Original Research Article

High resolution computed tomography (HRCT) for evaluation of pulmonary manifestations in patients with autoimmune diseases

Abstract

Background: The systemic autoimmune diseases can cause a variety of pulmonary parenchymal, vascular, airway, and pleural abnormalities. The characteristic thoracic manifestations of these diseases are influenced by the underlying autoimmune process. Although many of the complications can be detected at chest radiography, high-resolution computed tomography (CT) has been shown to be superior to radiography in the assessment of the presence and extent of parenchymal, airway, and pleural abnormalities.

Aim of the Work: The aim of this study is to evaluate the radiological findings on HRCT of the lung in patients with autoimmune diseases.

Methods: This retrospective cross- sectional study was carried on 25 patients (18 female and 7 male) ranging from 20-80 years old with autoimmune diseases proved by laboratory and clinical finding attending Tanta university Hospitals. Our patients were referred from chest department to Radiology department (CT units) at Tanta University Hospitals. The period of this study was from May 2020 to May 2021.

Results: Chest complications are common among autoimmune patients , the most frequent chest manifestations was fatigue followed by dyspnea representing 72% and 60% respectively, 40% of patients were presented with cough , The presence of weight loss and clubbing in autoimmune patients with chest manifestations is frequent representing about (24% and 16%) respectively.

Conclusion: HRCT is the imaging technique of choice for evaluation of patients with connective tissue diseases of chest manifestations (pain, shortness of breath, cough), According to HRCT , the most common chest findings was ground glass opacities representing 56% , followed by consolidation and bronchiectasis representing 28% and lastly pericardial effusion represents 4%.

Keywords: Rheumatoid Arthritis, Systemic lupus erythematosus, High-resolution CT

Introduction:

Autoimmune diseases are those in which the body is attacked by its own specific adaptive immune response. In normal, healthy states, the immune system induces tolerance, which is a lack of an anti-self immune response. However, with autoimmunity, there is a loss of immune tolerance, and the mechanisms responsible for autoimmune diseases include type II, III, and IV hypersensitivity reactions. Autoimmune diseases can have a variety of mixed symptoms that flare up and disappear, making diagnosis difficult[(1)] .

Rheumatoid Arthritis (RA) is a chronic inflammatory disease typically involving the small joints of the hands and feet in a symmetric fashion. Extra-articular manifestation of RA is frequent and may occur in virtually all organ systems.[(2)]

The rheumatoid arthritis (RA) can affect multiple organs and tissues including the lung. Several pleuro-pulmonary manifestations are associated with rheumatoid arthritis involving the lung parenchyma, pleura, airways, and vasculature.[(3)]

Systemic lupus erythematosus (SLE) is an autoimmune connective tissue disease, which can affect the skin, joints, kidneys, lungs, nervous system and other organs of the body. Up to now, the exact cause and pathogenesis of this disease remain unclear, which are generally accepted as the results of various factors.[(4)] Due to chest is rich in connective tissue, more than half of SLE patients have varying degrees of chest involvement during the course of the disease , mainly involving pleura, pulmonary interstitium,

pulmonary parenchyma and respiratory muscles.(5)

High-resolution CT (HRCT) of the chest refers to a CT technique in which thin-slice chest images are obtained and post-processed in a high-spatial-frequency reconstruction algorithm. This technique obtains images with exquisite lung detail, which are ideal for the assessment of diffuse interstitial lung disease.(6)

Aim of The Work

To evaluate the radiological findings on HRCT of the lung in patients with autoimmune diseases.

Patients And Methods

Patients:

This retrospective cross- sectional study was carried on 25 patients (18 female and 7 male) ranging from 20-80 years old with autoimmune diseases proved by laboratory and clinical finding attending Tanta university Hospitals. Our patients were referred from chest department to Radiology department (CT units) at Tanta University Hospitals. The period of this study was from May 2020 to May 2021.

Ethics committee approved and informed consent were obtained for all patients or their guardians. Privacy and confidentiality of all patients data were guaranteed, all Data provision were monitored and used for security purpose only.

Inclusion criteria:

Patients with autoimmune disease complaining of chest manifestations (pain, shortening of breath, cough, fatigue and weight loss)

Exclusion criteria:

1-Patients with mixed connective tissue disease (a disorder characterized by features of systemic lupus erythematosus, systemic sclerosis, and polymyositis).

2-Inco-operative patients

3-patient who is not proven to be specific autoimmune disease

1. All patient in this study were subjected to:

A) Complete history taking including:

- Personal history: as regards the name , age and gender ,residence and phone number
- Clinical data for any complain as cough, dyspnea, weight loss,fatigue and clubbing
- Past history of any previous operation, surgical intervention, stroke and trauma were recorded.

B) Clinical examination (By Doctors of chest department) **including:**

- General examination and vital signs (blood pressure and heart rate).
- Chest examination

C) High resolution computed tomography chest (HRCT)

D) Autoantibody tests (anti-nuclear antibody, rheumatoid factor, anti-double stranded antibody (anti-ds DNA).

Duration of study :

Started from May 2020 to May 2021.

Confidentiality :

We put a code number for each case; Names were hidden from any CT film to maintain privacy of participants and confidentiality of the data.

The benefits of the study to the subjects included:

The subjects included in the study gained the benefit of early diagnosis and management of any changes detected in their imaging.

High Resolution Computed Tomography (HRCT) :

Patient safety tips prior to the procedure:

- Wear comfortable, loose-fitting clothing to your exam
- Metal objects including jewelry, eyeglasses, dentures and hairpins may affect the CT images and should be left at home or removed prior to your exam. You may also be asked to remove hearing aids and removable dental work
- Women should always inform their physician or technologist if there is any possibility that they are pregnant.
- You may be asked not to eat or drink anything for several hours before your scan, especially if a contrast material will be used in your exam.

