

COVID 19: Spectrum of high-resolution computed tomography chest findings in peripheral district hospital

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Abstract

Background: COVID 19 (Coronavirus Disease 19) caused by SARS CoV 2 (Severe acute respiratory syndrome coronavirus 19). Global pandemic of COVID 19 declared by WHO in March 2020. Its clinical features include fever, dry cough, smell and taste disturbances, myalgia, breathlessness etc. Definitive test for diagnosis of COVID 19 infection is RTPCR (Reverse transcriptase polymerase chain reaction). HRCT chest is a non-invasive, nonoperator dependent effective imaging modality and plays a crucial role in early detection of lung parenchymal, airway, pleural changes. It is very useful tool detect complications of COVID 19 infection. HRCT chest is the imaging modality of choice for the evaluation of the COVID 19 related lung changes. The purpose of our study is to analyse imaging features of COVID 19 infection in detail. **Materials and Methods:** This study was performed in the department of Radio diagnosis of a district hospital of periphery of Maharashtra. 52 random RTPCR positive patients of COVID 19 referred from department of Medicine from November 2020 to January 2021 were included in this study. Subsequently HRCT chest done with 16 slice spiral Toshiba Aquillion scanner. Mediastinal and lung algorithm were used for analysis of the disease. Reconstructed Slice thickness was 1 mm. No intravenous contrast material administered. **Results:** In our study, we divided COVID 19 changes into 4 types. Lung parenchymal, airway, pleural and other changes. In lung parenchymal changes ground glass opacities is the most common feature (63 %) followed by interlobular septal thickening (61 %), crazy paving (42 %), consolidation (38%), band and plate type of atelectasis (40 %), peri lobular opacities (28 %), microvascular dilatation sign (36%), subpleural transparent line (26%) and vacuolar sign (19%). **Conclusion:** HRCT is an excellent modality with high level of accuracy detection of lung changes and complications of COVID 19 infection. It is very good in classifying different stages of the COVID 19 infection. **Key Words:** High resolution computed tomography (HRCT), COVID 19.

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INTRODUCTION

COVID 19 (Coronavirus Disease 19) caused by SARS CoV 2 (Severe Acute Respiratory Syndrome Coronavirus 19).¹ Global pandemic of COVID 19 declared by WHO in March 2020¹. Clinical features of COVID 19 infection include fever, dry cough, smell and taste disturbances, myalgia, breathlessness etc.³ Gold standard test for diagnosis of this disease is RTPCR (Reverse transcriptase polymerase chain reaction).² HRCT chest is a non-invasive, nonoperator dependent effective imaging modality and modality of choice for detection of lung

parenchymal, airway, pleural changes.⁴ Chest CT has a potential role in the diagnosis, detection of complications, and prognostication of coronavirus disease 2019 (COVID-19).⁴

AIMS AND OBJECTIVES

Discuss the key pulmonary, airway and pleural features of COVID-19.

MATERIALS AND METHODS

This study was performed in the department of Radio diagnosis of a district hospital of periphery of Maharashtra. 52 random RTPCR positive patients of COVID 19 referred from department of Medicine from November 2020 to January 2021 were included in this study. Subsequently HRCT chest of these patients done with 16 slice spiral Toshiba Aquillion scanner. Mediastinal and lung algorithm were used for analysis of the disease. Reconstructed Slice thickness was 1 mm. No intravenous contrast material was administered.

RESULTS

Age and sex distribution of patients: Out of randomly selected 52 patients, there were 14 females and 38 males in this study. Males patients exceeded the number of female patients. Range of age in our study was in between 21 years to 75 years.

IMAGING FEATURES:

In our study we divided COVID 19 infection lung changes in to 3 types, i.e. Lung parenchymal changes, airway changes and pleural changes.

LUNG PARENCHYMAL CHANGES

GROUND GLASS OPACITIES: Ground glass opacities are hazy increased opacity of lung, with preservation of bronchial and vascular margins⁵. There is release of cytokines and chemokines in response to the viral infection leads to accumulation of fluid in the alveoli and interstitium⁶. In our study ground glass opacities was present in 33 out of 52 patients (63 %).

