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HRCT Imaging Features of the 2019 Novel Corona Virus (COVID-19) Pneumonia

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ABSTRACT

To characterizeand further interpretthe HRCT radiological imaging signs of 2019 novel corona virus (COVID-19) pneumonia in Tamil Nadu. Where HRCT images of129patients who were diagnosed as the COVID-19 pneumoniapositive (on RT PCR)inSaveetha Medical College were included and their radiological imaging features were collected, analyzed and further interpreted, with the results of5cases beingcharacterized as unilateral lung involvement and 118cases as bilateral lung involvement and 6 cases showed no lung involvement on CT, the distribution were mainly subpleural (109) and the rest (14) showing diffuse distribution. And 3 cases with single focus of involvement, 120cases with multifocal involvementand 6cases showed no CT findingsand5 cases were only of pure ground glass opacity (GGO), 112 cases showing GGO associated with interstitial thickening (crazy paving pattern) and28 cases were of dense GGO with consolidatory changes; few of them had accompanying signs such as including vascular thickening (108cases), traction bronchiectasis (65 cases), subpleural bands (43 cases), mediastinal lymphadenopathy (26 cases), pleural thickening (25 cases) and pleural effusion (4 cases). A single RT PCR proven case of COVID

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19 pneumonia showed spontaneous penumomediastinum and pneumopericardium with pericardial thickening.Follow up CT examination was done in 16 patients, 10 of which turned better and 6 became worse, 2 showing complete white out so GGO, interstitial thickening and consolidatory changes are being most common HRCT features of the COVID-19 pneumoniawith, predominantlysubpleuralin distribution.

Keywords: Pneumonia; Ground Glass Opacities; Crazy Paving; Consolidation; Subpleural.

INTRODUCTION

The 2019 novel coronavirus caused an outbreak with a series of pneumonia cases in the Wuhan City, China, in December 2019[1,2,3].Thus, the pneumonia was named novel coronavirus pneumonia (NCP). The total number of positive COVID-19cases which were confirmed worldwide has increased to2,96,302 , out of those4632 have been declared dead, until as of 15th august 2020[4,5].Person to person transmission isprimarily through respiratory secretions and direct contact. Presently,clinical manifestations, close contact with other COVID 19 positive cases of epidemic area, Radiological diagnosis and nucleic acid test form the basis of diagnosing COVID-19 pneumonia[6,7]. Nonetheless, cases may be misdiagnosed on the basis of false negative results and atypical clinical symptoms. Hence, imaging examination attains paramount importance. In this present study, the HRCT radiological images of 129 COVID-19 positive pneumonia patients were accumulated and their radiological imaging features have been examined. The NCP classification is based on its distribution characteristics[8,9,10]Interpretation of CT signs from the viewpoint of anatomy, pathophysiology and immunity was done. This helps in early diagnosis and provides valuable information in the disease progression on subsequent CTs.

METHODOLOGY

A total of129 cases of all ages with a positiveCOVID-19 nucleic acid antibody in Saveetha Medical College from May 19 2020 to August 15, 2020 were included in the study. All the patients underwent HRCT scans of the thorax (slice thickness - 1mm, Spatial resolution -24 Lp/cm). All the HRCT imaging feature were examinedwith a 128-slice scanner (Philips) without infusing contrast material. The radiation doseage for a single scan is 120 kV/30 mA/142 mAs/454.7 mGy·cm.

RESULTS

Of the129 patients, 97 were male and 32 were female. Common symptomsat onset of illness were fever (64 patients), cough (50 patients) and myalgia/fatigue (41 patients)fewer common symptoms included sore throat (21 patients) and the recently evolving presentation of diarrhea (29 patients), and headache (14 patients).

HRCT imaging feature of initial scan

Distribution: -5 cases were characterized with unilateral lunginvolvement and 118 cases showed bilateral lung involvement. 6 cases had no lung involvement on CT. 109 patientsshowed a subpleural distribution and14 showed a diffuse distribution.

