Medical Journal of Eastern Nepal
M B Shrestha et al.Med J of Eastern Nepal.2022 June; 1(1):17-24
https://www.bnchospital.edu.np

Original Article

SPECTRUM OF CHEST COMPUTED TOMOGRAPHY (CT) FINDINGS OF COVID-19 PNEUMONIA PATIENTS IN B & C MEDICAL COLLEGE TEACHING HOSPITAL, BIRTAMODE, JHAPA, NEPAL.

Manmohan Bir Shrestha[1], Umesh Kumar Sharma[1], Suraj Thapaliya[1], Abishek Pokhrel[1], Shreya Shrestha[1], Prajwal Nepal[1], Ujwal Rai[2].

[1]Department of Radiology & Imaging, [2]Department of Pathology, B & C Medical College Teaching Hospital and Research Center, Birtamode, Jhapa, Nepal.

***Corresponding author:** Manmohan Bir Shrestha
Email: macbirshrestha@gmail.com.
***ORCID:** 0000-0002-1786-1611*

Submitted: 25-Feb-2022 ***Revised: 01-March-2022*** ***Accept: 03- March-2022***

ABSTRACT

Background: Coronavirus disease outbreak, first reported in Wuhan, China in December, 2019 is a WHO declared pandemic. Chest tomography (CT) findings can supplement in the diagnosis of COVID-19 pneumonia.
Methods: This was a retrospective descriptive study in 40 patients with reverse transcriptase polymerase chain reaction (RT-PCR) positive patients with respiratory symptoms who underwent Computed tomography (CT) chest. This retrospective study was conducted at B & C Medical College Teaching Hospital, Birtamode, Jhapa, Nepal.
Results: Total 40 patients, more than 3 lobes of lung involved in all 40 patients (100 %). Only ground-glass opacities seen in 11 patients, only consolidative opacities seen in 5 patients, both ground-glass and consolidation seen in 23 patients, and 1 patient had neither of them. Subpleural linear density was present in 16 patients (40%). Pleural effusion was present in 8 patients and crazy paving pattern in 9 patients. Total lung severity score range from 3 to 19 with a mean score of 9.8.
Conclusions: Characteristic chest Computed tomography (CT) findings were observed in Corona virus disease 2019 infection, which are helpful to the radiologists, clinical physicians and other public health officials in the early detection and diagnosis of this global health emergency.

Keywords: Coronavirus infections. Computed tomography. Reverse Transcription Polymerase Chain Reaction. Pneumonia.

INTRODUCTION

Coronavirus disease 2019 infection, the disease that barely needs its introduction worldwide by now is a World Health Organisation (WHO) declared pandemic, caused by Severe acute respiratory syndrome (SARS-CoV 2). Severe acute respiratory syndrome (SARS-CoV 2) infected cases have overtaken the number of cases we saw with Severe acute respiratory syndrome (SARS-CoV) infection. Coronavirus seriously affecting humans was first observed in 2002-3, caused by coronavirus causing severe acute respiratory syndrome (SARS-CoV), and then in 2012 the Middle East respiratory syndrome coronavirus (MERS-CoV) Saudi Arabia[1]. In Wuhan, the capital of central China's Hubei province, an outbreak of Corona virus disease 2019 began on December 2019[2, 3, 4].

The most common symptoms at onset of illness were fever, cough, myalgia or fatigue, sputum production and dyspnea. Whereas the less common symptoms include headache or dizziness, nausea, vomiting and diarrhea[5]. Patients also present with symptoms of anosmia and dysgeusia in Corona virus disease 2019 infection[6].

Chest X-rays have little diagnostic value in early stages of disease and may reveal patchy or diffuse airspace opacities and pleural effusion[7, 8].

