The Importance of Chest CT Scan in COVID-19: A Case Series

Eric D. Tenda[1,2], Mira Yulianti[1], Moses M. Asaf[1], Reyhan E. Yunus[3], Wita Septiyanti[3], Vally Wulani[3], Ceva W. Pitoyo[1], Cleopas M. Rumende[1], Siti Setiati[4]

[1] Division of Respirology and Critical Care, Department of Internal Medicine, Faculty of Medicine Universitas Indonesia - Cipto Mangunkusumo Hospital, Jakarta, Indonesia.
[2] National Heart and Lung Institute, Imperial College London, United Kingdom.
[3] Departement of Radiology, Faculty of Medicine Universitas Indonesia - Cipto Mangunkusumo Hospital, Jakarta, Indonesia.
[4] Division of Geriatric Medicine, Department of Internal Medicine, Faculty of Medicine Universitas Indonesia - Cipto Mangunkusumo Hospital, Jakarta, Indonesia.

Corresponding Author:
Eric Daniel Tenda, MD. National Heart and Lung Institute, Imperial College London. South Kensington Campus, London, Greater London SW7 2AZ, United Kingdom. email: ericdanieltenda@yahoo.com.

ABSTRAK

Coronavirus disease 2019 (COVID-19) adalah penyakit pernapasan akut yang sangat menular yang disebabkan oleh Severe Acute Respiratory Syndrome CoronaVirus-2 (SARS-CoV-2), sebuah beta coronavirus yang pertama kali ditemukan di Wuhan, Cina, pada akhir 2019. COVID-19 telah menyebar dengan cepat secara global, dan pada Maret 2020, telah secara resmi dinyatakan sebagai pandemi oleh World Health Organization (WHO). Salah satu tantangan dalam mengelola COVID-19 adalah identifikasi modalitas diagnostik yang cepat, mudah diakses, dan terpercaya yang dapat berfungsi sebagai alternatif untuk pemeriksaan reverse-transcriptase polymerase chain reaction (RT-PCR). Saat penulisan makalah ini, RT-PCR masih merupakan pemeriksaan yang direkomendasikan dalam mendiagnosis COVID-19, tetapi gagasan tentang alat diagnostik yang lebih cepat dan akurat adalah kemungkinan yang layak untuk diteliti. Tujuan dari studi kasus ini adalah untuk menyelidiki kepentingan dan kefaedahan chest computed tomography (CT) dalam diagnosis COVID-19, karena semakin banyak bukti yang memberi kesan bahwa chest CT dapat terbukti berguna dalam jalur klinis diagnosis COVID-19.

Kata kunci: respiratory medicine, radiologi, ilmu penyakit dalam.

ABSTRACT

The coronavirus disease 2019 (COVID-19) is a highly transmissible acute respiratory disease that is caused by the Severe Acute Respiratory Syndrome CoronaVirus-2 (SARS-CoV-2), a beta coronavirus first discovered in Wuhan, China, in late 2019. COVID-19 has been spreading swiftly globally, and as of March 2020, has been officially declared a pandemic by the World Health Organization (WHO). One of the challenges in managing COVID-19 is the identification of a swift, accessible, and reliable diagnostic modality that could serve as an alternative to reverse-transcriptase polymerase chain reaction (RT-PCR). As of the writing of this paper, RT-PCR is still the recommended tool in diagnosing COVID-19, but the notion of a more prompt and accurate diagnostic tool is a possibility worth looking into. The objective of this case study is to investigate the importance and utility of chest computed tomography (CT) in the diagnosis of COVID-19, as increasing pieces of evidence suggest that chest CT could prove useful in the clinical pathway in diagnosing COVID-19.

Keywords: respiratory medicine, radiology, internal medicine.

INTRODUCTION

Severe Acute Respiratory Syndrome CoronaVirus-2 (SARS-CoV-2) is a beta coronavirus that induces an acute respiratory disease called the coronavirus disease 2019 (COVID-19) by binding into the angiotensin-converting enzyme 2 (ACE2) receptor of humans.[1] Since its discovery in China in early January 2020, it has been spreading aggressively and globally at an alarming rate. On March 2, 2020, the first case of COVID-19 in Indonesia (Depok, West Java) was announced by the President of the Republic of Indonesia. Since then, COVID-19 has been spreading swiftly throughout Indonesia, with the epicentre of the disease being in Jakarta, the most populated city and the capital of Indonesia. As of April 9, 2020, 2,761 confirmed cases of COVID-19 with 280 fatalities had been reported in Indonesia. The World Health Organization (WHO) recommends suspected cases to be screened for the virus with nucleic acid amplification tests (NAAT), such as reverse-transcriptase polymerase chain reaction (RT-PCR).[2] However, recent studies have highlighted the potential importance of chest computed tomography (CT) in the screening and diagnosis of COVID-19. Chest CT has been suggested to possess the potential to diagnose COVID-19 with significant sensitivity, and even screen asymptomatic patients.[3-5] This case series will explore the suggested potential of chest CT and its utility for COVID-19.