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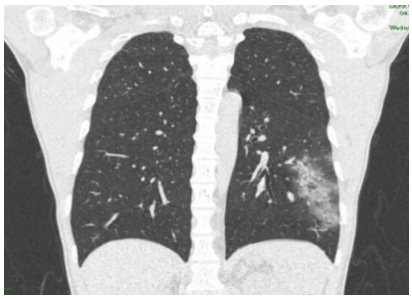
a)  b) 

Figure 1: CT thorax (a) Axial section of both lungs showing bilateral involvement of GGOs, (b) Coronal section showingunilateral distribution of GGOs in the left lung

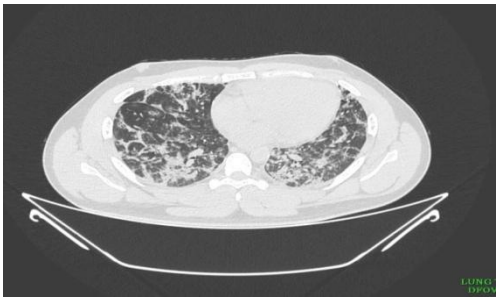
a)  b) 

Figure2: CT Thorax axial sections, (a) showing subpleural pattern of distribution, (b) showing diffuse distribution.

Subpleural distribution: As there is better growth of the secondary pulmonary lobules at the peripheral subpleural area with enriched blood flow and lymphatics, so the inflammatory activity of the lung in the lobular interstitium will be more extreme. NCP predominantlyoccupy the bronchioles and distal parenchyma of lungs, causing inflammatory changesprimarilyat the lobar interstitium. Hence, the distribution will beprimarily in the subpleural area, and being the most usual distribution pattern[11]

Diffuse Distribution: This occurs when lobular and subpleural patterns of distribution overlap. Simultaneously, they then further advance and integrate into a large high-opaque shadow, which involve the whole area of both lungs, owing to a diffuse pattern of distribution[12]

Number: -3 cases were only single focus of involvement, 120 cases with multifocal involvement. 6 cases showed no NECT detectable pulmonary changes.

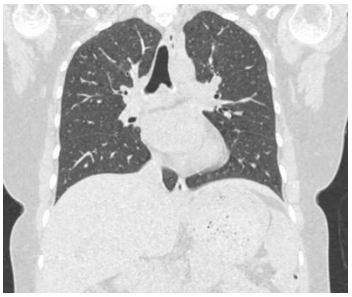
a)  b)  c) 

Figure 3: CT Thorax,(a) Coronal section of both lungs showing unifocalGGO on the right, (b)Multi-focal GGOs bilaterally, (c) No evident parenchymal changes seen bilaterally.

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At very early stages, rarely both lung fields can appear normal with no evident parenchymal abnormality[13]. On the onset of parenchymal changes, the lesions are commonly multiple. However, few of those at a very early stage can commence with a single lung involvement and later increases at follow-up imaging [14].

Density:-5 cases were with pure GGO, 112 cases with GGO & interstitial thickening and28 cases with dense GGO and consolidation.

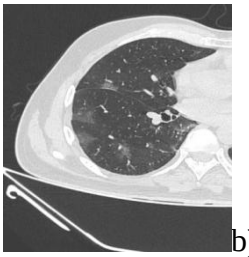
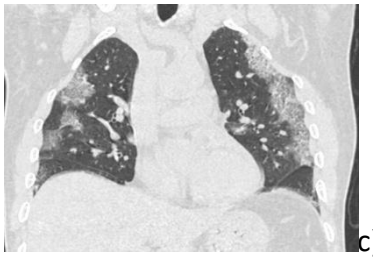
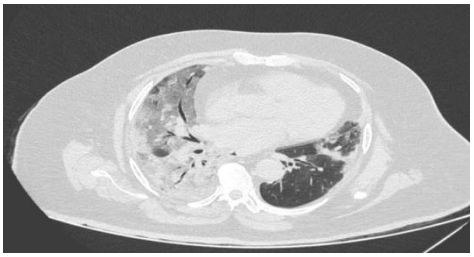
a)  b)  c) 

Figure4: CT Thorax (a) Axial section of right lung showing pure GGO, (b) Coronal section of both lungs showing a peripheral crazy paving pattern, (c) Axial section showing evolving consolidatory changes, more on the right.