Before starting the imaging, the following steps should be considered :

- For the display of soft tissues, a window level of 40 HU and a window width between 400 and 700 HU were selected; these provide enough contrast between fat and air.
- Patients were placed in the supine position, head first position.
- Scanning is planned from the level of the lung apex down to end of both costophrenic angles in a single breath hold.

During CT scan

At first we explain the examination to the patient. Total immbolization of the patient is of vital importance.

All CT scans were performed by a Toshiba 320 CT unit at Tanta educational hospital and Optima CT 660 GE healthcare 128 slice at General outpatient clinics in Radiodiagnosis and Medical Imaging Department, Tanta University Hospital.

The duration of the procedure varied but the average was less than 1 second.

Patients are imaged in supine position in suspended deep inspiration in the caudal direction from the root of the neck down to the level of the adrenal glands with arms extended overhead to reduce beam hardening artefact. Additional options, useful in many cases, include obtainin inspiratory prone images to differentiate posterior lung disease from dependent atelectasis and end-expiratory images to evaluate for air trapping.

HRCT was reviewed with lung (window width, 2000H; window level, -700H) and soft tissue window (window width, 400H; window level, 40H).

The acquired CT images are reconstructed into soft tissue mediastinal window (20-30 kernel) and lung window (in sharp algorithm, 60-80 kernel) and in 1.2 -1.5 mm section thickness for interpretations. The 60-80 kernel reconstruction becomes the high resolution CT.

The technique includes using thin collimation, usually 1-2 mm, which improves the spatial resolution and coupled with a high spatial frequency reconstruction algorithm which makes the structure visibly sharper. The images are acquired at 10mm interval, thereby considerably reducing the radiation dose.

KVp and Ma per slice: 120kVp and approximately ≤ 240 mA Algorithm available: bone or moderately high spatial frequency.

Intravenous contrast was not used

Results

There is significant value between findings in X – Ray and findings in HRCT in patients with dyspnea significant predictor risk factor p= 0.031

There is significant value between number of cases with consolidation in X – Ray and in HRCT significant predictor risk factor p= 0.009. There is significant value between number of cases with ground glass opacity in x –ray and HRCT Significant predictor risk factor p= 0.001. There is significant value between number of cases with honey comb appearance in x-ray and HRCT Significant predictor risk factor p=0.037.There is significant value between number of cases with bronchiectasis in x-ray and HRCT . Significant predictor risk factor p=0.009. There is significant value between number of cases with interlobular septal thickening in x-ray and HRCT Significant predictor risk factor p=0.037. There is significant value between number of cases with pulmonary nodules in x-ray and HRCT Significant predictor risk factor p=0.004

There is significant value between ground glass opacity and disease duration significant predictor risk factor p= 0.004. There is significant value between reticular or reticulonodular appearance and disease duration significant predictor risk factor p= 0.036

There is significant value between positive RF and HRCT and x –ray chest findings significant predictor risk factor p= 0.001

Result

Table (1): Distribution of the studied cases according to age

Age (year)	**No. of studied cases**	**%**
0 – 20n	0	0
21 – 40	2	8
41 – 60	8	32
61 – 80	15	60
Mean ± SD	60.6 ± 15.2	
Median	65	

Table (2) : Comparison between HRCT and X- ray findings in symptomatic patients

Clinical presentation	**Findings in X- ray**		**Findings in HRCT**		**X^2**	**P value**
	N	%	N	%		
Cough	3	12	7	28	2.001	0.157
Dyspnea	4	16	11	44	4.669	0.031*
Chest pain	3	12	7	28	2.001	0.157
Fatigue	7	28	11	44	1.387	0.239
Weight loss	2	8	4	16	0.759	0.384
Clubbing	1	4	3	12	1.090	0.297

P value for association between clinical presentation and HRCT and X – ray chest findings

*: Statistically significant at $p \leq 0.05$.