CASE ILLUSTRATION

The first patient is a 52-year-old male that came into the emergency unit of a general hospital in Central Jakarta, Indonesia, with a five-day history of subjective fever, which worsens during the afternoon or night, and diarrhoea at the start of the onset of the illness. The presence of active cough, expectoration and dyspnea were denied by the patient. The patient disclosed that he had no contact with suspected or confirmed COVID-19 patients other than his wife - who had symptoms of dry cough but no fever - and had been working from home two weeks prior to the onset of his illness. The patient had limited his contact with other people, but he still routinely went to a local mosque for prayer. The patient

had a history of grade I hypertension (JNC VIII), controlled by daily consumption of angiotensin receptor blocker. Physical evaluation by the physician showed relative bradycardia, a fever of 38.2°C, coated tongue, and absent rhonchi on bilateral pulmonary auscultation. Saturation measured using pulse oximetry was 97-99% in room atmosphere. Tubex®TF rapid typhoid test was conducted, and the result was +10 (strong positive). Laboratory results on admission reflected a decrease in white blood count (WBC), platelets, and eosinophil, a minor increase in D-dimer, and a significant increase in C-reactive protein (CRP). Chest X-ray (CXR) showed vague signs of bilateral pericardial infiltrate, suggestive of pneumonia. Chest CT was subsequently suggested to confirm the findings of CXR. Non-contrast chest CT showed peripheral ground-glass opacities and interlobular septal thickening in almost all segments of both lungs, suggestive of interstitial pneumonia. RT-PCR test using specimens taken from oropharyngeal and nasopharyngeal swabs were positive for SARS-CoV-2. The first patient was discharged after 11 days of hospitalization.

The second patient is a 37-year-old male that came into the emergency unit of a general hospital in Central Jakarta, Indonesia, with a three-day history of subjective fever, dry cough, sore throat, and a mild shortness of breath. The patient disclosed that he had not travelled anywhere in the month prior to the onset of illness, but he was still working in his office right until the disease manifested. The patient worked in the import and export division where he met with many foreign co-workers that came and went out of the country and suggested that he might have been infected by a foreigner that had been confirmed for COVID-19. Physical evaluation showed stable vital signs, except a fever of 38.5°C, and bilateral rhonchi on the basal region of the lungs. Saturation measured using pulse oximetry was 98% with 3 LPM flow oxygen supplementation delivered using nasal cannula. Laboratory results on admission reflected a significant increase in AST and CRP, while procalcitonin levels are normal. Differential blood count showed minor lymphocytopenia and a minor increase in segmented neutrophil. CXR showed infiltrates
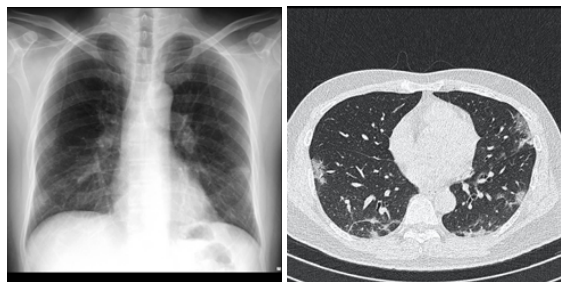
Figure 1. Radiological findings of the first patient. (a). CXR, vague bilateral peripheral ground-glass opacity infiltrates; (b). Chest CT (transverse), bilateral peripheral ground-glass opacity with interlobular septal thickening.
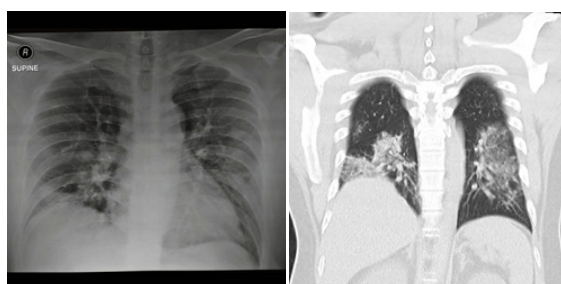