Radiological imaging manifestations of Corona virus disease 2019 pneumonia closely resemble other viral pneumonia and mainly include bilateral distribution of ground glass opacities (GGO) with or without consolidation in posterior or peripheral lungs as cardinal findings [9]. An initial prospective analysis in

Wuhan, China in chest Computed tomography (CT) in Corona virus disease 2019 pneumonia showed the most extensive disease approximately ten days after symptom onset [10]. Other than ground glass opacities and consolidation, there is a diverse interesting Computed tomography (CT) spectrum of Corona virus disease 2019 pneumonia and it varies widely in different patients and stages of disease. Typical and predominant chest Computed tomography (CT) findings are ground glass opacities and consolidation in posterior or peripheral lungs. And atypical chest Computed tomography (CT) findings in Corona virus disease 2019 pneumonia include: reticular pattern, crazy paving pattern, air bronchogram, bronchial wall thickening, bronchiectasis, pleural effusion, pleural thickening, subpleural curvilinear line, fibrosis, dilated pulmonary vessels around and within the lesions, nodular opacities, lymphadenopathy and pericardial effusion [11].

Due to a diverse spectrum of chest Computed tomography (CT) manifestations in Corona virus disease 2019 infection, we radiologists, clinical physicians, epidemiologists, virologists and other public health officials should be familiar with the imaging findings of this infection.

After a comprehensive review of published studies and the experience of Corona virus disease 2019 imaging interpretation in frontline, we aim to report the typical and relatively atypical chest Computed tomography (CT) findings of Corona virus disease 2019 infection in B & C medical college teaching hospital, Birtamode, Jhapa.

METHODS

Patient cohort and study design

This was a retrospective observational study from 7th October, 2020 to 22nd January, 2021, conducted in B & C hospital, Birtamode, Nepal. 40 patients with confirmed Corona virus disease underwent chest Computed tomography (CT). All patients were Reverse transcription – polyhmerase chain reaction (RT-PCR) positive for coronavirus via laboratory testing of respiratory secretions obtained by bronchoalveolar lavage, endotracheal aspirate, oropharyngeal swab or nasopharyngeal swab. Consecutive patient selection was done for this study. However, normal chest Computed tomography (CT) and those with any other chronic chest disease as of interstitial lung disease and pulmonary edema were excluded from the study. The ethical approval was obtained from the Institutional Review Committee of B & C Medical College Teaching Hospital & Research Centre (IRC.0062022).

Computed tomography (CT) acquisition protocol

Non-contrast chest Computed tomography (CT) was performed using two Computed tomography (CT) scan machines. Contrast study was done whenever required. Chest Computed tomography (CT) of 22 patients was performed using a SIEMENS Somatom Definition AS+ 128 slice Computed tomography (CT) scanner with slice thickness of 1 mm. And chest Computed tomography (CT) of 18 patients was performed using a GE Brivo CT385 16 slice Computed tomography (CT) scanner with slice thickness of 1.25 mm. All scans were done with the patient in the supine position and acquired in a single inspiratory breath-hold.

Image analysis

All Computed tomography (CT) images were reviewed using a viewing console in both lung window and mediastinal window settings.

For each of the 40 patients, Computed tomography (CT) images was evaluated for the following common characteristics of Corona virus disease 2019 pneumonia: 1) presence of ground glass opacities, 2) presence of consolidation, 3) laterality of lung involvement (unilateral or bilateral), 4) number of lobes involved, 5) degree of lobes involved in addition to overall lung “total Computed tomography (CT) severity score”, 6) axial distribution (central or peripheral), 7) antero-posterior distribution of opacities, 8) subpleural linear density, and 9) crazy paving pattern. Other less common Computed tomography (CT) findings were also noted: 1) nodules, 2) interstitial changes, 3) pleural effusion, 4) pericardial effusion, 5) thoracic lymphadenopathy (short axis>=10 mm), 6) cavitation, 7) bronchial wall thickening, 8) airways secretion, and 9) bronchiectasis. Presence of underlying lung disease was also noted: pulmonary emphysema or fibrosis.