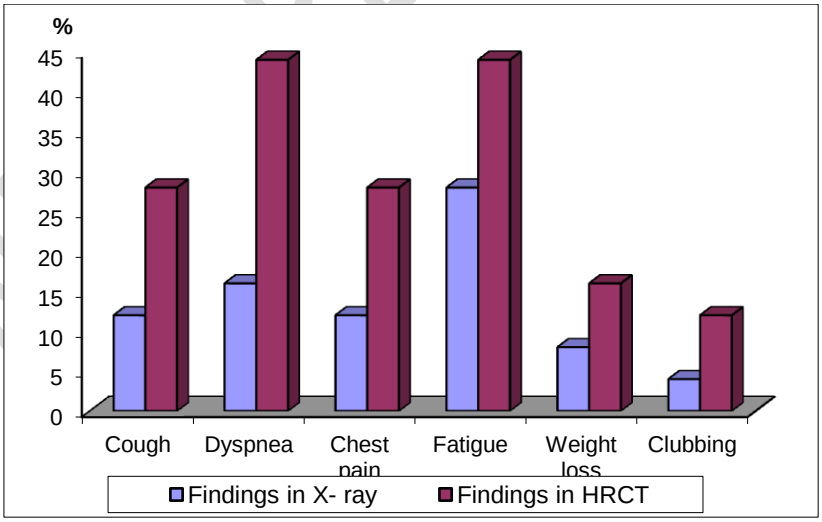


Figure (1) : Comparison between HRCT and X- ray findings in symptomatic patients

Table (3) : Comparison between HRCT and X-ray findings of the studied cases

		Rheumatoid arthritis		Systemic lupus erythematosus		Sarcoidosis		X2	P value
		N	%	N	%	N	%		
Consolidation	HRCT findings	6	24	1	4	0	0	6.821	0.009*
	X-Ray finding	0	0	0	0	0	0		
Ground glass opacity	HRCT findings	9	36	5	20	0	0	10.976	0.001*
	X-Ray finding	0	0	0	0	0	0		
Honey comb appearance	HRCT findings	4	16	0	0	0	0	4.352	0.037*
	X-Ray finding	0	0	0	0	0	0		
Interlobular septal thickening	HRCT findings	4	16	0	0	0	0	4.352	0.037*
	X-Ray finding	0	0	0	0	0	0		
Bronchiectasis	HRCT findings	6	24	1	4	0	0	6.821	0.009*
	X-Ray finding	0	0	0	0	0	0		
Pleural effusion	HRCT findings	4	16	0	0	0	0	0.762	0.384
	X-Ray finding	2	8	0	0	0	0		
Pericardial effusion	HRCT findings	1	4	0	0	0	0	0.0	1.0
	X-Ray finding	1	4	0	0	0	0		
Mosaic sign	HRCT findings	1	4	1	4	0	0	1.016	0.312
	X-Ray finding	0	0	0	0	0	0		
Pulmonary nodules	HRCT findings	7	28	0	0	1	4	8.139	0.004*
	X-Ray finding	0	0	0	0	0	0		
Reticular/Reticulonodular	HRCT findings	6	24	1	4	0	0	0.102	0.747
	X-Ray finding	7	28	2	8	0	0		
Lymphadenopathy	HRCT findings	1	4	0	0	1	4	0.0	1.0
	X-Ray finding	1	4	0	0	1	4		

P value for association between HRCT and X – ray chest findings

*: Statistically significant at $p \leq 0.05$.

Table (4) :Comparison between chest high-resolution computed tomography findings as regards disease duration

Groups Variables	< 5 years (n=4)		5 – 10 years (n=16)		> 10 years (n=5)		X^2	P value
	N	%	N	%	N	%		
Consolidation	2	8	2	8	3	12	5.412	0.067
Ground glass opacity	4	16	5	20	5	20	11.046	0.004*
Honey comb appearance	0	0	2	8	2	8	3.051	0.218
Interlobular septal thickening	1	4	1	4	2	8	3.523	0.172
Bronchiectasis	3	12	3	12	1	4	5.223	0.074
Pleural effusion	2	8	1	4	1	4	4.628	0.099
Pericardial effusion	0	0	1	4	0	0	0.591	0.746
Pulmonary nodules	3	12	3	12	2	8	4.839	0.089
Reticular/Reticulonodular	3	12	2	8	2	8	6.651	0.036*
Lymphadenopathy	0	0	1	4	1	4	1.392	0.498

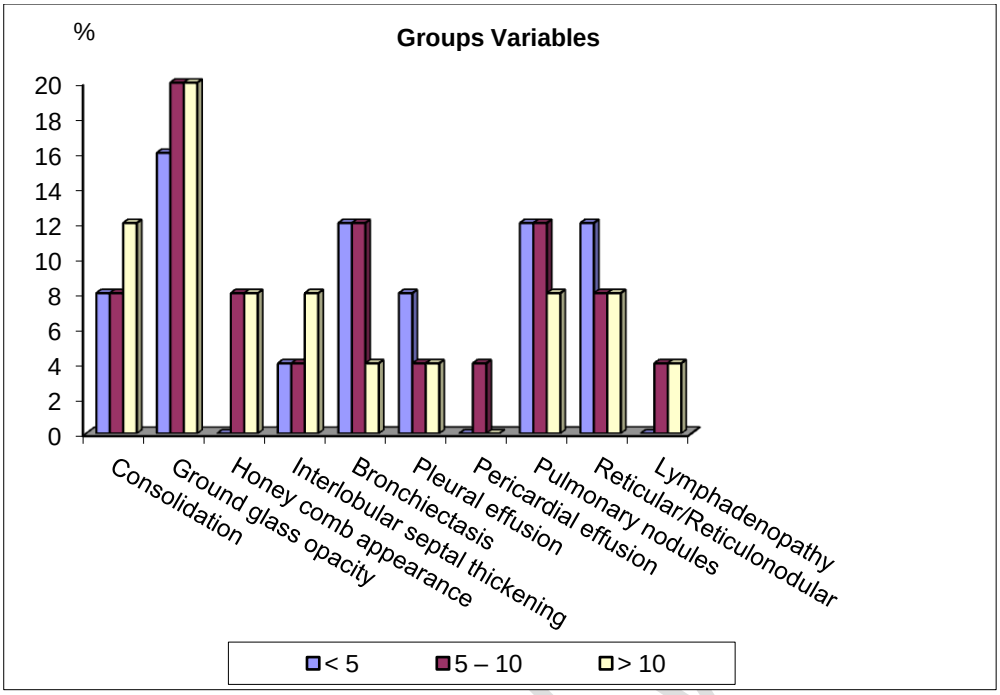


Figure (2) :Comparison between chest high-resolution computed tomography findings as regards disease duration

P value for association between disease duration and HRCT chest findings
*: Statistically significant at $p \leq 0.05$.