Figure 2. Radiological findings of the second patient. (a). CXR, bilateral ground-opacity in the peripheral section of the lungs, suggestive of pneumonia; (b). Chest CT (coronal), bilateral peripheral ground-glass opacity and multiple consolidated areas with interlobular septal thickening.
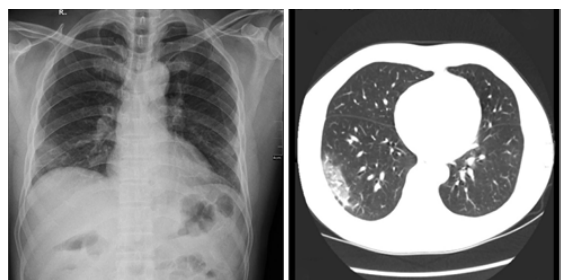

Figure 3. Radiological findings of the third patient. (a). CXR, bilateral pericardial pneumonic infiltrate; (b). Chest CT (transverse), subpleural ground glass opacity with interlobular septal thickening.

in the middle segment of both lungs, suggestive of pneumonia. Non-contrast chest CT showed multiple consolidated areas, with ground-glass opacities and interlobular septal thickening in all segments of both lungs with random distribution (suggestive of pneumonia), and multiple mediastinum lymphadenopathy. RT-PCR test using specimens taken from oropharyngeal and nasopharyngeal swabs were positive for SARS-CoV-2. The second patient was discharged after

12 days of hospitalization.

The third patient is a 57-year-old male that came into the emergency unit of a public hospital in West Jakarta, Indonesia, with a 5-day history of fever, malaise, and headache. The presence of active cough, expectoration, and dyspnea were denied. The patient is a doctor who works at a private clinic and suggested that he might have been infected during his daily practice by a possible COVID-19 patient. Physical evaluation by the physician showed nothing out of the ordinary and stable vital signs, except for a fever of 38.8°C. Saturation measured using pulse oximetry was 98-99% in room atmosphere. Laboratory results on admission reflected a minor increase in procalcitonin levels and an increase in ALT. Differential blood count showed lymphocytopenia and an increase in segmented neutrophil. CXR showed bilateral pericardial pneumonic infiltrate, suggestive of pneumonia. Chest CT showed subpleural ground glass opacity with interlobular septal thickening. COVID-19 antibody rapid test was conducted at admission and the result was negative for both IgM and IgG. RT-PCR specimens were taken from oropharyngeal and nasopharyngeal swabs during admission, but the results are yet to be produced. The third patient was discharged after 14 days of hospitalization.

X-ray and CT Scan

The x-ray equipment used in this case series was Polymobil Plus Mobile X-ray (Siemens Healthineers, Erlangen, Germany). Chest X-ray images were taken on AP supine projection with exposure factors of 100-110 kVp and 4-8 mAs. The CT equipment used in this case series was SOMATOM Definition AS 64 slices (Siemens Healthineers, Erlangen, Germany) with parameters of 120 kV, 124 mAs, and 5 mm image thickness continued with lung and mediastinum window reconstruction. Images were sent to INFINITT PACS (INFINITT Healthcare, Korea) to be read by the radiologists. Senior radiologists with practical experience of 20 years provided expertise for both CXR and chest CT images of each patient.

The patients in this case series were all males with an age range of 37-57 years old. All three had mild to moderate symptoms with the most

Table 1. Baseline characteristics of COVID-19 patients

	Patient 1	Patient 2	Patient 3	Reference range
Sex	Male	Male	Male	
Age	42	37	57	
Comordibities	HT gr I	No	No	
Travel history	No	No	No	
Symptoms				
- Fever	✓	✓	✓	
- Cough	x	✓	x	
- Expectoration	x	x	x	
- Malaise	x	x	✓	
- Headache	x	x	✓	
- Dyspnea	x	✓	x	
- Nausea/vomiting	x	x	x	
- Diarrhoea	✓	x	x	
Lab Results				
- Haemoglobin (g/dL)	13.2	15.3	14.5	13.0 – 17.0
- Thrombocyte ($10^3/\mu$L)	85	191	191	150 - 410
- Leukocyte ($10^3/\mu$L)	3.09	8.20	5.32	4.00 – 10.00
- Lymphocytes (%)	28.5	13	13	20 - 40
- Hs-CRP (mg/L)	16.1	100	No data	<5.0
- D-dimer (mg/L)	520	No data	No data	0 - 500
- Procalcitonin (ng/mL)	No data	0.21	0.18	<0.05
- PT (sec)	12	No data	No data	9 - 13
- aPTT (sec)	33.3	No data	No data	25.0 – 36.5
- Ureum (mg/dL)	40	15.7	25	19 - 44
- Creatinine (mg/dL)	0.90	0.90	0.90	0.73 – 1.18
- AST (U/L)	20	95	34	5.00 – 34.00
- ALT (U/L)	16	36	52	0.00 – 55.00
- O2 saturation	99%	98% with 3 LPM O2	99%	97-100%

