of Hatipoglu et al (1996)[28] who described HRCT findings in 32 patients of active tuberculosis, which included centrilobular nodules in 91% of patients; tree-in-bud appearance was seen 71 % of patients, consolidation in 44 % of patients and cavitations in 50% of patients.

However, this study reflected incidence of various findings in active cases. Our study did not correlate well with the above study, as we used no such criteria of activity as our inclusion criteria.

Peribronchovascular thickening and bronchiectasis were also common findings seen in 56% & 48% of patients respectively.

Lymphadenopathy and pleural effusion were noted in 24% & 20 % of patients of mycobacterial infection respectively.

Our findings are in concurrence with those of Traver et al (2005)22 who described the presence of bronchiectasis on HRCT scans in 40% of patients of post primary tuberculosis.

In present study two cases of pulmonary Koch showed 1-2 mm miliary nodules bilaterally in random distribution, similar in appearance to that described by OH et al (1994)29

Hong et al (1998)30 also reported randomly distributed 1-3 mm nodule along with septal thickening (44%), mediastinal lymphadenopathy (30%) and pleural effusion (16%).

In pyogenic infections consolidation, lobar or multifocal type, seen in 93% of cases and was the most common pattern observed. Theanother HRCT pattern was presence of bronchiectasis seen in 26.6. %. Peribronchial thickening was noted in 33.3%. In pyogenic infection involvement of lower lobes was most common, seen in 9 out of 15 patients. Pleural effusion was seen in 3/15 20% of bacterial LRTI.

Similar to our study Shah et al (2000)[31] had demonstrated lobar pattern of consolidation as the most common pattern seen in 81% of patients of CAP while Waite et al (2006)[25] showed lower lobe predominance in Staphylococcus infection similar to the present study.

In our study one case of Gram negative bacilli infection lobar parenchymal consolidation was observed with voluminous inflammatory exudates leading to lobar expansion and abscess and cavity formation,

Our findings were similar to those of Gharib AM (2001)[32] who described the findings in Klebseilla pneumoniae infection as homogenous lobar parenchymal consolidation containing air bronchogram He also described tendency of K. pneumoniae for formation of voluminous inflammatory exudates leading to lobar expansion with resulting bulging of interlobar fissure: a greater tendency for abscess and cavity formation, and a greater frequency of pleural effusion and empyema

Most common HRCT patterns observed with viral infections were ground glass opacity and peri-bronchovascular thickening, each seen in 5 out of 6 of patients (83%) Multifocal lobular consolidation was the second most common pattern seen in 2out of 6 patients (50%). Mosaic attenuation was seen in 50% (3/6 patients) patients. Centrilobular nodules were less commonly observed seen in only 1out of 6 patients. Tree-in-bud pattern was seen in one of the patients. Lower lobe involvement was most commonly observed seen in 4out of 6 patients of viral infections. Marked bronchial wall thickening and ground glass opacity were noted in 1 patient. Present study also included a patient of interstitial lung disease with viral pneumonia showing extensive areas of ground glass opacities bilaterally.

In our study 3 cases out of 6 proved to be H1N1 influenza .One of them have preexisting interstitial lung disease with evidence of honeycombing, showed marked ground glass opacity

These findings are similar to Qureshi NR et al (2006) [33] who reported that the most common CT findings of influenza virus consist of focal, multifocal, or diffuse ground-glass opacities or areas of consolidation. Our findings also coincides with Yuan Y et al (2012)[34] who demonstrated that, The most common imaging finding for lung involvement was GGO with a patchy pattern. Pulmonary involvement of the disease may be extensive and variable.

We included a patient of chronic renal failure on dialysis with viral pneumonia also showing peribronchovascular thickening and bilateral extensive ground glass opacity.

These findings were similar to those reported by Kang et al (1996)[35] and Kim et al (2002) [101]who also reported ground-glass attenuation, nodules, consolidation and irregular linear attenuation in patients of CMV pneumonia.