Table (5) : Comparison between the lab investigation (Anti- ds DNA) groups and findings in HRCT and X – ray

Anti- ds DNA	Findings in HRCT		Findings in x-ray		X^2	P value
	N	%	N	%		
Negative	3	12	0	0	3.187	0.074
Equivocal	5	20	1	4	3.031	0.082
Positive	17	68	4	16	13.882	0.001*

P value for association between laboratory investigations (Anti-ds DNA) and HRCT and X-Ray chest findings
*: Statistically significant at $p \leq 0.05$.
There is significant value between positive Anti-ds DNA and HRCT and x –ray chest findings
significant predictor risk factor p= 0.007

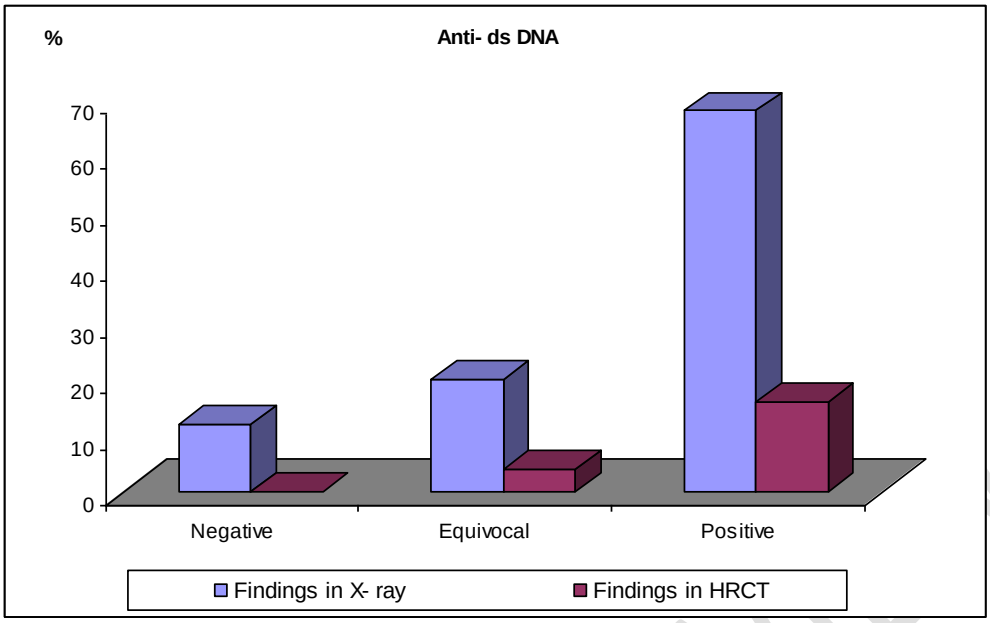


Figure (3): Comparison between the lab investigation (Anti- ds DNA) groups and findings in HRCT and X – ray

Table (6) : Comparison between the lab investiagation (ANA) groups and findings in HRCT and X – ray

ANA	Findings in HRCT		Findings in X-ray		X^2	P value
	N	%	N	%		
Negative	2	8	0	0	2.079	0.179
Equivocal	5	20	1	4	3.031	0.082
Positive	18	72	4	16	15.908	0.001*

P value for association between laboratory investigations (ANA) and HRCT and X-Ray chest findings

*: Statistically significant at $p \leq 0.05$.

There is significant value between positive ANA and HRCT and x –ray chest findings

significant predictor risk factor p= 0.001

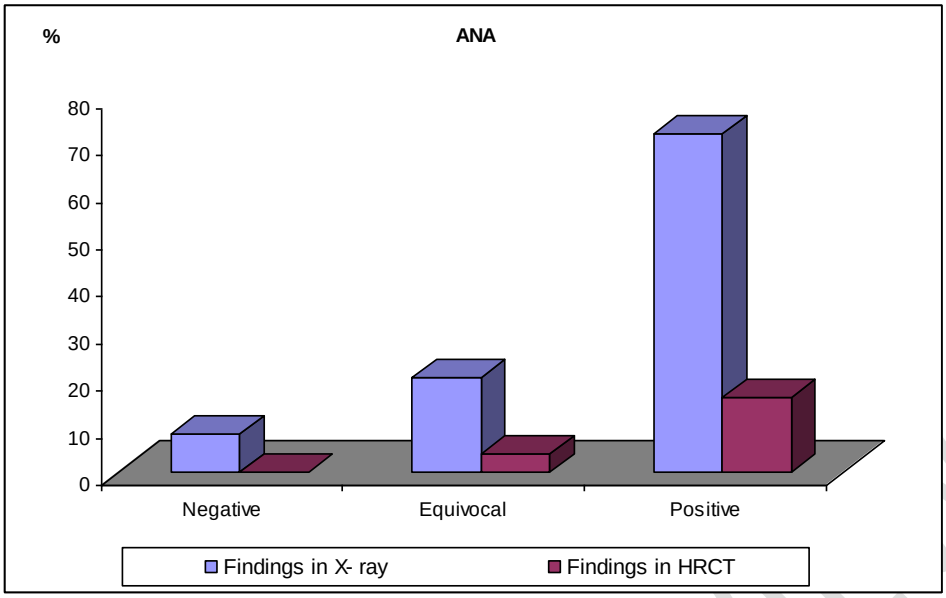


Figure (4): Comparison between the lab investiagation (ANA) groups and findings in HRCT and X – ray

Table (7) : Comparison between the lab investiagation (RF) groups and findings in HRCT and X – ray

RF	Findings in HRCT		Findings in X- ray		X^2	P value
	N	%	N	%		
Negative	3	12	0	0	3.187	0.074
Equivocal	3	12	1	4	1.087	0.297
Positive	19	76	4	16	18.121	0.001*

P value for association between laboratory investigations (RF) and HRCT and X-Ray chest findings

*: Statistically significant at $p \leq 0.05$.

