

Original Article

The Role of Computed Tomography in the Management of Patients with Suspected COVID-19 – A Nigerian Study

Abstract

Background: Computed tomography (CT) of the chest is a useful diagnostic adjunct in the management of COVID-19. It has proven useful in areas where ready access to real-time reverse transcriptase polymerase chain reaction (PCR) is not readily available. **Objectives:** This study sought to evaluate the chest CT findings of patients suspected with having COVID-19 on presenting at the emergency room. **Materials and Methods:** This is a retrospective study done in Cedarcrest Hospitals, Abuja, with patient information pooled from patients' electronic medical records from April to December 2020. Patients were selected based on suspicion of COVID-19 infection. Suspicion was stratified into high, moderate, and low using an in-house clinical suspicion score called the Cedarcrest Emergency COVID-19 Risk Assessment Tool. Patients with background pulmonary pathology or chest trauma were excluded. Plain chest CT scans were performed to evaluate for COVID-19 pneumonia. **Results:** CT imaging increased the clinical suspicion of COVID-19. However, no statistically significant relationship was found between the positive CT findings and the PCR results. **Conclusion:** Chest CT should be correlated with clinical findings and laboratory results for patient evaluation.

Keywords: Chest, computed tomography, COVID-19, pneumonia

Introduction

COVID-19 is an infectious disease caused by a novel pathogenic human coronavirus, a type of RNA virus, belonging to the family of coronaviruses, leading primarily to a pneumonia.^[1] It was first identified in Wuhan, Hubei Province, China in December 2019 and has since spread to all continents.^[1] On January 30, 2020, the World Health Organization announced that the outbreak of COVID-19 had become a Public Health Emergency of International Concern and further declared it a global pandemic on March 11, 2020. Vaccines have more recently become available and have been deployed to many countries. The incubation period ranges from 1 to 14 days, with most people developing symptoms between 3 and 7 days and clinical severity varies significantly.^[2,3]

Real-time polymerase chain reaction (RT-PCR) is the gold standard for diagnosis of COVID-19.^[3] Its availability for COVID-19 testing is, however, limited and turnaround times are long. Chest imaging is a useful adjunct for diagnosis

and is done mainly by chest X-rays and computed tomography (CT), with CT having a higher sensitivity.^[4] These can be done quickly and noninvasively and provides insight for diagnosis, isolation, evaluation of severity, complications, and disease progression.^[5]

Our study seeks to clarify the role of CT in the management of COVID-19 patients and to correlate the CT findings with the clinical findings to further help clinicians screen for suspected COVID-19 cases and evaluate the confirmed cases.

Materials and Methods

This study is a retrospective study that includes patients evaluated in our emergency room between April and December, 2020, and suspected to have COVID-19. With ethical approval from the FCT Health Research Ethics Committee, approval no: FHREC/2020/01/115/04-11-2020, patient data were reviewed and the clinical components and laboratory results were obtained. Clinical characteristics were standardized by a locally developed COVID-19 Risk Assessment

Olubukola Khadija Ajiboye,
Ohiole Ayeni¹,
Oludolapo Sherifat Katibi²,
Umami Musa Umar,
Chiedozie Osuoji³,
Said Ajibola Agboola,
Evelyn Ogedegbe⁴,
Felix Ogedegbe⁵

Departments of Radiology,
³Emergency, ⁴Medicine and
⁵Orthopaedic, Cedarcrest
Hospitals, ¹Treatment and
Isolation Centre, Cedarcrest
Hospitals, Abuja, Nigeria,
²Department of Infection,
Immunity and Cardiovascular
Diseases, University of Sheffield,
Sheffield, UK

Submitted: 27-Aug-2021

Revised: 22-Sep-2021

Accepted: 29-Sep-2021

Published: 30-Nov-2021

Address for correspondence:

Dr. Olubukola Khadija Ajiboye,
Department of Radiology,
Cedarcrest Hospitals, Abuja,
Nigeria.

E-mail: khadija.ajiboye@cedarcresthospitals.com

Access this article online

Website: www.jrmt.org

DOI: 10.4103/jrmt.jrmt_17_21

Quick Response Code:



How to cite this article: Ajiboye OK, Ayeni O, Katibi OS, Umar UM, Osuoji C, Agboola SA, *et al.* The role of computed tomography in the management of patients with suspected COVID-19 – A Nigerian study. J Radiat Med Trop 2021;2:61-5.

