International Journal of Radiology and Diagnostic Imaging

E-ISSN: 2664-4444
P-ISSN: 2664-4436
www.radiologypaper.com
IJRDI 2022; 5(1): 05-08
Received: 10-11-2021
Accepted: 14-12-2021

Dr. S Shanmuga Jayanthan
Consultant Radiologist, Meenakshi Hospital, Tanjore, Tamil Nadu, India

Dr. G Rupesh
Consultant Radiologist, Meenakshi Hospital, Tanjore, Tamil Nadu, India

Dr. Ganesh Rajagopal
Consultant Radiologist, Meenakshi Mission Hospital and Research Centre, Madurai, Tamil Nadu, India

Dr. N Moorthy
Consultant Radiologist, Meenakshi Hospital, Tanjore, Tamil Nadu, India

Corresponding Author:
Dr. S Shanmuga Jayanthan
Consultant Radiologist, Meenakshi Hospital, Tanjore, Tamil Nadu, India

COVID-19: The role of CT chest in severity assessment with Clinico-radiological correlation: A retrospective analysis

Dr. S Shanmuga Jayanthan, Dr. G Rupesh, Dr. Ganesh Rajagopal and Dr. N Moorthy

DOI: http://dx.doi.org/10.33545/26644436.2022.v5.i1a.247

Abstract
Objectives: To evaluate the computed tomography (CT) based scoring system, called as CT severity score (CT-SS), in the severity assessment of COVID cases with clinico-radiological correlation.
Methods: This retrospective study was done among 303 patients, who are RT-PCR positive for COVID-19. The CT chest images of the above patients were reviewed in the radiology database. CT severity score (CT-SS) was calculated as the sum of scores in five lobes, based on the percentage of parenchymal opacification (0:0%; 1, < 5%; 2:5–25%; 3:26–50%; 4:51–75%; 5, > 75%; range 0–5; global score 0–25). All patients were clinically categorized as mild, moderate and severe, based on severity by the Government of India Ministry of Health and Family Welfare, Directorate General of Health Services.
Results: The area under the ROC curve for identifying severe group was 0.937 and the optimal CT-SS threshold for identifying severe disease was 17.5, with a good sensitivity of 97.8% and specificity of 85.3%.
Conclusion: A CT-SS more than 17.5 could identify severe from non-severe forms of disease, and hence will be potentially useful in the triage of patients in scenarios combining high patient volumes and limited healthcare resources or PCR testing capabilities.
Clinical impact:
1. The CT severity score (CT-SS) was higher in patients with severe COVID-19 in comparison with patient with mild or moderate disease.
2. The optimal CT-SS threshold for identifying severe disease was 17.5, with 97.8% sensitivity and 85.3% specificity.
3. Hence, CT-SS will be very useful in triage of patients due to high patient volumes and limited available healthcare resources.

Keywords: COVID-19, CT severity score, viral pneumonia, Ground glass opacity, CORADS

Introduction
Covid-19 is caused by a novel corona virus with rapid spread across the world and so declared as a pandemic disease by World Health Organization (WHO) on January 30, 2020 [1]. An early diagnosis is crucial for the treatment and to control the spread of disease [1]. Although, RT-PCR remains the standard reference for the diagnosis, it carries high false negative rates, and hence computed tomography (CT) plays a vital role in overcoming such limitation [1, 2]. The most common imaging finding is ground glass opacities which are typically peripheral and bilateral [1, 3, 4]. Although these findings might lack specificity, in proven cases, CT could be used to provide objective assessment about the extension of the lung opacities [4]. Hence, CT is also helpful in assessing the severity status of the disease as well [3, 4]. The CT severity score (CT-SS) is calculated based on the parenchymal lobar involvement (0:0%; 1, < 5%; 2:5–25%; 3:26–50%; 4:51–75%; 5, > 75%; range 0–5; global score 0–25) [3]. The aim of our present study was to evaluate the performance of this semi-quantitative CT severity score to identify the severity of COVID-19. This might be helpful in quick triage of cases who might require intensive care unit admission [4].

Subjects and Methods
We retrospectively studied 303 patients diagnosed with COVID-19 from June 21, 2020 to September 21, 2020 in our hospital.

According to our hospital protocol, all patients with suspected COVID-19 routinely underwent non-contrast CT chest, at the time of admission, instead of chest radiographs as the former is more sensitive to detect lung opacities. This study included 303 patients, who were confirmed to have COVID-19 infection by RT-PCR. Patients with lung malignancy, a history of preexisting interstitial lung disease or lobectomy, pregnant patients and RT-PCR positive cases without lung opacities were excluded from this study.