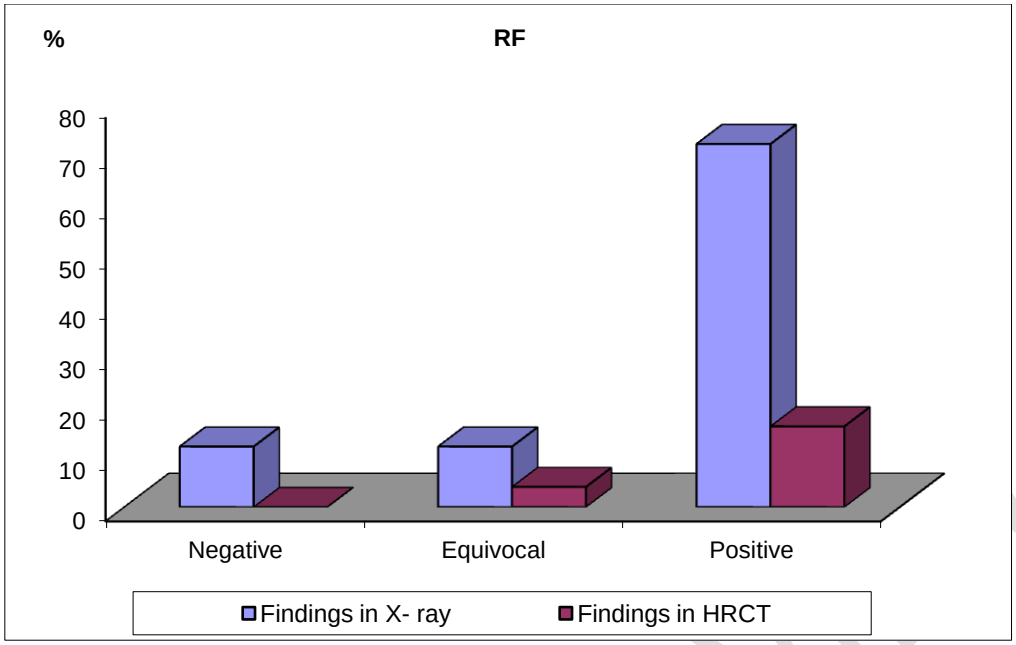


Figure (5): Comparison between the lab investiagation (RF) groups and findings in HRCT and X – ray

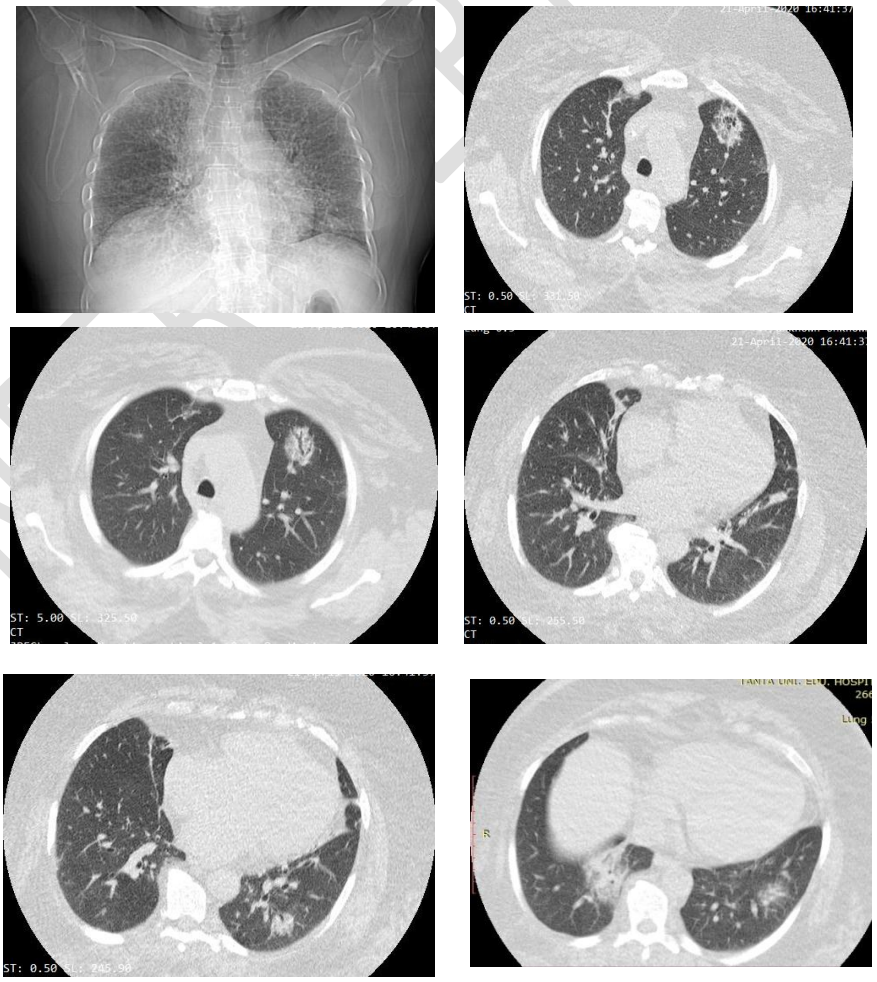
Case (2)

65 – year- old female with history of Rheumatoid Arthritis presented with dyspnea, cough, fatigue.

HRCT shows

Multifocal clearing consolidative patches with central ground glass opacity and air bronchogram with bubbly appearance seen within, predominantly peripheral and peri-bronchial in location, seen at anterior segment of the left upper lobe, posterior segment of left lower lobe and posterior segment of right lower lobe. Focal areas of reticular subinfilterate mountaining tree in bud configuration seen at apico- posterior segment of the left upper lobe, superior segment of the left lower lobe and lateral segment of left lower lobe. Superior ligular and middle lobe sub- segmental atelectasis.