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

Tool (CECRAT) and scores were obtained. The CECRAT score is made up of single to double digits and is based on a positive or negative response, respectively, to questions of a history of cough, loss of taste, smell, sore throat, body aches, difficulty in breathing, fever, travel to a COVID endemic region or contact with a COVID 19 patient^[5] Figure 1.

A single CT scanner (Somatom Emotion Duo/6/16, Siemens Healthcare) was used for all chest CT examinations. On account of this being a retrospective analysis, no standard CT protocol was applied. All CT images were reconstructed to 2-mm thin slices, and multiplanar images were obtained using the multiplanar reformatting technique on a workstation. Each chest CT examination was reported separately by two radiologists with a combined 15 years' experience in interpreting chest CT. Subjects with traumatic chest injuries or chronic preexisting lung disease were excluded from the study.

The data obtained was analyzed using the Statistical Package for the Social Science software for Windows, Version 20.0.1 (SPSS, Chicago, Illinois, USA). Continuous variables were presented as means and standard deviation (SD), while categorical variables were presented as proportions. The level of association between RT-PCR results and the chest CT findings was done using the Eta squared (h^2) test – a measure of the degree of association for the sample. In all cases, statistical significance was set at $P < 0.05$.

CEDARCREST EMERGENCY UNIT COVID-19 RISK ASSESSMENT TOOL (CECRAT)			
INDEX	SCORE	YES	NO
Cough?	2		
Hx of loss of taste &/or smell?	3		
Are you having diarrhea?	1		
Are you having a sore throat?	1		
Any body aches?	1		
Headache?	1		
Hx of Fever /Temp > 37.8°C/ cold/chills?	2		
Any difficulty breathing/SpO ₂ on room air <92?	2		
Are you experiencing fatigue?	1		
Hx of Chest pain	3		
Have you travelled in the last 14 days?	2		
History of travel to a COVID-19 endemic area?	3		
Any contact with a COVID-19 positive person?	3		
TOTALS			

INTERPRETATION

< 4 – Low risk

≥ 4 – 5 Moderate Risk: maintain index of suspicion for COVID -19.

≥ 6 - High risk: high index of suspicion for COVID-19. Interview further to determine severity but attend to patient in full contact & droplet PPE precautions.

NOTE:

- The above is a guide to clinical judgment.
- There are documented cases of community transmission. Always maintain a high index of suspicion even in the absence of symptoms and travel history or history of contact.
- Patient may be asymptomatic for COVID-19 and present with non COVID symptoms e.g. trauma. Please observe protective measures (face mask, gloves, surgical gown, and apron) and preventive measures (hand washing, social distancing etc.).
- Paediatric patients should be screened using the Paediatric COVID-19 Risk assessment tool

Adapted from CDC guidelines on Triage of suspected COVID-19 infection
<https://www.cdc.gov/coronavirus/2019-ncov/hcp/non-us-settings/sop-triage-prevent-transmission.html>

Figure 1: Cedarcrest hospital COVID-19 risk assessment tool

Results

This study included 49 patients with features suspicious of COVID-19, of whom 33 were male (67%) and 16 were female (33%) with an average age of 51.59 years. The most common clinical features were fever, cough, and fatigue. Myalgia, chest pain, and dyspnea were also with anosmia and ageusia or dysgeusia in very few subjects Table 1.

About 61% of our study subjects had a high risk of COVID-19, based on the CECRAT tool, with scores of 6 and above. A medium risk (CECRAT 4-5) and low risk (CECRAT <4) were found in 33% and 6%, respectively. Approximately half of the study subjects had comorbidities, particularly hypertension and diabetes mellitus. 67% of the subjects tested positive for COVID-19. 11 tested negative, four of whom had repeat tests, also negative and not documented here.

No evidence of pneumonia was found in the CT images of 12% of the study subjects. Ground-glass opacification was the most common feature and consolidation with a mixed ground-glass opacification and consolidation in 53%. The most common CT distribution was peripheral (84%), central distribution (61%), and a mixed central and peripheral distribution in 59%. These were largely bilateral and in the lower lobes Figure 2 and Table 2.

No statistically significant relationship was found between the positive CT findings and the PCR results. There was, however, a strong correlation between the RT-PCR results and the CECRAT-scores $r = 0.455$, $P = 0.035$, when the PCR-CHML is the dependent variables. The levels of CECRAT scores and thus the clinical findings have a significant impact on the PCR-CHML results, $F(1,47) = 4.70$, $P = 0.035$.

