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A STUDY OF IMAGING FINDINGS ON HRCT THORAX IN CORONA VIRUS DISEASE 2019 (COVID-19)

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Abstract: ABSTRACT

INTRODUCTION:

In December 2019, a large outbreak of a novel coronavirus infection occurred in wuhan hubei province, china. The disease caused by the virus, named novel coronavirus disease (COVID-19) by the world health organization (WHO) can be spread through human to human contact. In human coronavirus can cause spectrum of diseases ranging from asymptomatic patient, simple cold cough to severe acute respiratory syndrome (SARS). HRCT is very useful to see the extent of disease spread in lungs and to assess the severity of infection. It also helps in monitoring the response and therapeutic effectiveness and prognosis.

AIMS AND OBJECTIVES: 1]To evaluate the various HRCT thorax Findings in RT-PCR confirmed patients of covid-19 infection. 2] To correlate the findings of HRCT of thorax with patient's clinical symptoms.

METHODOLOGY:

A retro- prospective clinical study was carried out on patients who were referred for HRCT thorax to the Department of Radiodiagnosis, Sheth L.G. general hospital having signs and symptoms of covid-19 and whose RT PCR report was awaited and who had undergone HRCT thorax and only patients who were RT PCR test positive within 72 hours were taken in the study. Total of 250 patients from May 2020 to January 2021, who confirmed covid-19 diagnosis with RT-PCR were taken.

RESULTS

In our study we found, the most common initial CT findings in COVID-19 pneumonia are bilateral, patchy or rounded ground-glass opacities that most frequently occur bilaterally and in the lung periphery with a subpleural basal predominance in left lower lobe. Most common finding were patchy bilateral ground glass opacity most commonly associated with inter and intralobular septal thickening giving crazy paving pattern. Consolidation was also seen with or without GGO suggesting infective etiology.

CONCLUSION

HRCT Thorax may be useful as a standard method for the rapid diagnosis of COVID-19 to optimize the management of severely ill PATIENTS.

Key words: HRCT THORAX IN CORONA

Introduction

On December 31, 2019, the China Health Authority alerted the World Health Organization (WHO) to several cases of pneumonia of unknown aetiology in Wuhan City in Hubei Province in central China.[1] On January 7, a novel coronavirus, originally abbreviated as 2019-nCoV by WHO has since been declared a pandemic by the WHO.[2] It was identified from the throat swab

sample of a patient.[3] This pathogen was later renamed as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by the Coronavirus Study Group and the disease was named coronavirus disease 2019 (COVID-19) by the WHO.[4] SARS-CoV-2 is a member of the family Coronaviridae and order Nidovirales. The family consists of two subfamilies, Coronavirinae and Torovirinae and members of the subfamily Coronavirinae.[1]

Person-to-person transmission is thought to occur among close contacts mainly via respiratory droplets produced when an infected person coughs or sneezes. Fomites may be a large source of transmission, as SARS-CoV has been found to persist on surfaces up to 96 hours and other coronaviruses for up to 9 days.[5,6]

Since the original outbreak, SARS-CoV2 has rapidly spread across the world and, in January 2020, the World Health Organization (WHO) declared COVID-19 a global public health emergency.[7,8] A study indicated the mean incubation period was 5.2 days (95% confidence interval [95%CI]:(4.1–7.0).[9] The incubation period has been found to be as long as 19 or 24 days, although case definitions typically rely on a 14 day window.[10-12]

The incidence of SARS-CoV-2 infection is seen most often in adult male patients with the median age of the patients was between 34 and 59 years.[13,14] with highest proportion of severe cases occurs in adults ≥60 years of age SARS-CoV-2 is also more likely to infect people with chronic comorbidities such as cardiovascular and cerebrovascular diseases and diabetes.[15]

Recombination rates of Coronaviruses are very high because of constantly developing transcription errors and RNA Dependent RNA Polymerase (RdRP) jumps. With its high mutation rate, Coronaviruses are zoonotic pathogens that are present in humans and various animals with a wide range of clinical features from asymptomatic course to requirement of hospitalization in the intensive care unit; causing infections in respiratory, gastrointestinal, hepatic and neurologic systems.[16-18]