According to the clinical management protocol: COVID-19, Government of India Ministry of Health and Family Welfare, Directorate General of Health Services (EMR Division) (version 3) on June 13, 2020 [5], COVID-19 patients are classified as mild, moderate and severe. All the patients underwent non contrast chest CT with a 64-slice GE scanner in supine position. CT images were obtained with single inspiratory breath-hold. The scanning range was from the apex of lung to costophrenic angle. CT scan parameters: X-ray tube parameters - 120KVp, 350mAs; rotation time - 0.5 second; pitch - 1.0; section thickness – 5 mm; intersection space – 5 mm; additional reconstruction with sharp convolution kernel and a slice thickness of 1.25 mm. Thin sections were reviewed at a window width and level of 1000 to 2000 HU and -700 to -500 HU, respectively, for lung parenchyma.

The CT severity score (CT-SS) is calculated based on the parenchymal lobar involvement in the form of opacity (0:0%; 1, < 5%; 2:5–25%; 3:26–50%; 4:51–75%; 5, > 75%; range 0–5; global score 0–25) [3]. Each lobe was given a score and total CT-SS obtained by the sum of scores in all five lobes. The representative images of CT are given in figures 1-3.

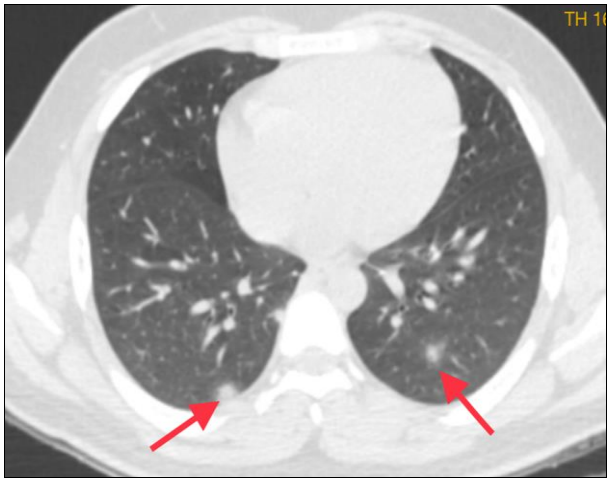


Fig 1: Axial CT image with few patchy peripheral opacities - Mild covid-19 pneumonia

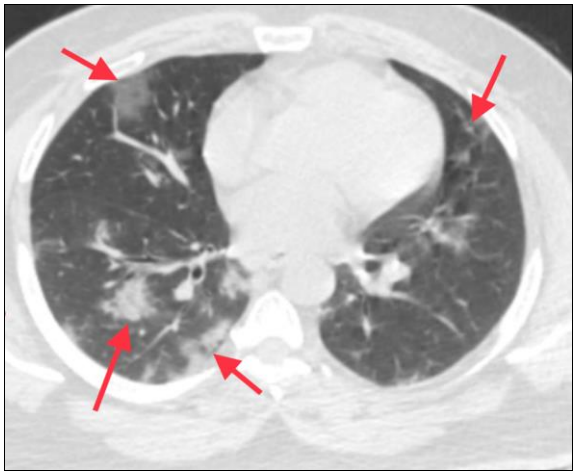


Fig 2: Axial CT image with multiple patchy peripheral opacities - Moderate covid-19 pneumonia

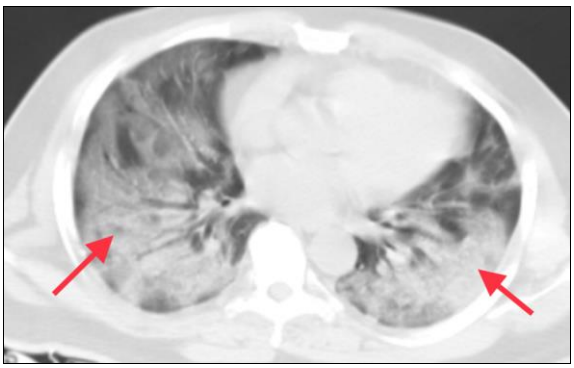


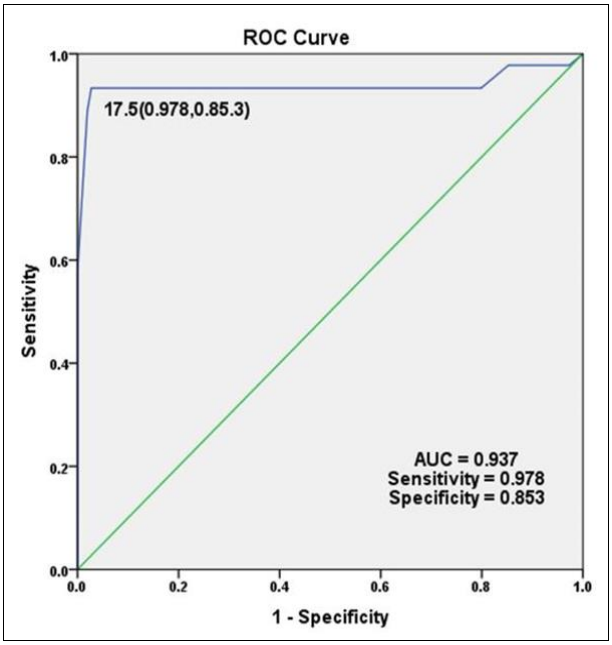
Fig 3: Axial CT image with multiple patchy and confluent central and peripheral opacities - Severe covid-19 pneumonia