Image 1: These findings in correlation with lab investigations denotes rheumatoid interstitial fibrosis



Case (5)

36 Year – old – female with history of sarcoidosis , presented with cough , fatigue and weight loss.

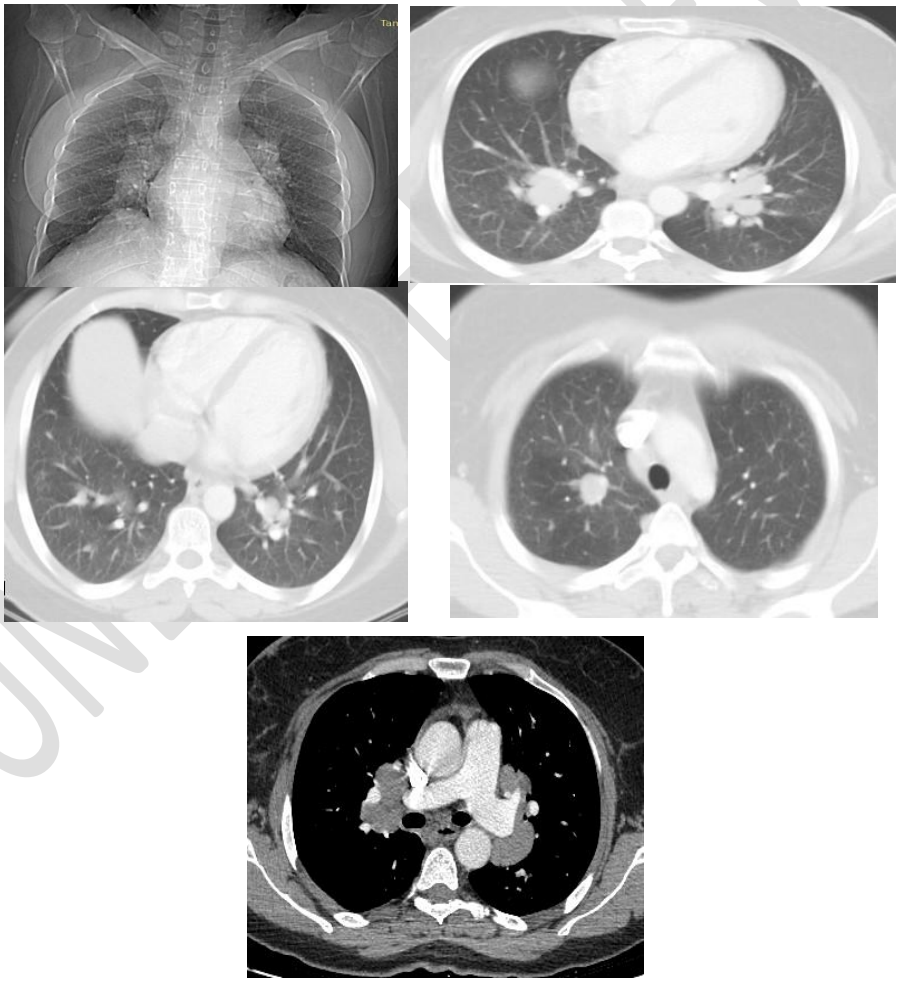
HRCT shows

Multiple variable sized pulmonary and pleural based pulmonary nodules , the largest on right side at anterior segment of right upper lung lobe measures about 2.1 x 1.7 cm with irregular margins, the largest on left side seen at lingual measures about 1.5 x 1 cm.

Bilateral multiple hilar lymph nodes , the largest on right side measures about 6.1 x 3.3 cm and on left side measures about 6.6 x 3.3 cm.

Multiple enlarged mediastinal lymph nodes, retrocaval, prevascular, pretracheal and subcarinal lymph nodes , the largest measures 1.6 x 1.5 cm.

Image 2: These findings in view of history denotes sarcoidosis pulmonary findings



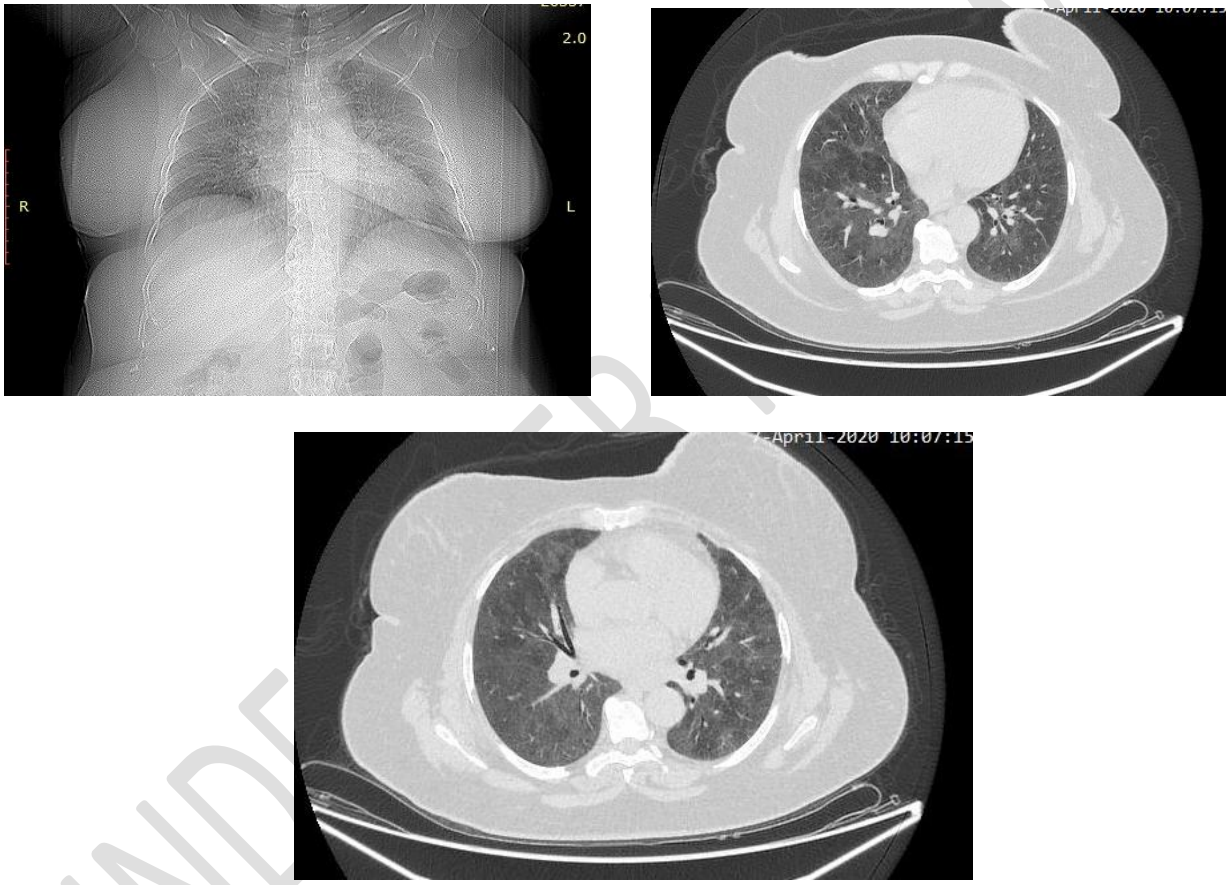
Case (6)