Clinical manifestations of 2019-nCoV infection have similarities with SARS-CoV where the most common symptoms include fever, dry cough, dyspnoea, chest pain, fatigue and myalgia.[19,20] The most common symptoms at presentation are fever, fatigue, dry cough, weakness, myalgia, and dyspnea. Less commonly, patients present with headache, hemoptysis, diarrhoea, or pleuritic chest pain.[21]

From current knowledge of the cases, most patients with mild and common symptoms have a relatively good prognosis while cases of death are more frequently seen in severe and critical patients, which could progress to severe pneumonia, ARDS and multiple organ failures leading to higher mortality. Early diagnosis and accurate staging, therefore, are essential in COVID-19 patients.[22]

Throat swabs tested by real-time reverse transcription polymerase-chain-reaction (RTPCR) of viral nucleic acid is regarded as the reference standard[8]. However, previous studies have shown that several defects may limit the clinical application of laboratory tests.[23] In addition, nucleic acid detection cannot accurately determine the severity of disease in COVID-19 patients. However, recent studies addressed the importance of chest computed tomography (CT) examination in COVID-19 patients with false negative RT-PCR results.[24,25] and reported the CT sensitivity as 98%.[26]Additionally, according to the official diagnosis and treatment protocol (6th edition) declared by the National Health Commission of China.[27] CT examination is of great significance not only in diagnosing COVID-19 but also in monitoring disease progression and evaluating therapeutic efficacy.[28]

Hence we conducted a study to evaluate the various HRCT thorax Findings in RT-PCR confirmed patients of covid-19 infection.

Method

Study design:

A retro- prospective clinical study was carried out after taking approval from the review board of the Ethics committee. Patient who were referred for HRCT thorax to the Department of Radiodiagnosis, Sheth L.G. general hospital having signs and symptoms of covid-19 and whose RT PCR report was awaited and who had undergone HRCT thorax test were followed for maximum 72 hours (by telephonic communication) and only patients who were RT PCR test positive within 72 hours were taken in the study. Total of 250 patients from May 2020 to January

2021, who confirmed covid-19 diagnosis with Rt-PCR tests were taken. Signed, written, and informed consent was obtained from all the participants.

Inclusion criteria:

Total of 250 male and female patients reported to the department of radiodiagnosis department with mild or severe symptoms of the covid-19 and who fulfill the following criteria.

- All the patients having suspected signs and symptoms for COVID-19 disease and whose RT-PCR report was awaited and who had undergone HRCT thorax and only patients who were RT PCR test positive within 72 hours were taken in the study.
- All patients with mild, moderate or severe symptoms.
- All patients who follows the criteria of maintaining hygiene and distancing.
- All patients who gives consent for study.

Also, all patients continued to follow the instructions regarding treatment given from physician like medicines, steam, hot water and other advice as to control symptoms.

Exclusion criteria:

- Pregnant females.
- Patients who had undergone HRCT thorax and RT PCR test were negative for corona virus.

Technique :

All the patients reported for the HRCT scan, were kept in supine position and imaged with a 16 slice multi detector CT scanner during full inspiration and plain HRCT thorax study was carried out without injecting any contrast. The scanning parameters were as follows: 120 kilovolt peak, 146 mA, 0.28 s gantry rotation, 16 x 1.5 mm collimation, a 360-mm field of view and 512-mm matrix. Images were reconstructed with a high-spatial-resolution algorithm for parenchymal analysis.

The following pre- validated questionnaire was given to every patient and they were asked to fill the appropriate information.

Questionnaire :

- Name:
- Age:
- Gender:
- Occupation:

- History of: Fever: yes/no

  Cough : yes/no

  Breathlessness: yes/no

  No symptoms:

- Anorexia/weight loss: yes/no
- Associated complaints:
- Past history: similar complain:
- Past history of TB:
- Family history:
- Contact history of Covid positive patient :
- Addiction history- Smoking

  Alcohol
- Allergy: yes/no
- Investigation: Routine investigations:
- RT-PCR test for corona virus :
- Chest x ray :
- CT scan:

Evaluation method:

All the patients with signs and symptoms who underwent thoracic high resolution computed tomography (HRCT) plain study while RT-PCR report was awaited and who came to be positive in RT PCR test within 72 hours after follow up, were included and all the images were reviewed by two highly experienced radiologists who were blind to the clinical records.