Table 1

GROUND GLASS OPACITIES	NO.	Percentage
PRESENET	33	63
ABSENT	19	37

INTERLOBULAR SEPTAL THICKENING:

Interlobular septal thickening is manifestation of the fluid accumulation in the interlobular septa of secondary pulmonary lobule ⁵. In our case study interlobular septal thickening was second most prominent finding i.e. in 32 out of 52 patients (62%).

Table 2

INTERLOBULAR SEPTAL THICKENING	NO.	Percentage
PRESENET	32	62
ABSENT	20	38

CRAZY PAVING: It is combination of ground glass opacities and interlobular septal thickening ⁵. It was present in 22 patients (42%) out of 52 patients.

Table 3

CRAZY PAVING	NO.	PERCENTAGE
PRESENT	22	42
ABSENT	30	58

CONSOLIDATION: It is filling of alveoli by the inflammatory fluid material with non-visualization of the vessels and bronchi ⁵. In our study consolidation was present in the 20 (38%) patients out of 52 patients.

Table 4

CONSOLIDATION	NO.	PERCENTAGE
PRESENT	20	38
ABSENT	32	61

PERILOBULAR OPACITEIES: A perilobular pattern was defined as curvilinear opacities that were of greater thickness and, more important, were less sharply defined than those encountered in thickened interlobular septa, with an arcadelike or polygonal appearances.^{6,7} In our case study perilobular opacities are present in 15 (29%) out of 52 patients.

Table 5

PERILOBULAR OPACITIES	NO.	PERCENTAGE
PRESENT	15	29
ABSENT	37	71

REVERSE HALO: Presence of central ground glass opacity and peripheral consolidation⁵. It is well known feature of the organizing pneumonia and COVID 19 infection^{5,6,7}. In our case series reverse halo sign showed by 4 (7.7 %) patients out of 52 patients.

Table 6

REVERSE HALO	NO.	PERCENTAGE
PRESENT	4	7.7
ABSENT	48	92

ATELECTASIS: Band and plate type or linear type of subsegmental atelectasis is common feature of organizing pneumonia and COVID 19^{5,6}. It is subsegmental collapse of lung parenchyma horizontal or linear to the pleural⁵. This finding was present in 21(40%) out of 52 patients.

Table 7

BAND AND PLATE TYPE OF ATELECTASIS	NO.	PERCENTAGE
PRESENT	21	40
ABSENT	35	67

SUBPLEURAL TRASPARENT LINE: A curvilinear 2-5 cm normal lung parenchyma between visceral pleural-chest wall and the subsegmental band and plate type of atelectasis. It is thin and transparent line. It is sparing of the peripheral subpleural lung⁹. In our study this finding was present in 14 (27%) out of 52 patients.

Table 8

SUBPLEURAL TRASPARENT LINE	NO.	PERCENTAGE
PRESENT	14	27
ABSENT	38	73

VACUOLAR SIGN: Vacuole like sparing usually (less than 5 mm) within the ground glass opacity or consolidation⁹. In our study we found it in 10 (19%) out of 52 patients.

Table 9

VACUOLAR SIGN	NO.	PERCENTAGE
PRESENT	10	19
ABSENT	42	80

MICROVASCULAR DILATATION SIGN: Dilatation of vessel within the ground glass opacity is known as microvascular dilatation sign⁹. It occurs due to inflammatory mediators⁶. In our study this sign was found in 19 (36%) patients.

Table 13

Sr no	Lung parenchymal Imaging features	Number of cases (n)	Percentage (%)
1.	GROUND GLASS OPACITIES	33	63
2.	INERLOBULAR SEPTAL THICKENIGN	32	61
3.	CRAZY PAVING	22	42
4.	CONSOLIDATION	20	38
5.	PERILOBULAR OPACITEIES	15	29
6.	REVERSE HALO	4	7.7
7.	ATELECTASIS	21	40.4
8.	SUBPLEURAL TRASPARENT LINE	14	26
9.	VACUOLAR SIGN	10	19
10.	MICROVASCULAR DILATATION SIGN	19	36
11.	HALO SIGN	0	0
12.	TAEGT SIGN	0	0

AIRWAY FEATURES:

Airway features of COVID 19 includes, bronchial dilatation, air bronchogram and bronchial distortion^{7,10}.