Since the viral particles are small, after their inhalation, the large airways are seldom invaded owing to their strong immune function and abundant cilia. The viral particles invade the bronchioles, resulting in bronchiolitis and peripheral inflammation, further spreading to invade the lung tissue [15]. On HRCT image, the early lung changes showed GGO density. With three different forms of densities as: (1) GGO, (2) GGO with interstitial thickening, and (3) Dense GGO withconsolidatory changes. Marginal hazy GGO frequently appears in initial stagedue to inflammatory exudation; then exudation changes to the proliferation, hazy GGO becomes clear GGO with interstitial thickening (crazy paving), then to consolidation, these changes are similar to acute respiratory distress syndrome (ARDS) as initial exudative phase then to the proliferative phase. And later stage, the repair is accompanied by the formation of organization and the consolidation is accompanied by fibrosis, fiber traction and bronchiectasis [16].

Other accompanying signs- Vascular thickening (108 cases), traction bronchiectasis (65 cases), subpleural bands (43 cases), mediastinal lymphadenopathy (26 cases), pleural thickening (25 cases) and pleural effusion (4 cases). Later follow-up HRCT examination on 16 COVID 19 positive patients, 10 cases turned better and 6 became worse.

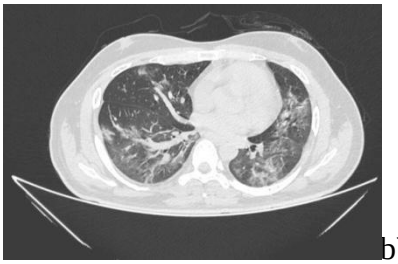
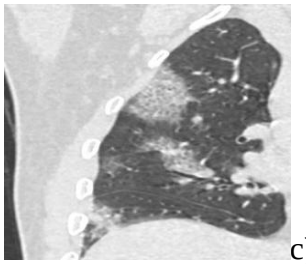
a)  b)  c) 

Figure5: CT Thorax (a) axial sectionshowing vascular thickening, more on the right (b) coronal section of the right lung showing traction bronchiectasis along the middle lobe, (c)left pleural effusion.

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As there is active inflammation. The inflammation results in increased vascular permeability and further relevant pulmonary artery thickening. However, this sign cannotdifferentiatebetween viral and other inflammatory diseases.

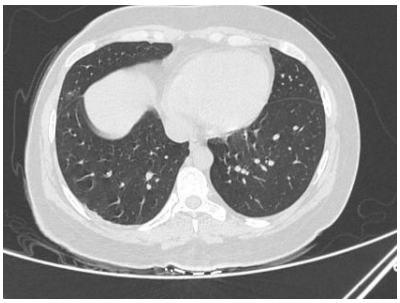
a)  b)  c) 

Figure 6: CT Thorax (a) subpleural bands noted along bilateral lung bases, (b)Prominent mediastinal adenopathy noted, (c)Right costal pleural thickening.

Prominent Mediastinal adenopathy was found predominantly in the critically ill ICU patients with severe form and degree of the disease with the commonest location being subcarinal.

A single 37-year-old male RT PCR proven COVID 19 pneumonia patient with no history of intubation showed evidence of spontaneous pneumomediastinum and pnaumopericardium with pericardial thickening on HRCT images.

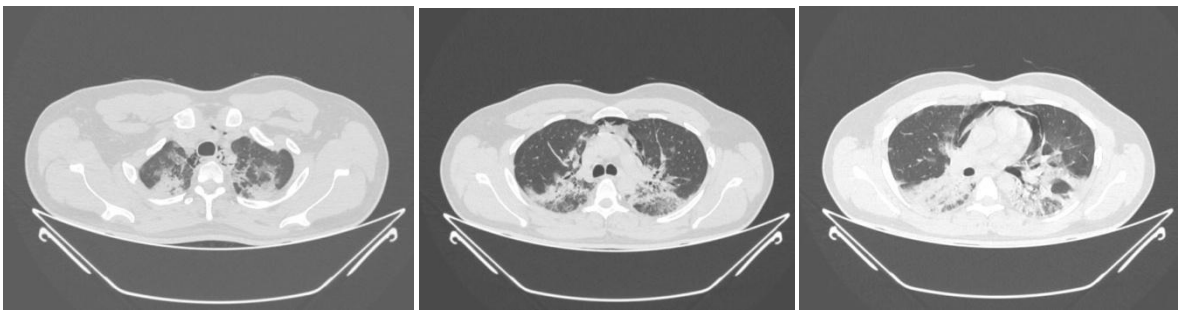


Figure 7: CT serial axial sections of a 37-year-old male (RT PCR proven COVID 19 positive) showing mild pneumomediastinum and moderate pneumopericardium.