Ground-glass opacification was defined as hazy increased lung attenuation with preservation of bronchial and vascular margins. Consolidation was defined as lung opacification with obscuration of margins of vessels and airway walls[12]. Crazy paving pattern was defined as the appearance of ground glass opacity with superimposed interlobular and intralobular septal thickening [13].

For total lung severity score, each of the five lung lobes was assessed for degree of involvement. The Computed tomography (CT) severity score was calculated based on the extent of lobar involvement. Lobe scoring was done from score ranging from 0 to 5, based on areas involved of each lobe. Score of 0 indicating no involvement, 1 indicating <5% involvement, 2 indicating 5-25% involvement, 3

indicating 26-49% involvement, 4 indicating 50-75% involvement, and 5 indicating > 75% involvement An overall "total lung serevity score" was reached by summing the five lobe scores with a possible range of scores from 0 to 25

RESULTS

Our study included 32 men and 8 women with mean age of 51.7, and age range of 5-85.

Of the 40 patients, 1 patient had opacities in three lobes, 4 patients had opacities in four lobes and 35 patients had opacities in all five lobes of lung. Right upper and middle lobes were involved in 38 patients (95 %). Right lower lobe and left upper lobe were involved in 39 patients (97.5 %). And lower lobe of left lung was involved in all 40 patients.

Regarding antero-posterior distribution of opacities in lungs: 35 patients had both anterior & posterior distribution, out of which 25 had mostly posterior distribution. In 5 patients, only posterior distribution was seen.

On Computed tomography (CT) images, regarding axial distribution of opacities, 34 patients had both central & peripheral distribution and 6 patients had peripheral distribution.

Of the 40 patients, 11 patients had ground-glass opacities only, 5 patients had consolidation only, and 23 patients had both ground-glass opacities & consolidation. Ground-glass opacity and consolidation were absent in 1 patient, in which nodular opacities, cavitation and pleural effusion were seen in Computed tomography (CT) images.

16 (40 %) patients showed subpleural linear density in Computed tomography (CT) images.

Regarding less common chest Computed tomography (CT) findings of COVID-19 infection: nodular lesion was seen in 1 patient, interstitial changes in 14 patients, crazy paving pattern in 9 patients, cavitation in 1 patient, pleural effusion in 8 patients and enlarged mediastinal lymph nodes in 4 patients.

Airways changes, such as bronchial wall thickening, bronchiectasis and airways secretion not seen in all 40 patients.

Pulmonary fibrotic changes were observed in 7 patients (17.5 %).

The mean total severity score was 14.85 with a range of minimum score of 6 and maximum score of 24. Tables

Table 1: Patient Characteristics

GENDER	All patients N=40
Men	32 (80 %)
Women	8 (20 %)
AGE (YEARS)	
Mean	51.7
Range	5-85

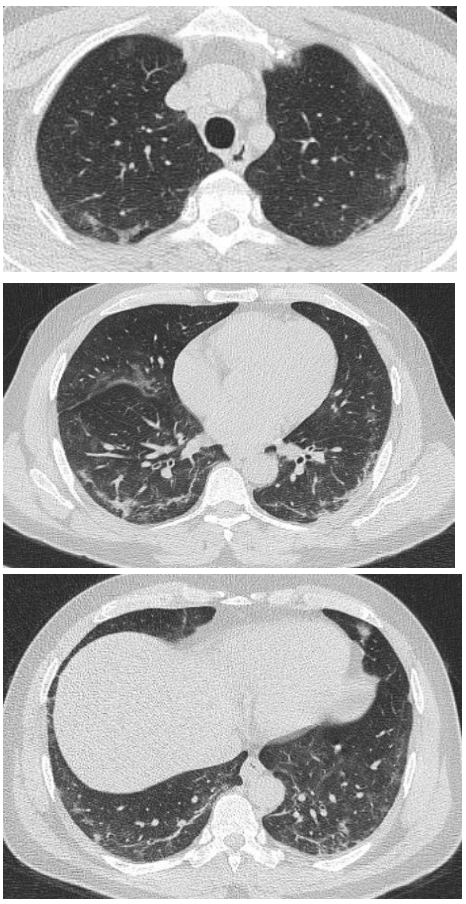

Fig 1:Non-contrast axial Computed tomography (CT) images in a 44-year-old male patient shows bilateral ground-glass opacities and subpleural linear density in all five lobes of both lungs. The distribution of the opacities is strikingly peripheral and mostly posterior.