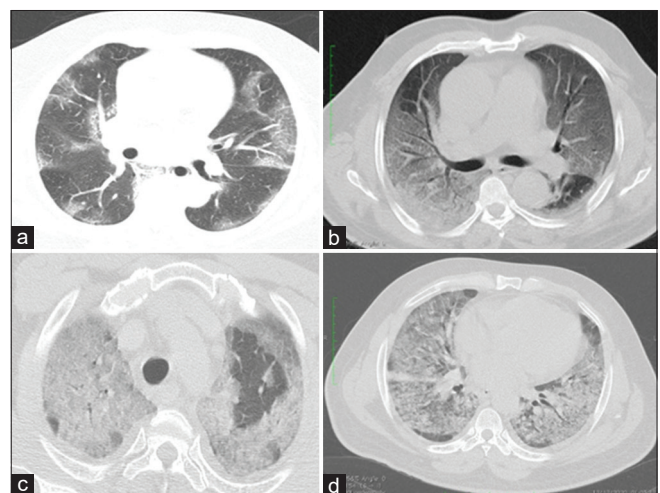


Figure 2: (a) computed tomography image of the chest showing ground-glass opacities in mild COVID-19. (b) computed tomography image of the chest showing a mixture of ground-glass opacification and consolidation. (c) computed tomography image showing a central and peripheral distribution of consolidation and ground-glass opacification. (d) computed tomography image showing a diffuse pattern of consolidation in a patient with severe COVID-19

Table 1: Patient demographics and clinical characteristics

Parameter	n (%)
Gender	
Male	33 (67)
Female	16 (33)
Clinical features	
Fever	35 (71)
Cough	33 (67)
Dyspnea	20 (41)
Diarrhea	8 (16)
Vomiting	8 (16)
Anosmia	3 (6)
Ageusia	3 (6)
Myalgia	16 (33)
Fatigue	36 (73)
Chest pain	15 (31)
CECRAT scores	
High >5	30 (61)
Medium 4-5	16 (33)
Low <4	3 (6)
Comorbidities	
Hypertension	26 (53)
Diabetes mellitus	15 (31)
Laboratory findings	
Neutrophilia	29 (59)
Lymphocytopenia	33 (67)
PCR positive	33 (67)

Total number $n=49$. CECRAT: Cedarcrest Hospital COVID-19 risk assessment tool, PCR: Polymerase chain reaction, COVID-19: Coronavirus disease 2019

Table 2: Pattern and distribution of computer tomography findings

CT findings	n (%)
CT pattern	
Ground-glass opacity	40 (82)
Consolidation	29 (60)
Pleural effusion	3 (6)
GGO + consolidation	26 (53)
Normal	6 (12)
CT distribution	
Peripheral	41 (84)
Central	30 (61)
Mixed central and peripheral	28 (59)
Multifocal	34 (69)
Diffuse	7 (14)
Lower lobes	41 (84)
Upper lobes	37 (76)
Bilateral lung	40 (82)
Unilateral lung	3 (6)

CT: Computer tomography, GGO: Ground-glass opacity

Discussion

The gold standard for the diagnosis of COVID-19 infection is real-time reverse transcription polymerase chain

reaction (RT-PCR) of nasopharyngeal and oropharyngeal swabs. Its sensitivity is, however, reported to be about 30% to 70% at initial presentation.^[6-9] Many false-negative patients then constitute a risk for infecting others on account of the highly contagious nature of the coronavirus. In addition, turnaround times are long and may not be very helpful for prompt isolation and treatment. Alternatively, a chest CT scan is an imaging tool for diagnosing pneumonia and is relatively easy to perform, providing rapid screening and diagnosis.

All our patients were adults, with twice as many males as females. Several studies show a male preponderance of COVID-with increased case and mortality rates in men compared with women, possibly on account of physiological differences in innate and adaptive immunity or a higher expression of angiotensin-converting enzyme in males than females.^[10,11]

In our study, fever, cough, fatigue, and myalgia were the most common clinical symptoms, consistent with other reports.^[12-14] Other symptoms include anorexia, chest tightness, shortness of breath, dyspnea, and muscle soreness and these, as well as olfactory and gustatory dysfunction, were relatively infrequent symptoms in our study.^[15] These results are consistent with descriptive studies from Nigeria and a meta-analysis by Zhu *et al.*^[12,14] Some patients showed neutrophilia, lymphocytopenia, elevated levels of C-reactive protein, and erythrocyte sedimentation rate, also consistent with other reports.^[16,17]