BRONCHIAL DILATATION, BRONCHIECTASIS AND BRONCHIOLECTASIS: Usually bronchial dilatation is feature of chronic disease. The rapid onset of bronchiectasis in COVID patients could be a sign of a rapid and progressive pulmonary fibrotic process triggered by virus infection¹¹. It was present in 24(%) out of 52 patients.

Table 14

BRONCHIAL DILATATION, BRONCHIECTASIS AND BRONCHIOLECTASIS	NO.	Percentage
PRESENT	24	46
ABSENT	28	53

AIR BRONCHOGRAM: Pattern of air-filled bronchi in high attenuation lung (ground glass opacities or consolidation)⁵. In our study we air bronchogram was present in 21 (40%) out of 52 patients.

Table 10

MICROVSACULAR DILATATION	NO.	PERCENTAGE
PRESENT	19	36
ABSENT	33	63

HALO SIGN: Presence central consolidation and peripheral ground glass opacity⁵. In our study none of our patient presents with halo sign.

Table 11

HALO SIGN	NO.	PERCENTAGE
PRESENT	0	0
ABSENT	52	100

TAEGT SIGN: It is new sign described in the COVID 19 infection. It describes presence of central nodular opacity in peripheral ring like opacity⁸. In our case series we could not found target sign.

Table 12

TARGET SIGN	NO.	PERCENTAGE
PRESENT	0	0
ABSENT	52	100

Table 15

AIR BRONCHIOGRAM	NO.	Percentage
PRESENT	21	40
ABSENT	31	59

BRONCHIAL DISTORTION: Bronchus distortion occurs due to absorption of local inflammation and retraction of bronchus⁷. Bronchial distortion was present in 7(13%) out of total 52 patients in our study.

Table 16

BRONCHIAL DISTORTION	NO.	Percentage
PRESENT	7	13
ABSENT	45	86

Table 17

Sr no	Airway features	Number of cases (n)	Percentage (%)
1.	BRONCHIAL DILATATION, BRONCHIECTASIS AND BRONCHIOLECTASIS	24	46
2.	AIR BRONCHIOGRAM	21	40
3.	BRONCHIAL DISTORTION	7	13

PLEURAL FEATURES:

Pleural features of COVID 19 includes pleural thickening, pleural retraction sign or pleural tag and pneumothorax in some patients.^{7,10} Pleura is thickened and retracted due to inflammatory reaction. Pleural is usually involved in late phase of the disease.⁷

PLEURAL THICKENING

Table 18

PLEURAL THICKENING	NO.	Percentage
PRESENT	17	32
ABSENT	35	67

PLEURAL RETRACTION SIGN

Table 19

PLEURAL RETRACTION SIGN	NO.	Percentage
PRESENT	9	17
ABSENT	43	82

PLEURAL EFFUSION: it is uncommon finding in COVID 19 infection⁴. In our study pleural effusion was present in 10(19%) out of 52 patients.

Table 20

PLEURAL EFFUSION	NO.	Percentage
PRESENT	10	19
ABSENT	42	80

PNEUMOTHORAX: It is rare finding in COVID 19⁴. In our study only 2 (3.8 %) patients out of 52 were suffered from pneumothorax.

Table 21

PNEUMOTHORAX	NO.	Percentage
PRESENT	2	3.8
ABSENT	50	96

Table 22

Sr no	Pleural features	Number of cases (n)	Percentage (%)
1.	PLEURAL THICKENING	17	32
2.	PLEURAL RETRACTION SIGN	9	17
3.	PLEURAL EFFUSION	10	19
4.	PNEUMOTHORAX	2	3.8

DISCUSSION

This study included 52 patients with RTPCR positive patients of COVID 19. We analysed the HRCT features of 52 cases COVID 19 and divided them into the 3 types: lung parenchyma, airway and pleural features.

PULMONARY PARENCHYMAL FEATURES

Ground glass opacities were present in 33 (63%) out of 52 patients. It was most common finding in our study. In study conducted by Zhou *et al.*⁷ ground glass opacities are present in 40% patients. Han X *et al.*¹² study ground glass opacities are found in 62 % patients.