Pneumomediastinum is the existence of air or other gas within the mediastinum. Due to rupture of alveoli free air from it escapes dissecting through the bronchovascular bundle to the mediastinum. Among a few patients with spontaneous pneumomdeiastinum and COVID noted in literature, features included a critical clinical course, parameters being affected were increased mean neutrophil counts when compared to other subsets of patients, after being admitted to hospital theythen developed pneumothorax within a span of 14-37 days. With increased levels of severe inflammation for a prolonged period may injure pulmonary parenchyma with further development of pneumomediastinum and/or pneumothorax [17].

Follow-up HRCT imaging Findings:

16 cases were followed up; CT manifestations incases were as follows: (1) The area of lung involvement and the number of GGO or consolidation reduced; (2) the density of GGO further increased to a crazy paving pattern and then dense consolidatory changes.The development of GGO

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into crazy paving and then into consolidatory changespossibly due to the secondary interstitial and alveolar edema, and tissue organization, and partially combined with other bacterial infection. The absorption of GGO, fiber strips, consolidation, or bronchiectasis, and subpleural line thesespecify organization changes. Both GGO and interstitial thickening persist in the transitional phase. Dense GGO and consolidation occur in the laterphase.

Out of 16 cases, 6 patients aggravated, manifesting withfurther increased in area and number of the involvement,In addition, 2 cases which turned as complete “white lung” changes involving both of the lungs associated with regression and mortality.

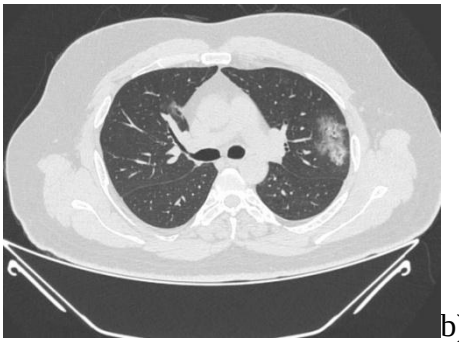
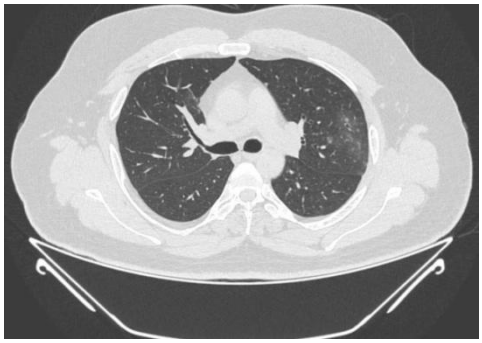
a)  b) 

Figure8: CT axial section of thorax on the (a) 8th and (b) 14th days shows progressive resolution of the density and area of GGOs in left upper lobe.

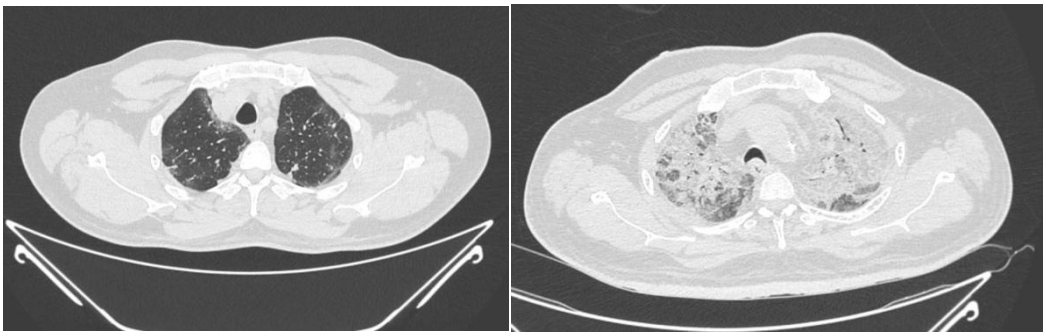


Figure 9: CT axial sections of thorax on the (a) 6th and (b) 13th days showing progression of GGOs to complete white out lungs.

Few limitations in the present study should be acknowledged. As this study is done during the period where there wasinadequate familiarity with the disease. Because of the panic for an unknown pandemic, follow-up HRCT imaging features, ifvery frequent it might have caused harm to other patients. Even though CT examination is veryuseful in early diagnosis, follow-up CT is not completely required and it should be excluded especially for patients with minimal symptoms and to avoid the risk of being transmission.