In fungal infections most common HRCT patterns observed with fungal infections were centrilobular nodules 2 out of 4 cases (50%) & ground glass opacity also seen in 2 cases out of 4 cases (50%)

Lobar consolidation seen in 1/4 cases and multifocal lobular consolidation seen in2/4 cases second most common

pattern. Upper lobe involvement was most commonly observed seen in 3 out of 4 cases (75%). Bronchiectasis was noted in one out of five of patients of fungal infection seen in the case with ABPA with cystic dilatation of airway and mucus plugging resulting in bronchocele formation. In addition centrilobular nodules and peribronchial thickening was noted.

Our findings were similar those observed by Panchal et al (1997)[36] in their study of 23 patients with ABPA; central bronchiectasis could be identified in 85% of lobes and 52% of lung segments. Central bronchiectasis occurred in association with bronchial occlusion due to mucous plugging, air fluid levels in dilated, cystic airways and bronchial wall thickening. Central bronchiectasis was seen in 95% of patients, mucous plugging in 67 % and centrilobular nodules were seen in 93% of cases.

In our study case with pneumocystis pneumonia showed findings of ground glass haze, patchy areas of consolidation and centrilobular nodules, which are in agreement with those of Bergin et al (1990)[37] in a study of 1-4 patients of pneumocystis pneumonia. The study showed predominant HRCT finding of ground glass opacity or consolidation or both.

In another study by Hartmann et al (1994)[38] reported similar CT findings in PCP pneumonia patients including ground glass opacity (92%), patchy areas of consolidation (38%) and centrilobular nodules (25%), cystic change (33%), pleural effusion (17%), and lymphadenopathy in 25% cases.

In our study two patient of aspergillosis showed fibro-calcific cavities with soft tissue density ball within them showing air crescent sign which was favored by Franquet et al (2001)26 who observed that at computed tomography (CT), saprophytic aspergillosis (aspergilloma) is characterized by a mass with soft-tissue attenuation within a lung cavity. The mass is typically separated from the cavity wall by airspace (air crescent sign) and often associated with thickening of the wall and adjacent pleura.

CONCLUSSION:

The following conclusions can be drawn from the study:-

Lower respiratory tract infections showed no obvious age predilection. LRTI were found to be nearly uniformly distributed among all age groups.

Mycobacterial infections were the most common group followed by non- tubercular pyogenic infections.

Lower respiratory tract infection is easily suggested by clinical signs i.e. cough and sputum associated with fever. However, the clinical features cannot be reliably used to identify the causative organism.

Laboratory investigations including raised total leukocyte count observed in association with all etiological groups was also nonspecific. Sputum examination was conclusive in only approximately half of the cases..

Consolidation (lobar / lobular) was the most common chest radiographic pattern observed in Mycobacterial and, pyogenic bacterial and fungal LRTI. Reticulonodular, reticular and multifocal lobular consolidations were observed in viral LRTI.

On HRCT consolidation, lobar & multifocal type together, formed the most common pattern of LRTI. The second most common HRCT pattern was presence of centrilobular nodules.

In cases of mycobacterial LRTI multifocal lobular consolidation formed the most common pattern. The second most common HRCT pattern was presence of centrilobular nodules. Concomitant presence of lobular

Consolidation and centrilobular nodules, was most commonly observed with mycobacterial infection with involvement of upper zones.

In pyogenic infections consolidation, lobar or multifocal type, formed the most common pattern with involvement of mid and lower zones.

Most common HRCT patterns observed with viral infections were ground glass opacity and peribronchovascular thickening followed by multifocal lobular consolidation.

In fungal infections most common HRCT patterns observed with fungal infections were centrilobular nodules and ground glass opacity.

Fungal aspergilloma more commonly seen in old tuberculous cavitatory lesions.