54 year- old- female with history of SLE presented with dyspnea

HRCT shows

Patchy ground glass opacification of both lungs intermelged with hyper and hypo attenuated areas of lung parenchyma giving mosaic appearance.

Image 3: These findings denotes lung parenchymal changes of connective tissue disease in view of history



Case (7)

76 year- old- male with history of rheumatoid arthritis presented with cough and dyspnea

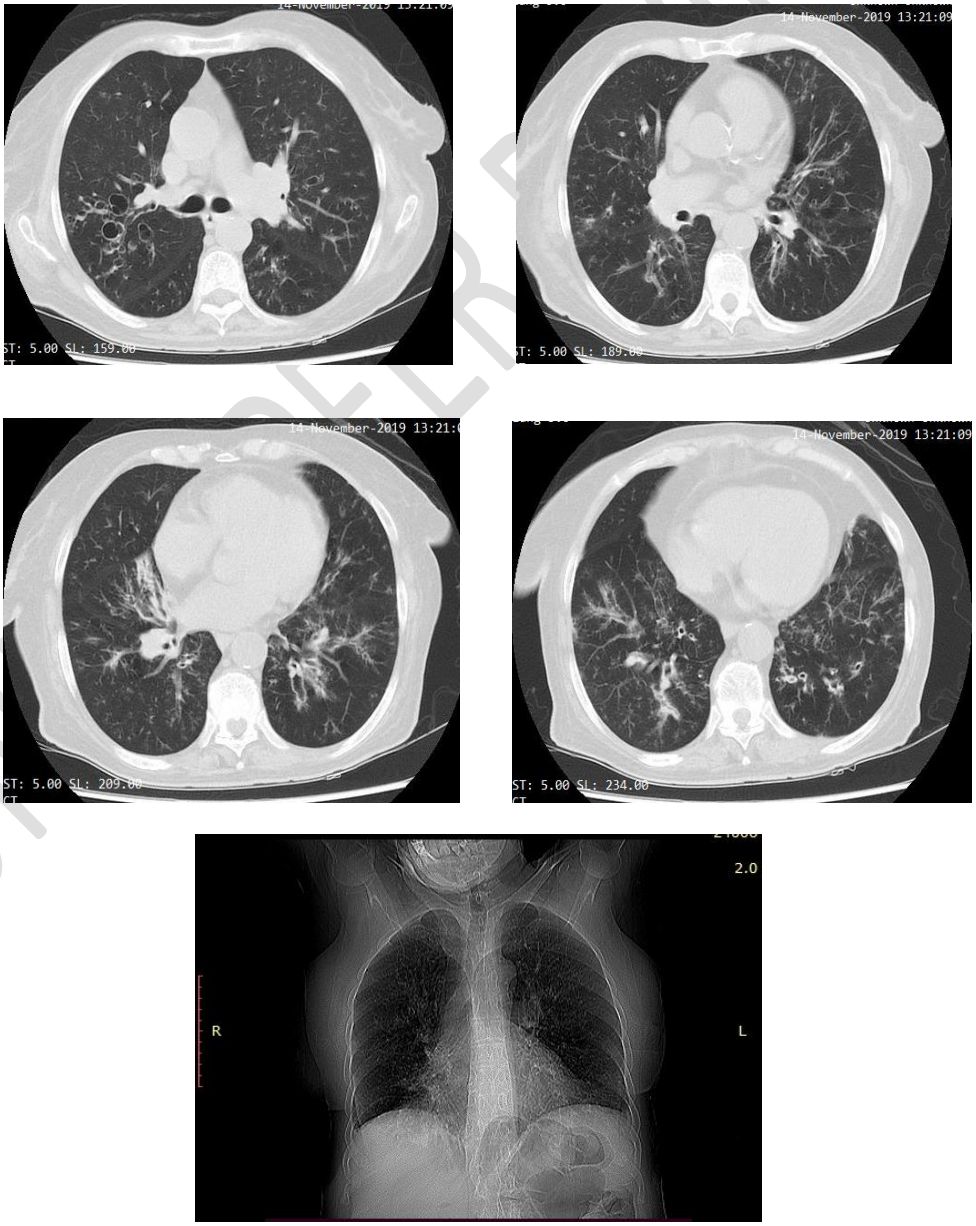
HRCT shows

Well inflated both lung lobes with bilateral bronchiectatic changes.

Centri-lobular nodules some of them give tree in bud appearance.