- Imaging features were evaluated including following pattern:
  1. Location of the lobe involved : Location of the lobe was divided into

     1)Right- Upper, middle and lower lobe and

2) left upper and lower lobe

2. Number of ground glass opacity lesions: Was divided into 1 lesion, 2 lesions and ≥3 lesions.
3. Imaging manifestation :
   1) GGOs and consolidation: i)Absence of both GGOs and consolidation
      ii)Presence of GGOs with consolidation
      iii)Presence of GGOs without consolidation
      iv)Presence of consolidation without GGOs
   2) Presence of inter and intralobular septal thickening giving crazy paving appearance.
   3) Discrete pulmonary nodules: i) Nodules with halo sign
      ii) Nodules without halo sign
   4) "Reversed halo" sign:
   5) Fibrosis around the lesion:
   6) Air bronchogram sign:
   7) Mediastinal lymphadenopathy:
   8) Other pleural and mediastinal abnormalities : emphysema, cavitation, pleural thickening, pleural effusion

- All the patients were evaluated for CO-RADS to know the level of suspicion of COVID-19 infection.

CO-RADS **Level of suspicion of COVID-19 infection**		
CO-RADS SCORE		**CT FINDINGS**
CO-RADS 1	No	Normal or non-infectious abnormalities
CO-RADS 2	Low	Abnormalities consistent with infections other than covid-19
CO-RADS 3	Intermediate	Unclear whether covid-19 is present
CO-RADS 4	High	Abnormalities suspicious for

		covid-19
CO-RADS 5	Very High	Typical covid-19
CO-RADS 6	RT-PCR+	

- All the patients were also evaluated for CT Severity index and CT Severity score was used for the same out of maximum score of 25.

  Infection severity criteria for single lobe involvement was counted as below:

  5% infected: score 1

  5-25% infected score 2

  25-50% infected score 3

  50-75% infected score 4

  >75% infected score 5

  Each lobe has maximum score 5 and so 5 lobes has maximum score of 25.
- CT severity scoring system was used, divided into mild, moderate and severe categories.

SEVERITY CATEGORY	SCORE (OUT OF 25)
MILD	<8
MODERATE	9- 15
SEVERE	>15

Results:

Table 1: Demographic characteristic of patients

Characteristic	Group	No. of patients	Percentage-% (out of 250 patients)

Age	10-30	60	24%
	31-50	89	35.6%
	51-70	67	26.8%
	71-90	34	13.6%
Gender	Male	135	54%
	Female	115	46%
Symptoms	Fever	169	67.6%
	Breathlessness	128	51.2%
	Weakness	205	82%
	Cough	187	74.8%
	Asymptomatic	27	10.8%
History of TB	-	176	70.4%
Addiction history	Smoking	86	34.4%
	Alcohol	73	29.2%

Table 2: Findings of HRCT

CT Findings	Subgroup	No. of patients	Percentage-% (out of 250 patients)
Lung Involvement	Unilateral	4	1.6%
	Bilateral	228	91.2%
Location of the lobe involved	Right upper	168	67.2%
	Right middle	131	52.4%
	Right lower	110	44%
	Left upper	144	57.6%
	Left lower	203	81.2%
Number of GGO lesions	One	6	2.4%
	Two	18	7.2%
	Three or more	208	83.2%
GGO and consolidation	Absence of both GGOs and consolidation	18	7.2%
	Presence of GGOs with consolidation	44	17.6%
	Presence of GGOs without consolidation	173	69.2%
	Presence of consolidation without GGOs	15	6%
Location of GGO	Predominantly peripheral/subpleural GGO	165	66%
	Central	55	22%

Inter and intralobular septal thickening –crazy paving appearance		165	66%
Discrete pulmonary nodules	Nodules with halo sign	2	0.8%
	Nodules without halo sign	8	3.2%
“Reversed halo” sign		13	5.2%
Fibrosis around the lesion		62	24.8%
Air bronchogram sign		7	2.8%
Mediastinal lymphadenopathy		44	17.6%
Other pleural and mediastinal abnormalities	Emphysema	5	2%
	Cavitation	8	3.2%
	pleural thickening	37	14.8%
	pleural effusion	5	2%