The present study concluded that high resolution computed tomography is an invaluable tool in defining the imaging features of lower respiratory tract infection and characterization of the disease based on various pattern as well as early detection of subtle pathological changes in lung by high resolution computed tomography

References:

1. Mizgerd JP. Lung infection-a public health prioriy PLOS Med 2006;3(2)e 76 (PubMed16401173)
2. Effect of inhaled triamcinolone on the decline in pulmonary function in chronic obstructive pulmonary disease. N Engl J Med 2000; 343: 1902-9.
3. Bartlett JG, Dowell S.F, Mandell L.A. et al. Practice guideline for management of community acquired pneumonia in adult. Clin. Inf, Dis. 31(2000)347.
4. Metlay J. P Kapoor W. N. & Fine MJ: Does this patient community acquired pneumonia? Diagnosing pneumonia by history and physical examination. JAMA278 (1997)1440.
5. Lahde S, Jartti A, Broas M, Koivisto M and Syrjala H. HRCT finding in lung of primary care patient with lower respiratory tract infection. Acta Radiolgica2002, 43:159-163.
6. Boiselle PM, Crans CA Jr Kaplan MA. The changing face of pneumocystitis carinii pneumonia in AIDS patient.AJR 1999;172 1301-1309.
7. Epler GR. Disease of bronchioles, Reven Press, New York 19948 Tanka N. Matsumoto T. Kuramitsu T et al HRCT finding in community acquired pneumonia; J. Comput. Assist. Tomogr. 20 (1996), 600.
8. Lee KS, Song KS, Lim TH, et al. Adult-onset pulmonary tuberculosis: finding on chest radiograph and CT scan. AJR Am J Roentgenol1993; 160:753-758.
9. Sharma SK, Mukhopadhyay S, Arora R, et al. Computed tomography in miliary tuberculosis: comparison with plain films, bronchoalveolar lavage,pulmonary functions and gas exchange. Australas Radiol 1996;40:113-118.
10. Heussel CP, Kauczor HU, Heussel G, et al. Early detection of pneumonia in febrile netropenic patients: use of thin section CT. AJR Am J Roentgenol;1997: 169:967-975.
11. Gordon S Teel, Cristopher E et al: Imaging of small airway disease :Radiographic 1996;16:24-41.
12. Tanka N. Matsumoto T. Kuramitsu T et al. HRCT finding in community acquired pneumonia; J. Comput. Assist. Tomogr. 20 (1996),600.
13. R.Sherwani, K. Aktar, T. Saiddiqui, R Bhargav, S. Zaheer. Bilateral lower zone Shadows on chest radiograph — A olinicopathological profile. Indian J Tuberc 2005; 52: 137-141.
14. B. D. W. Harrison Community-acquired pneumonia in adults in british

Volume : 5 | Issue : 6 | June 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

hospitals in 1982-1983: a survey of etiology, mortality, prognostic factors and outcome. The British Thoracic Society and the Public health laboratory service. Q J Med. 1987 Mar; 62(239): 195-220.Griliner L, Jalonen E, Kallings I, Leinonen M, Orb:mit et al. ateiology, outcome and prognostic factors in community acquired pneumonia requiring hospitalization. Eur Respir J 1990; 3(10): 1105-10.