RT-PCR was positive for COVID-19 in 67% of our subjects. 11 tested negative for COVID-19, 4 of whom had repeat tests. False-negative RT-PCR tests have been reported in patients with CT findings of COVID-19 who eventually tested positive with serial sampling.^[5]

Six patients had no evidence of pneumonia in the CT images. This is consistent with the findings of Hefeda in a literature review and also of Kwee *et al.* who reported that the incidence of normal chest CT findings in symptomatic patients with COVID-19 is estimated at about 10.6%.^[13,17] Low viral loads and confinement to the upper respiratory tract are possible explanations for false-negative chest CT findings for COVID-19 at presentation.^[13,18]

The most common CT features reported in COVID-19 pneumonia are bilateral and subpleural areas of ground-glass opacification, consolidation affecting the lower lobes, or both.^[13,19] CT findings in our study subjects were largely of ground-glass opacification, consolidation and a mix of these, predominantly peripheral and in the lower lobes, consistent with other studies.^[8,13,20] This may be explained by viral invasion and replication in the bronchioles and alveolar epithelium causing inflammation and edema of the alveolar wall with a distribution mainly around the lung and under the pleura.^[21] Combinations of peripheral and central distributions were also found in 59%, consistent with other reports.^[9]

The early stage of COVID-19 is characterized by dilatation of capillaries and engorgement of vessels, mild fluid exudates in the alveoli, and interstitial edema, resulting in single or multiple patchy ground-glass opacities which are mostly peripheral, basal and subpleural.^[21,22] Next is the advanced stage in which the lesions increase in density and size, forming a mixed pattern of GGO and consolidation with or without air bronchograms. The cause of this appearance is said to be the exudation into the alveolar space and the lung interstitium.^[20,23] As severity increases, fibrous exudates into the alveoli shown as wide areas of consolidation with air bronchograms resulting from pathogenic invasion of the epithelial cells, causing inflammatory thickening and swelling of the bronchial wall without obstructing the bronchiole.^[20] In some cases, the diffuse ground-glass infiltration may give the lungs a white lung appearance.^[18] Our other findings of pleural effusion and mediastinal lymphadenopathy were uncommon. Other CT findings (e.g., tree-in-bud pattern, reverse halo sign, nodules, cysts, cavitation, and lymphadenopathy) were not seen in our study subjects and are reported to be uncommon.^[9,24]

There was no statistically significant correlation between our CT findings and RT-PCR results, consistent with the reports of Leong, who, however, reported a correlation with inflammatory markers.^[25] This may be as a result of the limited sensitivity of RT-PCR tests with negative results, not excluding COVID-19. Other studies reported a significant correlation between clinical features and CT findings.^[26]

Our study was limited by the inherent selection bias of a retrospective study and a limited sample size. Furthermore, negative RT-PCR tests may not exclude COVID-19 infection, and further studies may be necessary to confirm the actual COVID status of the patient using serial RT-PCR tests.

Conclusion

Chest CT has played a vital role in the management of COVID-19 for prompt diagnosis, isolation, and treatment as well as to rule out other conditions. The imaging findings should, however, be evaluated in conjunction with clinical features and laboratory investigations for patient management.

Acknowledgments

We acknowledge the co-operation and contributions of the management and staff of the