Interlobular septal thickening was found in 32(61%) out of 52 patients. It is the second most common finding in our study. In study conducted by Zhou *et al.*⁷ and Han X *et al.*¹² interlobular septal thickening was present in 62% and patients 14 % patients.

Consolidation percentage in our study was 38% (20 patients). In literature review of COVID 19 imaging findings by Ng My *et al.*¹³ consolidation findings were present in 62 % of patients. In study conducted by Zhou *et al.*⁷ and Han X *et al.*¹² consolidations were present in 33-62% and 24 % patients.

In our study **Crazy paving** were present in about 42% (22 patients). By Zhou *et al.*⁷ crazy paving is present in 50% of patients. **Perilobular opacities** percentage in our study was 28% (15 patients), by Parekh M *et al.*¹⁴ perilobular pattern of opacities are seen in more than half of patients of COVID 19.

Reverse halo sign is a feature of organizing pneumonia, and it was seen in 4 (7.7%) out of 52 patients in our study. In study of Bernheim *et al.*¹⁵ this feature found in 20 % patients.

Band and plate type or linear type of subsegmental atelectasis is common feature of organizing pneumonia and COVID 19.^{5,6} It is subsegmental collapse of lung parenchyma horizontal or linear to the pleural⁵. This finding was present in 21(40%) out of 52 patients. In study of Zhou *et al.*⁷ the atelectatic bands were present in 25 % patients. **Subpleural transparent line:** A curvilinear 2-5 cm normal lung parenchyma between visceral pleural-chest wall and the subsegmental band and plate type of atelectasis. It is thin and transparent line. It is sparing of the peripheral subpleural lung.⁹ In our study this finding was present in 14 (27%) out of 52 patients. In study of Zhou *et al.*⁷ this feature was found in 42 % patients. **Vacuolar sign:** Sparing of the alveoli (less than 5 mm) within the ground glass opacity or consolidation.⁹ In our study we found it in 10 (19%) out of 52 patients. In study of Zhou *et al.*⁷ this feature was found in 40 % patients. **Microvascular dilatation sign:** Dilatation of vessel within the ground glass opacity is known as microvascular dilatation sign.⁹ it occurs due to inflammatory mediators.⁶ In our study this sign was

found in 19 (36%) patients. In study of Zhou *et al.*⁷ this feature was found in 47 % patients.

AIRWAY FEATURES

Airway features of COVID 19 includes, bronchial dilatation, air bronchogram and bronchial distortion.^{7,10}

BRONCHIAL DILATATION, BRONCHIECTASIS AND BRONCHIOLECTASIS:

Usually bronchial dilatation is feature of chronic disease. The rapid onset of bronchiectasis in COVID patients could be a sign of a rapid and progressive pulmonary fibrotic process triggered by virus infection.¹¹ It was present in 24(%) out of 52 patients. In study of Zhou *et al.*⁷ and kwee and kwee *et al.*¹⁶ bronchiectasis was seen in 62% and 24 %.

AIR BRONCHOGRAM: Pattern of air-filled bronchi in high attenuation lung (ground glass opacities or consolidation).⁵ In our study we air bronchogram was present in 21 (40%) out of 52 patients. By Kwee and Kwee *et al.*¹⁶ this feature was seen in about 40% of patients.

BRONCHIAL DISTORTION: Bronchus distortion occurs due to absorption of local inflammation and retraction of bronchus.⁷ Bronchial distortion was present in 7(13%) out of total 52 patients in our study. By Zhou *et al.*⁷ this finding was noted on about 10 % of patients.

PLEURAL FEATURES

Pleural features of COVID 19 includes pleural thickening, pleural retraction sign or pleural tag and pneumothorax in some patients.^{7,10}

PLEURAL THICKENING AND RETRACTION:

Pleura is thickened and retracted due to inflammatory reaction. Pleural is usually involved in late phase of the disease⁷. Pleural thickening and retraction is seen in 32 % and 17 % patients respectively in our study. In study of Zhou *et al.*⁷ pleural thickening and retraction noted in 42% and 57 %. In study of Kwee and kwee *et al.*¹⁶ pleural thickening was feature of 34 % patients.