Results

The demographic profile of 303 patients are summarized in table 1. Among 303 patients, 157 were in the mild group, 101 were in the moderate category and 45 were in the severe group, with respective average ages of 51.4, 56.2 and 59.0 (P = 0.001) and male/female ratios of 108/49, 79/22 and 41/4. The most common clinical symptom was fever (143/157, 91.1%) in mild group and moderate categories (95/101, 94%), whereas, dyspnea was the predominant complaint in severe group (44/45 97.8%). The time from onset of symptoms in the severe group (11 days) were higher than that of the mild (5.7 days) or moderate (8.8 days) groups. The ROC curve analysis for CT-SS, for severe group is shown in graph 1. The area under the ROC curve for identifying severe group was 0.937 and the optimal CT-SS threshold for identifying severe patients was 17.5, with a good sensitivity of 97.8% and specificity of 85.3%.

Table 1: Demographic profile and statistical analysis

Variable		Mild(n=157)	Moderate(n=101)	Severe(n=45)	P-Value
Sex	Male	108(68.8%)	79(78.2%)	41(91.1%)	.006 Sig
	Female	49(31.2%)	22(21.8%)	4(8.9%)	
Age	Mean	51.4±14.7	56.1±13.7	59.0±10.5	.001 Sig
	Range	18 - 82	19 - 85	34 - 83	
Fever	Yes	143(91.1)	95(94.1%)	42(93.3%)	.657 NS
	No	14(8.9%)	6(5.9%)	3(6.7%)	
Cough	Yes	81(51.6%)	68(68.0%)	36(80.0)	.001 Sig
	No	76(48.4%)	32(32.0%)	9(20.0%)	
Myalgia	Yes	82(52.2%)	59(58.4%)	25(55.6%)	.618 NS
	No	75(47.8%)	42(41.6%)	20(44.4%)	
Dyspnoea	Yes	5(3.2%)	29(28.7%)	44(97.8%)	.001 Sig
	No	152(96.8%)	72(71.3%)	1(2.2%)	
Duration		5.7±2.8	8.8±.80	11.0±.82	.002 Sig



Graph 1: ROC curve to identify severe covid-19 pneumonia with CT severity score (CTSS)

Discussion

A novel virus named by International Virus Classification Commission, as Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) [6] is known to cause a disease termed by the WHO as "Coronavirus Disease 2019 (COVID-19)" [7]. Containment of this highly contagious disease heavily relies upon early diagnosis and contact tracing [8, 9, 10]. Though RT-PCR remains as the diagnostic investigation of choice [11], it has less utility in describing disease severity and also has high false negative rates, wherein CT has an edge over it [1, 2]. Various studies stated that CT has higher sensitivity than RT-PCR in the disease diagnosis [12, 13]. The disease is further complicated with asymptomatic carriers who can act as super spreaders of the disease [14]. CT chest findings of lungs include ground-glass opacities (GGO), consolidation, interstitial thickening and subpleural band [15]. The common pattern of involvement is bilateral, peripheral one-third and posterior segments of lung [15, 16, 17].

There are various risk factors associated with the development of acute respiratory distress syndrome (ARDS) and mortality, including age, lab parameters like neutropenia, increased D-dimer, lactate dehydrogenase (LDH) levels etc. [18]. Many recent studies highlight the role of CT as a severity predictor by using a semi-quantitative scoring system, known as CT severity score (CT-SS) [3, 4]. Score of more than 18 out of 25 is associated with more severity and the requirement for intensive care unit admission [3].

In our study, we found that the semi-quantitative scoring method using the amount of lung opacification involving 5 lobes of lungs as a useful surrogate for COVID-19 burden. We found that the CT-SS was higher in severe when compared to mild and moderate cases. We also found that the CT-SS value of 17.5, has optimal threshold in identifying the severe COVID-19 infection, with a good sensitivity of 97.8% and specificity of 85.3%.