Table 2: Findings on Chest Computed tomography (CT) in 40 patients

1. UNILATERAL/BILATERAL LUNG DISEASE	
Unilateral	0
Bilateral	40
2. NUMBER OF LOBES AFFECTED	
0	0
1	0
2	0
3	1
4	4
5	35
3. FREQUENCY OF LOBE INVOLVEMENT	
Right upper lobe	38 (95 %)
Right middle lobe	38 (95 %)
Right lower lobe	39 (97.5 %)
Left upper lobe	39 (97.5 %)
Left lower lobe	40 (100 %)
4. ANTERO-POSTERIOR DISTRIBUTION	
Anterior only	0
Posterior only	5
Both	10
Both, mostly posterior	25
5. OPACITY (AXIAL) DISTRIBUTION	
Both central and peripheral	34
Central	0
Peripheral	6
6. GROUND-GLASS OPACITIES AND CONSOLIDATION	
Ground glass only	11
Consolidation only	5
Ground glass and consolidation both	23
Absence of both	1
7. Subpleural linear density/Reticulations/Fibrous stripes	
Present	16
Absent	24
8. OTHER FINDINGS:	
Nodules	1
Interstitial changes	14
Crazy paving	9
Cavitation	1
Pleural effusion	8
Pericardial effusion	0
Mediastinal lymphadenopathy	4
9. AIRWAYS	
Bronchial wall thickening	0
Bronchiectasis	0
Airways Secretions	0
10. UNDERLYING LUNG DISEASE	
Pulmonary emphysema	0
Pulmonary fibrosis	7
11. TOTAL LUNG SEVERITY SCORE	
Mean	14.85
Range	6 to 24

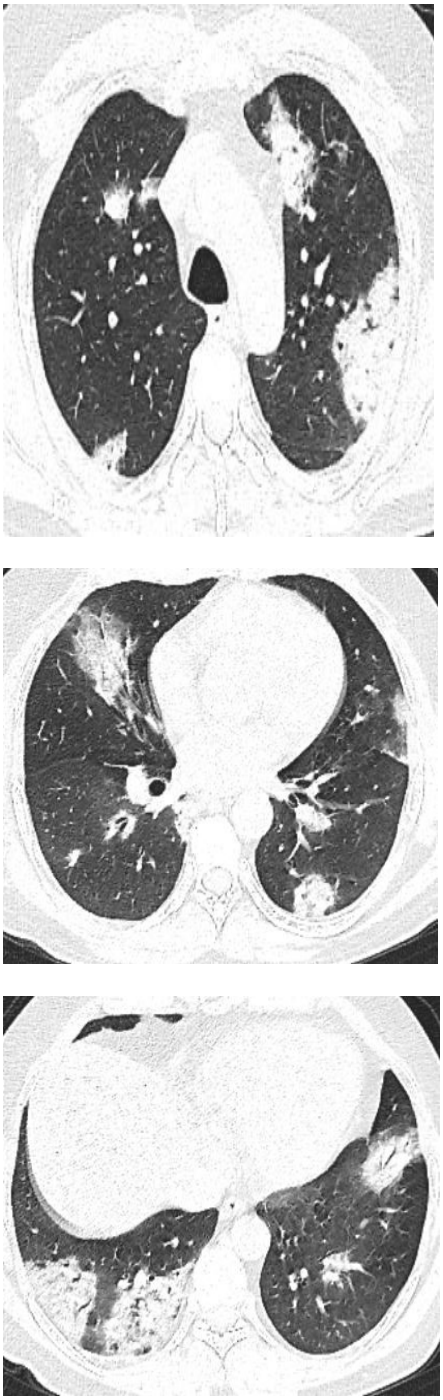

Fig 2: An axial Computed tomography (CT) image obtained without intravenous contrast in a 43-year-old male patient revealed multifocal consolidations with almost rounded morphology in all five lobes of both lungs. No any other typical and less common findings was observed in this patient.