15. S.K. Sharma, S. Lawaniya, H. Lal, U.B. Singhl and P.K. Sinha2: DOTS Centre at a Tertiary Care Teaching Hospital: Lessons Learned and Future Directions: Indian J Chest Dis Allied Sci 2004; 46: 251-256.
16. Leroy O, Guilley J, Georges H, et al. Effect of hospital-acquired ventilator- associated pneumonia on mortality of severe community-acquired pneumonia. J Crit Care 1999; 14:12-19.
17. Philippart F. Managing lower respiratory tract infections in immunocompetent patients. Definitions, epidemiology, and diagnostic features. Med Mal Infect. 2006; 36(11-12): 538-545.
18. Ian C. Michelow, Kurt Olsen, Juanita Lozano, Nancy K. Rollins, Lynn B. Duffy et al.Epidemiology and Clinical Characteristics of Community-Acquired Pneumonia in Hospitalized Children. Pediatrics 2004; Vol. 113 No. 4: 7017707.
19. Stebbings AE, Lim TK. Causes, treatment and outcome of patients with life threatening hemoptysis. Singapore Med J. 1999; 40 (2): 67-69.
20. Sopena N, Sabria M, Pedro-Botet ML, Manterola JM, Matas L, Dominguez J, et al. Prospective study of community-acquired pneumonia of bacterial etiology in adults. Eur J Olin Microbiol Infect Dis 1999; 18:852-8.
21. Robert D. Tarvera, Shawn D Teague; Darel E Heitkamp ; Dewey J C.cirices. RCNA 2005; 43: 497-512.
22. Syrjala H, Broas M,.Suramor I, et aCHigh-resolution -computed tomography for the diagnosis of community-acquired pneumonia. Clin Infect Dis 1998; 27:358-363.
23. Eun A Kim, Kyung Soo Lee, Steven L. Primack, Hye Kyung Yoon, Hong Sik Byun et al. Viral Pneumonias in Adults: Radiologic and Pathologic Findings Radiographics. 2002; 22:137-149.
24. S.waite, Jeans Jeudy, Charles S. White. Acute lung infections in normal and immunocompromised hosts. RCNA. 2006; 44:295-315.
25. Franquet T, sterm ET. Bronchiolar inflammatory HRCT finding with histopathological correlation. Eur Radiology 1999; 9:1290-1303.
26. Poey, F Verhaegan , J Giron , J lavay sseire, P fajadet and B Dupare. High- resolution chest CT-in tuberculosis. Evolutive pattern and signs of activity. J Compt Assist Tomogr 1997; 21(4) 601 -607.
27. Hatipoglu ON, osma E, Manisali M,et al. hrct findings in pulmonary tuberculosis. Thorax 1996; 51:397-402.
28. Yu Whan OH. Yu Hawan Kim, Nam Joon, Jung Hyuk Kim, Kyoo B Yung Chung et al. High resolution CT appearance of miliary tuberculosis. J Comput Assist Tomogr. 1994 Nov-Dec; 18(6):862-6.
29. Hong, Sung Hwan; Im, Jung-Gi; Lee, Jin Seong; Song, Jae-Woo; Lee, Hak Jong; Yeon, Kyung Mo High Resolution CT Findings of Miliary Tuberculosis:Thoracic imaging.
30. Rosita M. Shai, Sanjay Gupta et al ; Pneumococcal Pneumonia inPatients Requiring Hospitalization: Effects of Bacteremia and HIV Seropositivity on Radiographic Appearance AJR:175, December 2000.
31. Gharib AM, Stern EJ, radiology of pneumonia. Med clin north America.85:1461-1491.2001.
32. Qureshi NR, Hien TT, Farrar J, Gleeson FV. The radiologic manifestations of H5N1 avian influenza. J Thorac Imaging 2006;21:259–64.
33. Yuan et al. (2012) Initial HRCT findings of novel influenza A (H1N1) infection. Influenza and Other Respiratory Viruses 6(601), May 2012.
34. Kang EY, Patz EF, Muller NL. Cytomegalovirus pneumonia in transplant patients: CT findings. J Comput Assist Tomogr 1996; 20: 295.
35. Panchal N, Bhagat R, Pant C. Allergic bronchopulmonary aspergillosis spectrum of computed tomography appearances. Respir med 1997; 91: 213-219.
36. Bergin CJ, VVirth RL, Berry GJ. Pneumocystis carnii pneumonia: CT and HRCT observation. J Comput Assit Tomogr 1990; 14: 756-759.
37. Hartmann TE, Primack SL, Muller NL. Diagnosis of thoracic complications of AIDS: accuracy of CT. AJR Am J Roentgenol.199; 162: 547-553.