The various limitations of our study include that the CT-SS assumes that the amount of lung opacification as a surrogate for COVID-19 burden; however, there was no histologic confirmation of the findings. Secondly, we chose to analyze the first chest CT obtained at the time of admission; therefore, the studies were not controlled by the number of days since the start of symptoms, which could have potential implications for interpretation of the CT-SS. Also, our data showed that patients in the severe group had a larger interval between beginning of symptoms and hospital admission in comparison with patients in the mild and moderate groups. Further research is needed to identify the degree of consistency of CT-SS with larger cohort studies.

To conclude, this study provides a rapid semi-quantitative method for assessing severity of COVID-19 in the initial chest CT. A CT-SS more than 17.5 could identify severe or critical forms of disease with a good sensitivity of 97.8% and specificity of 85.3%. Further CT-SS could be potentially used in the triage of patients needing hospital admission, especially in scenarios combining high patient volumes and limited healthcare resources or PCR testing capabilities.

References

1. Carotti M, Salaffi F, Sarzi-Puttini P, *et al*. Chest CT features of coronavirus disease 2019 (COVID-19) pneumonia: key points for radiologists. La radiologia medica. 2020. https://doi.org/10.1007/s11547-020-01237-4.
2. Li Y, Xia L. Coronavirus Disease 2019 (COVID-19): Role of Chest CT in Diagnosis and Management. Am J Roentgenol. 2020;214:1280-1286.
3. Francone M, Iafrate F, Masci GM, *et al*. Chest CT score in COVID-19 patients: correlation with disease severity and short-term prognosis. Eur Radiol. 2020. https://doi.org/10.1007/s00330-020-07033-y.
4. Yang R, Li X, Liu H, *et al*. Chest CT Severity Score: An Imaging Tool for Assessing Severe COVID-19. Radio Graphics. 2020 Mar; 30:2(2). DOI: 10.1148/ryct.202020004.
5. Clinical Management Protocol. Covid-19, Government of India Ministry of Health and Family Welfare Directorate General of Health Services (EMR Division) (version 3) https://www.mohfw.gov.in/pdf/ClinicalManagementProtocolforCOVID19.pdf
6. Gorbalenya AE, Baker SC, Baric RS, *et al*. Severe acute respiratory syndrome-related coronavirus: The species and its viruses – a statement of the Coronavirus Study Group. https://doi.org/10.1101/2020.02.07.937862. DOI: bioRxiv preprint.
7. WHO. Novel coronavirus – China. Feb 11, 2020. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200211-sitrep-22-ncov.pdf?sfvrsn=fb6d49b1_2.
8. Li Q, Guan X, Wu P, *et al*. Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus–Infected Pneumonia. N Engl J Med. 2020 Jan 29. DOI: 10.1056/NEJMoa2001316. [Epub ahead of print]
9. Carlos WG, Dela Cruz CS, Cao B, *et al*. Novel Wuhan (2019-nCoV) Coronavirus. Am J Respir Crit Care Med. 2020 Feb 15;201(4):7-8.
10. Zhu N, Zhang D, Wang W, *et al*. A Novel Coronavirus from Patients with Pneumonia in China, 2019. N Engl J Med. 2020 Jan 24. DOI: 10.1056/NEJMoa2001017. [Epub ahead of print]

11. Huang C, Wang Y, Li X, *et al*. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020 Jan 24;6736(20):30183-5. DOI: 10.1016/S0140-6736(20)30183-5. [Epub ahead of print]
12. Fang Y, Zhang H, Xie J, *et al*. Sensitivity of chest CT for COVID-19: comparison to RT-PCR. Radiology. 2020;200432
13. Xie X, Zhong Z, Zhao W, *et al*. Chest CT for typical 2019-nCoV pneumonia: relationship to negative RT-PCR testing. Radiolog. 2020, 200-343.
14. Inui S, Fujikawa A, Jitsu M *et al*. Chest CT findings in cases from the cruise ship "diamond princess" with coronavirus disease 2019 (COVID-19). Radiology: Cardiothoracic Imaging. 2020;2:e200110. 10.1148/ryct.2020200110
15. Zhou S, Wang Y, Zhu T, *et al*. CT features of coronavirus disease 2019 (COVID-19) pneumonia in 62 patients in Wuhan, China. AJR Am J Roentgenol. 2020, 1-8. 10.2214/AJR.20.22975
16. Song F, Shi N, Shan F, *et al*. Emerging Coronavirus 2019- nCoV Pneumonia. Radiology. 2020 Feb 6, 200274. DOI: 10.1148/radiol.2020200274. [Epub ahead of print]
17. Salehi S, Abedi A, Balakrishnan S, Gholamrezanezhad A. Coronavirus disease 2019 (COVID-19): a systematic review of imaging findings in 919 patients. AJR Am J Roentgenol. 2020, 1-7. 10.2214/AJR.20.23034.