Table 3: CO-RADS SCORE

CO-RADS Level of suspicion COVID-19 infection				
CO-RADS SCORE		**CT FINDINGS**	**NO. OF PATIENTS**	**PERCENTAGE-%(OUT OF 250)**
CO-RADS 1	No	Normal or non-infectious abnormalities	18	7.2%
CO-RADS 2	Low	Abnormalities consistent with infections other tan covid-19	13	5.2%
CO-RADS 3	Intermediate	Unclear whether covid-19 is present	5	2%
CO-RADS 4	High	Abnormalities suspicious for covid-19	41	16.4%
CO-RADS 5	Very High	Typical covid-19	173	69.2%

CO-RADS 6	RT-PCR+		All patients	**100%**

Table 4: CT SEVERITY INDEX SCORE

SEVERITY CATEGORY	SCORE (OUT OF 25)	NO. OF PATIENTS	PERCENTAGE-% (OUT OF 250)
MILD	<8	18	7.2%
MODERATE	9- 15	41	16.4%
SEVERE	>15	173	69.2%

Discussion

Currently, real-time reverse transcription polymerase chain reaction (RT-PCR) performed on respiratory specimens is considered the reference by which to diagnose COVID-19 infection. However, the limitations of RT-PCR, specifically, the fact that it is time-consuming (as it generally takes 48 to 72 hours) and inadequate for the assessment of disease severity.[2] Radiology finding may vary with patient's age, disease progression, immunity status, co morbidity, and initial medical intervention.[29]

Demographic distribution of patients according to age, gender and other symptoms has been described in table -1. Maximum numbers of patient were between 31-50 years of age (35.6%). Male and females were almost equally affected with slight male predominance. (Male- 135/250, 54%). Among all the symptoms weakness was the most common symptom followed by cough and fever were seen. 27 patients (10.8%) were asymptomatic and positive on RT- PCR test and they were having contact history of positive patient. More than half of the patient had history of TB (176 patient- 70.4%).

Most of the patients, 228 (91.2%) had bilateral lung involvement. Left lower lobe of lung was involved in the most cases (203 patients-81.2%), followed by right upper, left upper, right middle and lastly right lower lobe. Maximum number of patients had 3 or more number of ground glass opacity lesions present.

In our study, most common imaging findings were presence of GGO without consolidation (173, 69.2%) followed by GGO associated with inter and intralobular septal thickening giving crazy paving appearance were seen in 165 patients i.e. 66%.

44 patients showed presence of GGOs with consolidation and 15 patients had findings of consolidation without GGO.

165 patients showed presence of GGOs predominantly in subpleural/ peripheral location. Occasionally, they occur centrally in a bronchovascular distribution (22 %) or a combination of both.[30,31]

All the other less frequent findings like nodules with or without halo sign, cavitation, pleural thickening, pleural effusion etc are mentioned in the table. (Table-2).

Upon evaluation with CO-RADS score, maximum number of patient (173- 69.2%) was with CO-RADS -5 score suggesting very high suspicion of typical COVID-19 infection. Among 250 patients, 18 patients had CO RADS-1, even though RT PCR test were positive in these patients. Rests of the CO RADS score were according to table no.3.

As shown in table-4. Highest CT severity index score (> 15 score) was found in 173 patients (69.2%) suggesting 50-75% of lung involvement.

Abnormalities on chest CT-scan were also seen in another study of 6 cases, in which all of them showed multifocal patchy ground-glass opacities notably nearby the peripheral sections of the lungs.[32] Pleural effusion, lung cavitation, lymphadenopathy, and calcification are not typically seen.[33,34] Additionally, the extent of GGO and consolidation in severe and critical were greater

than that of common cases. Similarly, severe and critical cases tend to have higher extent and density scores compared with common type patients by semi-quantitative score system. Therefore, CT findings could accurately evaluate the severity of disease with different clinical types, and provide evidence for the further management.[22]

In conclusion, HRCT thorax is useful as a standard method for the diagnosis of COVID-19 infection based on CT features. Rapid diagnosis can lead to early control of potential transmission.