CONCLUSION:

GGO, interstitial thickening and consolidatory changes are the most common CT signs of COVID-19 pneumonia in the order of disease progression, predominantly with a subpleural distribution. Other accompanying signs, the number, common symptoms and follow up changes have been discussed in the study to develop a reasonable imaging-based idea regarding this pandemic.

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REFERENCES

1. Wu, J., Pan, J., Teng, D., Xu, X., Feng, J., & Chen, Y. C. (2020). Interpretation of CT signs of 2019 novel coronavirus (COVID-19) pneumonia. *European radiology*, *30*(10), 5455-5462.
2. Yang, X., Yu, Y., Xu, J., Shu, H., Liu, H., Wu, Y., ... & Shang, Y. (2020). Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. *The Lancet Respiratory Medicine*, *8*(5), 475-481.
3. Li, Q., Guan, X., Wu, P., Wang, X., Zhou, L., Tong, Y., ... & Feng, Z. (2020). Early transmission dynamics in Wuhan, China, of novel coronavirus–infected pneumonia. *New England journal of medicine*.
4. Velavan, T. P., & Meyer, C. G. (2020). The COVID-19 epidemic. *Tropical medicine & international health*, *25*(3), 278.
5. World Health Organization (August 15, 2020) Coronavirus disease 2019 (COVID-19). Situation report-208: World Health Organization; 2020 https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200815-covid-19-sitrep-208.pdf?sfvrsn=9dc4e959_2
6. Singhal, T. (2020). Review on COVID19 disease so far. *Indian J Pediatr*, *87*(4), 281-6.
7. Shen, M., Zhou, Y., Ye, J., Al-Maskri, A. A. A., Kang, Y., Zeng, S., & Cai, S. (2020). Recent advances and perspectives of nucleic acid detection for coronavirus. *Journal of pharmaceutical analysis*, *10*(2), 97-101.
8. Li, K., Fang, Y., Li, W., Pan, C., Qin, P., Zhong, Y., ... & Li, S. (2020). CT image visual quantitative evaluation and clinical classification of coronavirus disease (COVID-19). *European radiology*, *30*(8), 4407-4416.
9. Bernheim, A., Mei, X., Huang, M., Yang, Y., Fayad, Z. A., Zhang, N., ... & Chung, M. (2020). Chest CT findings in coronavirus disease-19 (COVID-19): relationship to duration of infection. *Radiology*, 200463.
10. Song, F., Shi, N., Shan, F., Zhang, Z., Shen, J., Lu, H., ... & Shi, Y. (2020). Emerging 2019 novel coronavirus (2019-nCoV) pneumonia. *Radiology*, *295*(1), 210-217.
11. Ojha, V., Mani, A., Pandey, N. N., Sharma, S., & Kumar, S. (2020). CT in coronavirus disease 2019 (COVID-19): a systematic review of chest CT findings in 4410 adult patients. *European radiology*, *30*, 6129-6138.
12. Li, Y., & Xia, L. (2020). Coronavirus disease 2019 (COVID-19): role of chest CT in diagnosis and management. *American Journal of Roentgenology*, *214*(6), 1280-1286.
13. Wang, Y., Dong, C., Hu, Y., Li, C., Ren, Q., Zhang, X., ... & Zhou, M. (2020). Temporal changes of CT findings in 90 patients with COVID-19 pneumonia: a longitudinal study. *Radiology*, *296*(2), E55-E64.
14. Meng, H., Xiong, R., He, R., Lin, W., Hao, B., Zhang, L., ... & Geng, Q. (2020). CT imaging and clinical course of asymptomatic cases with COVID-19 pneumonia at admission in Wuhan, China. *Journal of Infection*, *81*(1), e33-e39.
15. Deshmukh, V., Motwani, R., Kumar, A., Kumari, C., & Raza, K. (2021). Histopathological observations in COVID-19: a systematic review. *Journal of Clinical Pathology*, *74*(2), 76-83.
16. Adair II, L. B., & Ledermann, E. J. (2020). Chest CT findings of early and progressive phase COVID-19 infection from a US patient. *Radiology case reports*, *15*(7), 819-824.
17. Taha Mallick, A. D., Engdahl, R., & Sabado, M. (2020). COVID-19 complicated by spontaneous pneumothorax. *Cureus*, *12*(7).