Fig 3: Non-contrast axial Computed tomography (CT) images obtained in a 58-year-old male patient with Corona virus disease 2019 pneumonia shows multifocal diffuse ground-glass opacities and consolidations in both lungs. Computed tomography (CT) images also show interstitial changes with a "crazy-paving pattern". Pulmonary fibrotic changes also observed at medial segment of middle lobe of right lung.

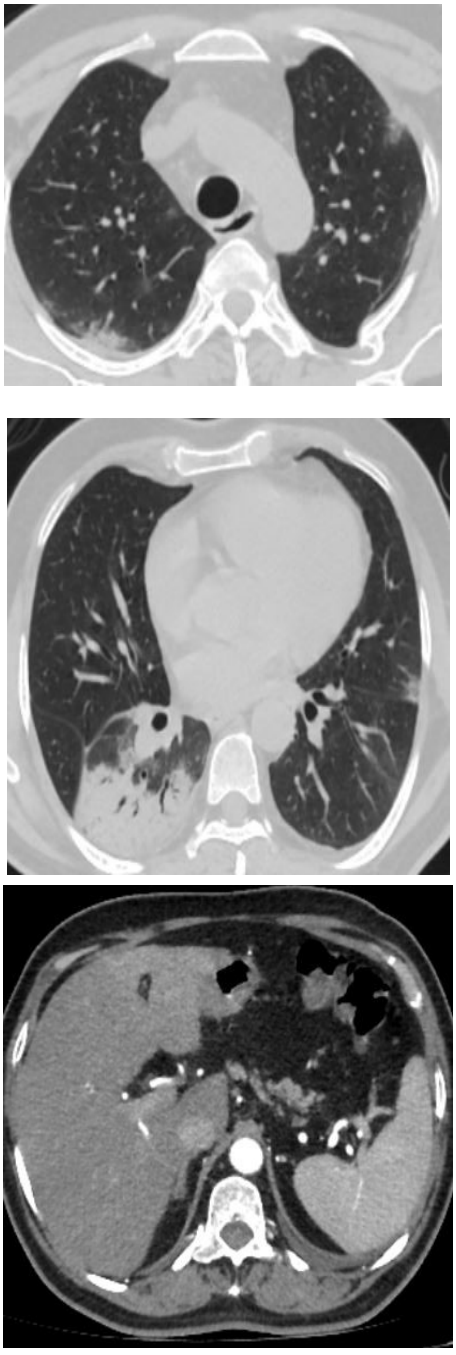

Fig 4: Non-contrast and post intravenous contrast axial Computed tomography (CT) images obtained in a 55-year-old male patient revealed multifocal ground-glass and consolidative opacities in both lungs predominantly in peripheral and posterior distribution. Subpleural linear density observed in left lung. Minimal pleural effusion also noted on left side.