Cedarcrest Hospitals, Abuja, in bringing this project to fruition.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Li M. Chest CT features and their role in COVID-19. *Radiol Infect Dis* 2020;7:51-4.
2. People's Republic of China. Diagnosis and Treatment Protocol for COVID-19 (Trial Version 7). *Chin Med J* 2020;17.
3. Li X, Zeng W, Li X, Chen H, Shi L, Li X, *et al.* CT imaging changes of corona virus disease 2019(COVID-19): A multi-center study in Southwest China. *J Transl Med* 2020;18:154.
4. Rubin GD, Ryerson CJ, Haramati LB, Sverzellati N, Kanne JP, Raouf S, *et al.* The role of chest imaging in patient management during the COVID-19 pandemic: A multinational consensus statement from the fleischner society. *Radiology* 2020;296:172-80.
5. WHO Coronavirus (COVID-19) Dashboard | WHO Coronavirus Disease (COVID-19) Dashboard with-vaccination-data. Available from: <https://covid19.who.int> > info.
6. Fang Y, Zhang H, Xie J, Lin M, Ying L, Pang P, *et al.* Sensitivity of chest CT for COVID-19: Comparison to RT-PCR. *Radiology* 2020;296:E115-7.
7. Yang Y, Yang M, Shen C, Wang F, Yuan J, Li J, *et al.* Evaluating the accuracy of different respiratory specimens in the laboratory diagnosis and monitoring the viral shedding of 2019-nCoV infection. *medRxiv* 2020. DOI: 10.1101/2020.02.11.20021493.
8. Wu J, Wu X, Zeng W, Guo D, Fang Z, Chen L, *et al.* Chest CT findings in patients with coronavirus disease 2019 and its relationship with clinical features. *Invest Radiol* 2020;55:257-61.
9. Brogna B, Bignardi E, Brogna C, Alberigo M, Grappone M, Megliola A, *et al.* Typical CT findings of COVID-19 pneumonia in patients presenting with repetitive negative RT-PCR. *Radiography (Lond)* 2021;27:743-7.
10. Gadi N, Wu SC, Spihlman AP, Moulton VR. What's sex got to do with COVID-19? Gender-based differences in the host immune response to coronaviruses. *Front Immunol* 2020;11:2147.
11. Bwire GM. Coronavirus: Why men are more vulnerable to Covid-19 than women? *SN Compr Clin Med* 2020;1-3. doi: 10.1007/s42399-020-00341-w.
12. Bowale A, Abayomi A, Idris J, Omilabu S, Abdus-Salam I, Adebayo B, *et al.* Clinical presentation, case management and outcomes for the first 32 COVID-19 patients in Nigeria. *Pan Afr Med J* 2020;35:24.
13. Kwee TC, Kwee RM. Chest CT in COVID-19: What the radiologist needs to know. *Radiographics* 2020;40:1848-65.
14. Zhu J, Ji P, Pang J, Zhong Z, Li H, He C, *et al.* Clinical characteristics of 3062 COVID-19 patients: A meta-analysis. *J Med Virol* 2020;92:1902-14.
15. Otuonye NM, Olumade TJ, Ojetunde MM, Holdbrooke SA, Ayoola JB, Nyam IY, *et al.* Clinical and demographic characteristics of COVID-19 patients in Lagos, Nigeria: A descriptive study. *J Natl Med Assoc* 2021;113:301-6.
16. Xie X, Zhong Z, Zhao W, Zheng C, Wang F, Liu J. Chest CT for typical Coronavirus disease 2019 (COVID-19) pneumonia: Relationship to negative RT-PCR testing. *Radiology* 2020;296:E41-5.
17. Hefeda MM. CT chest findings in patients infected with COVID-19: Review of literature. *Egypt J Radiol Nucl Med* 2020;51:239.
18. Wölfel R, Corman VM, Guggemos W, Seilmaier M, Zange S, Müller MA, *et al.* Author correction: Virological assessment of hospitalized patients with COVID-2019. *Nature* 2020;588:E35.
19. Zhao W, Zhong Z, Xie X, Yu Q, Liu J. Relation between

- chest CT findings and clinical conditions of coronavirus disease (COVID-19) pneumonia: A multicenter study. *AJR Am J Roentgenol* 2020;214:1072-7.
20. Ai T, Yang Z, Hou H, Zhan C, Chen C, Lv W, *et al.* Correlation of chest CT and RT-PCR testing for coronavirus disease 2019 (COVID-19) in China: A report of 1014 cases. *Radiology* 2020;296:E32-40.
21. Chen H, Ai L, Lu H, Li H. Clinical and imaging features of COVID-19. *Radiol Infect Dis* 2020;7:43-50.
22. Zhu J, Zhong Z, Li H, Ji P, Pang J, Li B, *et al.* CT imaging features of 4121 patients with COVID-19: A meta-analysis. *J Med Virol* 2020;92:891-902.
23. Li Y, Xia L. Coronavirus disease 2019 (COVID-19): Role of chest CT in diagnosis and management. *AJR Am J Roentgenol* 2020;214:1280-6.
24. Yang W, Cao Q, Qin L, Wang X, Cheng Z, Pan A, *et al.* Clinical characteristics and imaging manifestations of the 2019 novel coronavirus disease (COVID-19): A multi-center study in Wenzhou city, Zhejiang, China. *J Infect* 2020;80:388-93.
25. Jeong CM, Xu X, Kong SC, Luo L. Evaluation of chest CT and clinical features of COVID-19 patient in Macao. *Eur J Radiol Open* 2020;7:100275. doi: 10.1016/j.ejro.2020.100275.
26. Song S, Wu F, Liu Y, Jiang H, Xiong F, Guo X, *et al.* Correlation between chest CT findings and clinical features of 211 COVID-19 suspected patients in Wuhan, China. *Open Forum Infect Dis* 2020;7:ofaa171.