This study had several limitations. Firstly, the sample size was small especially in the critical type. A larger sample size of COVID-19 patients is thus required for further investigation to compare imaging features among different groups of different clinical types.

Conclusion

In our study we found, the most common initial CT findings in COVID-19 pneumonia are bilateral, patchy or rounded ground-glass opacities that most frequently occur bilaterally and in the lung periphery with a subpleural basal predominance in left lower lobe.

In our study we found that male of 31 to 50 years of age group people are most commonly affected. Patients having history of tuberculosis were affected more severely.

Patients who were asymptomatic but had history of contact of Covid 19 disease positive patient on RT-PCR test and had lung involvement on HRCT thorax were proven to be COVID-19 diseases positive.

Most common finding were patchy bilateral ground glass opacity predominantly in subpleural location and most commonly associated with inter and intralobular septal thickening giving crazy paving pattern most common in left lower lobe. Consolidation was also seen with or without GGO suggesting infective etiology. Nodules were seen in patients having past history of tuberculosis. Fibrosis was seen in 62 patients (24.8%) as a significant finding in positive patient; however it could be due to past tuberculosis or other chronic infection.

Other findings like pleural thickening, cavitation, emphysema or lymphadenopathy were seem to be associated with either old infection like tuberculosis or other past history of diseases or smoking associated findings.

We found that chest CT had a low rate of false negative rate i.e. 18 patients out of 250 total cases (only 7.2%) showed CORADS-1score of COVID-19. Thus patient may have covid-19 infection even though HRCT finding was CO RADS-1. HRCT Thorax may be useful as a standard method for the rapid diagnosis of COVID-19 to optimize the management of severely ill patients. hence, COVID-19 infection cannot be ruled out only by HRCT thorax. RT PCR test and HRCT thorax both has to be used with each other, complimenting each other to diagnose and to evaluate the severity of disease.

COVID-19 is clearly a serious disease of international concern. Disrupting the chain of transmission is considered key to stopping the spread of disease. Imaging plays an important role in the management of COVID-19 patients. Early recognition and isolation of COVID-19 patients is of crucial importance in controlling this outbreak, especially in those with false negative RT-PCR or without symptoms. Thin-slice chest CT helps to achieve a prompt diagnosis, guide

clinical decision-making and in evaluation of the severity of disease thus playing a critical role in the early prevention and control of COVID-19.

FIGURE LEGENDS

1. Axial image showing GGO with inter and intralobular septal thickening in both lower lobes.

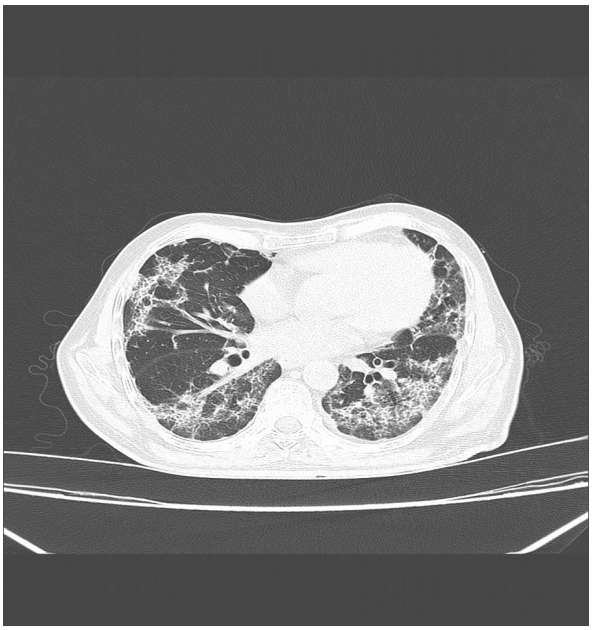
2. Axial image showing GGO with inter and intralobular septal thickening in both lower lobes.

3. Axial image showing Patchy scattered areas of GGO seen in both lung fields.

4. Coronal images showing patchy scatterd patchy area of GGO .

1

2



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