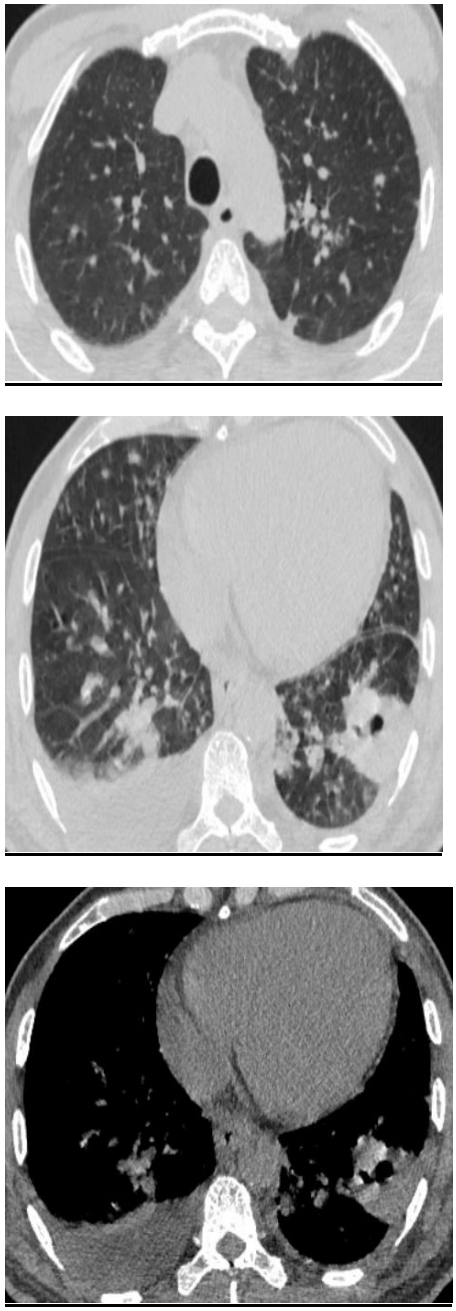

Fig 5: A 62-year-old male patient with Corona virus disease 2019 infection. Axial non-contrast Computed tomography (CT) images shows discrete small nodular opacities in both lungs, sparing upper lobe of right lung. Thick-walled cavitary lesion with smooth inner and outer margins noted at basal region of lower lobe of left lung. Mild amount of pleural effusion also noted on right side.

DISCUSSION

We recorded chest Computed tomography (CT) findings in 40 Reverse transcription polymerase chain reaction (RT-PCR) positive patients for coronavirus, who developed respiratory symptoms and underwent chest Computed tomography (CT).

Our results showed that chest Computed tomography (CT) findings of Corona virus disease 2019 infection is ground glass opacity in the form of pure ground glass opacity (27.5%), ground glass opacity admixed with consolidation (57.5%), or only consolidative opacities (12.5%). Our findings are in concordance with the summary of multiple studies in the systematic review (14).

In our study, we observed lung parenchymal abnormalities on chest Computed tomography (CT) mostly with a bilateral (100%) and peripheral lung distribution. Our results fairly matched with the distribution and type of pulmonary opacities reported in COVID-19 pneumonia, as studied (9, 11).

We observed nodular opacities in 1 patient with Reverse transcription polymerase chain reaction (RT-PCR) proven Corona virus disease 2019 infection. Nodular opacities can also be manifested in chest Computed tomography (CT) findings in Corona virus disease 2019 infection as observed (11, 15, 16).

There are several limitations to our study. Firstly, chest Computed tomography (CT) findings of patients were not correlated with time period of symptomatology. Secondly, co-morbidities and immune status were also not correlated in our study.

CONCLUSIONS

As the disease is globally pandemic at present and with emergence of new cases every day, we radiologists are also evaluating more suspected patients, and interpreting more chest Computed tomography (CT) in those of suspected Corona virus disease 2019 infection. And keeping in mind of possibility of false negative Reverse transcription polymerase chain reaction (RT-PCR) results, we radiologists, clinical physicians, epidemiologists, virologists and other public health officials should be familiar with the typical and atypical imaging findings of this infection.

Thus, we also should keep in mind about the less common chest Computed tomography (CT) findings in Corona virus disease 2019 infections, such as subpleural bands, nodular opacities, interstitial changes, crazy paving pattern, cavitation and pleural effusion.