PLEURAL EFFUSION: it is uncommon finding in COVID 19 infection.⁴ In our study pleural effusion was present in 10(19%) out of 52 patients. In study of Zhou *et al.*⁷ and kwee and kwee *et al.*¹⁶ pleural effusion was seen in 2.5 % and 5.2 %.

PNEUMOTHORAX: It is rare finding in COVID 19.⁴ In our study only 2 (3.8 %) patients out of 52 were suffered from pneumothorax. Pneumothorax in COVID patient is usually associated with the positive pressure ventilation though spontaneous pneumothorax can occur.¹⁷

Limitations of our study: Our study had few limitations. We had a relatively a smaller number of patients. Only 52 RTPCR positive patients were included with no follow-up imaging for post infection changes. We did not review chest radiographs. We did not classified patients

according to the stages of COVID 19 infection. We limited our study to HRCT chest as CT is more sensitive to the early changes of COVID 19.

CONCLUSION

In conclusion, the most common lung parenchymal manifestation in coronavirus disease 2019 pneumonia is ground-glass opacities, most common pleural manifestation is pleural thickening and airway features is bronchial dilatation. In summary, this study represents a constellation of findings of all the phases of 2019 SARS coronavirus 2 (2019-SARS CoV 2), with the intention of creating familiarity with common imaging manifestations of the disease. The radiologist plays a crucial role in the rapid identification of early lung, airway and pleural changes, which can be of great benefit not only to the patient but to the larger public health surveillance and response systems.

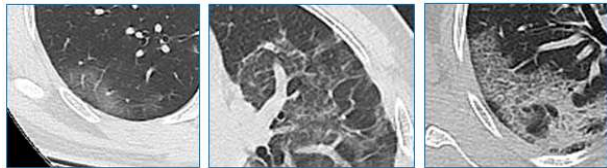


Image A

Image B

Image C

Image A: presence ground galls opacities i.e. increased lung attenuation without obscuration of underlying lung vessels. This is most common finding in COVID 19 Infection; **Image B:** Interlobular septal thickening - thickening of interlobular septa of secondary pulmonary lobule. This image also shows intermixed areas of ground glass opacities; **Image C:** Crazy paving pattern – interlobular septal thickening with ground glass opacities.

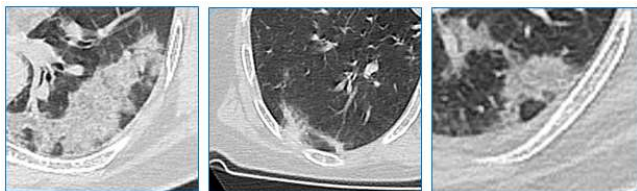


Image C

Image D

Image E

Image C: presence of peripheral consolidation; **Image D and E:** peripheral polygonal thickening / consolidation of interlobular septa or around secondary pulmonary lobule.

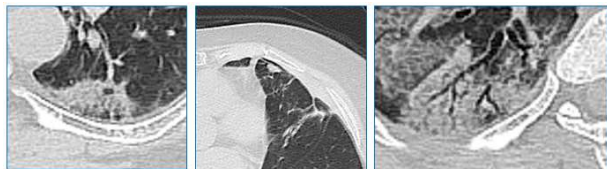


Image F

Image G

Image H

Image F: Sparing of alveoli within the consolidation – giving vacuolar sign; **Image G:** pleural retraction lines and pleural thickening; **Image H:** bronchiolar dilatation and air bronchogram sign.

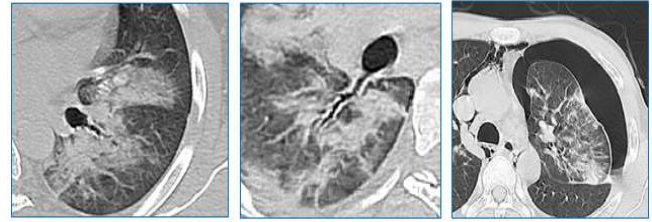


Image I

Image J

Image K

Image I and J: Bronchial wall; **Image K:** Spontaneous pneumothorax and pneumomediastinum without history of barotrauma.

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