Multiple small ground glass patches and consolidation with air bronchogram seen within more on right lower lung lobe.

Image 4: These findings in view of history and lab investigations denotes rheumatoid lung parenchymal changes



Discussion

Autoimmune diseases are those in which the body is attacked by its own specific adaptive immune response. In normal, healthy states, the immune system induces tolerance, which is a lack of an anti-self immune response. However, with autoimmunity, there is a loss of immune tolerance, and the mechanisms responsible for autoimmune diseases include type II, III, and IV hypersensitivity reactions. Autoimmune diseases can have a variety of mixed symptoms that flare up and disappear, making diagnosis difficult.(7)

This cross- sectional retrospective study was done on 25 patients (19 rheumatoid representing 76%, 5 SLE representing 20%, 1 Sarcoidosis representing 4%) found that autoimmune diseases was more common in female than male with 72 % in female and 28% in male. This result is nearly similar to Zahra Mirfeizi, Donya Farrokh, Aida Javanbakht study, et al(8), in which the prevalence was 78% in female .

The mean age in this study is 60.6 ± 15.2 which is nearly similar to the study of Abdel Moneim Medhat Elemary , et al in which the mean age is 55.7(9), but different from that of the study of Zahra Mirfeizi, et al[8]. The mean disease duration in this study is 7.52 ± 3.48 which is nearly similar to that of Marie Doualla-Bija, et al (10) in which the mean duration of CTD was 10.1±6.6 years

Connective tissue diseases can cause pulmonary parenchymal involvement as well as vascular and pleural abnormalities due to autoimmune processes. The most frequent types of CTD that affect the pleural cavity are rheumatoid arthritis (RA) and systemic lupus erythematosus (SLE)(11) . Lung disorders can increase morbidity and mortality in these diseases(12). For evaluation of the presence and extent of parenchymal and pleural abnormalities, high-resolution computed tomography (HRCT) has been shown to be more helpful than radiography(13)

HRCT is the imaging technique of choice for evaluation of patients with connective tissue diseases, demonstrating the presence, gross characteristics and distribution of pulmonary disease with greater sensitivity than conventional chest radiographs. In certain clinical circumstances, HRCT findings can suggest a specific diagnostic process

Rheumatoid arthritis (RA) is the most common type of CTD, affecting about 1% of people worldwide. The frequency of pulmonary abnormalities found in association with RA has been shown to vary widely. Pleural involvement, either pleural effusion or pleural thickening is the most common thoracic manifestation of RA. The degree of interstitial lung involvement does not necessarily correlate with the severity of articular involvement. The radiographic findings are often subtle and chest radiographs may be normal or show only honeycombing opacities.

The HRCT findings of interstitial fibrosis in autoimmune disease include ground glass attenuation, subpleural reticular opacities, traction bronchiectasis, architectural distortion, pleural thickening or effusion, and centrilobular micronodules in a predominantly peripheral and basilar distribution.[14]

Linear and reticular opacities are among the most important CT findings in connective tissue disease. Reticular pattern represents thickening of the interlobular interstitium within the secondary pulmonary lobule. In end stage disease, honeycomb pattern may be seen and represents terminal lung disease. Other patterns of pulmonary involvement include nodular opacities, ground glass opacities, air space consolidation and decreased lung opacity such as in emphysema[15]

The most frequent HRCT chest finding in autoimmune diseases in this

study were ground glass opacity similar to the study of Sathi N , et al[16]

Mohd Noor et al[17] study reticulation followed by ground glass opacities was the most common HRCT findings.(18) And different also from that of study of Tanaka et al. reticulation (98%) and Ground Glass opacity (91%) is the most common CT finding followed by traction bronchiectasis (75%), architectural distortion (62%) and honey combing (60%).(19) These differences may be due to variable ethnicity, disease activity and duration of disease in patients.

The most x ray chest finding in rheumatoid arthritis is reticulo-nodular pattern representing 28%

Sarcoidosis is a disease that can involve multiple systems. Thoracic involvement is the most common presentation and accounts for most of the symptoms. In sarcoidosis the most common HRCT findings include: mediastinal and bilateral hilar lymphadenopathy; interstitial lung disease(20), Chest radiographs reveal bilateral hilar lymphadenopathy in 50% to 80% of cases and may show a range of pulmonary parenchymal abnormalities including micronodules (often with a perilymphatic distribution), macronodules (often with a peribronchovascular distribution), reticulonodular opacities, ground-glass changes, and pulmonary fibrosis(21)

In this study x ray of sarcoidosis shows bilateral hilar lymphadenopathy (100%) which is similar to that of the study of Ketaki Utpat, Chinnu Sasikumar, Unnati Desai, et al in which 95% of cases shows bilateral hilar lymphadenopathy(22)

In our study the most common radiological finding in x- ray in autoimmune patients is reticulonodular pattern representing (36%) which is similar to the study of Areca Wangnoo , et al in which reticulonodular pattern is the most common finding in chest x – ray representing 39.3% (23)

In this study we found that there is association between positive RF patients and HRCT findings which is similar to the study of Y. Zhang, et al.(24)

In this study, we found that ESR was associated with pulmonary parenchymal lesions, patients of ESR positive were prone to have pulmonary parenchymal lesions which is similar to the study of Ping Li , et al.(25)

In this study there was 25 cases(100%) with positive HRCT chest findings while 13 cases (52%) only with positive finding in CXR which is different from the results of the study of Fenlon et al. in which about 70% of the patients have HRCT chest findings compared with only about 24% of the patients having CXR findings.(26)

The sensitivity of HRCT in this study representing 100% which is nearly similar to the study of RuiQiang Xin, et al in which sensitivity of HRCT representing 90%. (27)

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