Funding: None
Conflict of interest: None
Ethical approval: Yes

REFERENCES

1. Ng, L. and Hiscox, J., 2020. Coronaviruses in animals and humans. *BMJ*, p.m634.
2. Bernheim, A., Mei, X., Huang, M., Yang, Y., Fayad, Z., Zhang, N., Diao, K., Lin, B., Zhu, X., Li, K., Li, S., Shan, H., Jacobi, A. and Chung, M., 2020. Chest CT Findings in Coronavirus Disease-19 (COVID-19): Relationship to Duration of Infection. *Radiology*, 295(3), p.200463.
3. Zhu N, Zhang D, Wang W, et al. A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med 2020 January 24 (Epub ahead of print), doi: 10.1056/NEJMoa2001017.
4. Tan WJ, Zhao X, Ma XJ, et al. A novel coronavirus genome identified in a cluster of pneumonia cases - Wuhan, China 2019-2020. China CDC Weekly 2020; 2:61-62.
5. Li, L., Huang, T., Wang, Y., Wang, Z., Liang, Y., Huang, T., Zhang, H., Sun, W. and Wang, Y., 2020. COVID-19 patients' clinical characteristics, discharge rate, and fatality rate of meta-analysis. *Journal of Medical Virology*, 92(6), pp.577-583.
6. Meng, X., Deng, Y., Dai, Z. and Meng, Z., 2020. COVID-19 and anosmia: A review based on up-to-date knowledge. *American Journal of Otolaryngology*, 41(5), p.102581.
7. Cellina, M., Orsi, M., Valenti Pittino, C., Toluian, T. and Oliva, G., 2020. Chest computed tomography findings of COVID-19 pneumonia: pictorial essay with literature review. *Japanese Journal of Radiology*, 38(11), pp.1012-1019.
8. Knipe, H., 2021. *COVID-19 (summary) | Radiology Reference Article | Radiopaedia.org*. [online] Radiopaedia.org. Available at: <https://radiopaedia.org/articles/covid-19-summary?lang=us> [Accessed 6 February 2021].
9. Parry, A., Wani, A. and Yaseen, M., 2020. Spectrum of Chest CT Findings in Coronavirus Disease-19 (COVID-19)

Patients in India with Emphasis on Segmental Pulmonary Changes. *SSRN Electronic Journal*,

10. Pan F, Ye T, Sun P, et al. Time course of lung changes on chest CT during recovery from 2019 novel coronavirus (COVID-19) pneumonia. Radiology 2020 February 13 (Epub ahead of print), doi: 10.1148/radiol.2020200370.
11. Ye, Z., Zhang, Y., Wang, Y., Huang, Z. and Song, B., 2020. Chest CT manifestations of new coronavirus disease 2019 (COVID-19): a pictorial review. *European Radiology*, 30(8), pp.4381-4389.
12. Hansell DM, Bankier AA, MacMahon H, McLoud TC, Müller NL, Remy J. Fleischner Society: glossary of terms for thoracic imaging. Radiology. 2008; 246(3):697-722.
13. Amini, B., 2021. Crazy paving | Radiology Reference Article | Radiopaedia.org. [online] Radiopaedia.org. Available at: <https://radiopaedia.org/articles/crazy-paving?lang=us> [Accessed 6 February 2021].
14. Salehi, S., Abedi, A., Balakrishnan, S. and Gholamrezanezhad, A., 2020. Coronavirus Disease 2019 (COVID-19): A Systematic Review of Imaging Findings in 919 Patients. *American Journal of Roentgenology*, 215(1), pp.87-93.
15. Pan, Y., Guan, H., Zhou, S., Wang, Y., Li, Q., Zhu, T., Hu, Q. and Xia, L., 2020. Initial CT findings and temporal changes in patients with the novel coronavirus pneumonia (2019-nCoV): a study of 63 patients in Wuhan, China. *European Radiology*, 30(6), pp.3306-3309.
16. Ai, T., Yang, Z., Hou, H., Zhan, C., Chen, C., Lv, W., Tao, Q., Sun, Z. and Xia, L., 2020. Correlation of Cheat CT and RT-PCR Testing for Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases. *Radiology,* 296(2) pp.E32-E40