Table 2. Chest X-ray and Chest CT findings of COVID-19 patients

	Patient 1	Patient 2	Patient 3
Chest X-ray			
- Unilateral Infiltrate	X	X	X
- Bilateral infiltrate	✓	✓	✓
Chest CT			
- Ground-glass opacity	✓	✓	✓
- Bilateral consolidation	✓	✓	✓
- Interlobular septal thickening	✓	✓	✓
- Pleural effusion	X	X	X

common symptom being fever. Two out of the three patients had lymphocytopenia, while only the first patient had decreased white blood count and platelets. The first and second patient had a significantly high level of CRP, especially the second patient with CRP levels of approximately 20 times over the normal range. The CXR of all three patients showed bilateral infiltrates, suggestive of pneumonia. Chest CT of all three patients showed bilateral subpleural ground-

glass opacity with interlobular septal thickening, also suggestive of pneumonia. RT-PCR for the first and second patient was confirmed positive for SARS-CoV-2. As of the writing of this paper, the RT-PCR result of the third patient is yet to be released. The mean duration of hospitalization was 12.3 days.

DISCUSSION

To our knowledge, as of the writing of this paper, this is the first case series in Indonesia that discusses the importance of chest CT in diagnosing COVID-19. The median age in this study was 42 years old, which is younger than that reported by Guan et al.[6] (47 years old), Wang et al.[7] (56 years old), Zhou et al.[8] (56 years old), and Zhang et al.[9] (57 years old). In accordance with recent studies, the most common clinical symptom in this report was fever, while gastrointestinal symptoms only appeared in one patient in the form of early onset diarrhoea.[6-9] However, out of the three patients, only one manifested dry cough, which, in tandem with fever, were the two most dominant clinical characteristics as reported by several recent studies.[6-9] All three patients had mild to moderate symptoms, most likely due to their relatively young age, with the oldest patient being 57 years old. Studies have shown that older patients tend to manifest more severe symptoms, while younger patients tend to manifest mild to moderate symptoms.[7-10] The mean duration of hospitalization was 12.3 days, quite similar to the data reported by Guan et al.[6] (12.8 days), and Zhou et al.[8] (11.0 days). The patients were discharged based on clinical, laboratory, and radiological improvements. Ideally, two consecutive negative RT-PCR results should be the decisive factor in the discharge of COVID-19 patients. However, due to the continually increasing number of confirmed patients, and limited access to RT-PCR results, physicians adapted and discharged patients based on the improvements of the patients' general conditions and minimalized the chance of transmission by monitoring the number of days since the first onset of their illness.

Although the three patients manifested different clinical symptoms that are mostly mild

and different laboratory findings that are not specifically indicative of COVID-19, all three chest CT scans had uniformed results which point to the diagnosis of COVID-19. Physicians should be aware and not be misled by vague laboratory findings of the patients. Such as in the case of the first patient, where the Tubex®TF rapid typhoid test even suggested a strong positive result for typhoid. The patient received antibiotics prescribed for typhoid, but the fever persisted, and CRP levels kept increasing. Only after the patient received a new therapy regiment (Hydroxychloroquine 2 x 400mg, Azythromycin 1 x 500mg, Vitamin C 2 x 2000mg) did the fever subside and CRP levels started decreasing. To the authors' knowledge, there is no study yet reporting a false positive for Salmonella sp. IgM in COVID-19 patients.

The chest CT findings in this case series were largely consistent with those found in recent studies, with the hallmark of novel coronavirus pneumonia (NCP) being the presence of a bilateral subpleural distribution of ground-glass opacity accompanied by interlobular septal thickening.[5,11] All three patients had positive chest CT findings for COVID-19 before RT-PCR confirmed the diagnosis a few days after, indicating that chest CT is a swift screening tool for COVID-19. Moreover, chest CT has also been exhibited to be able to diagnose COVID-19 accurately, with a sensitivity of over 97% and a specificity of approximately 25%.(3, 4) The study of Fang et al. has even argued that chest CT is a more reliable alternative to RT-PCR in diagnosing COVID-19 patients, due to various variables that could potentially render the results of RT-PCR invalid.[4] While Shi et al.[5] proposed that chest CT could be used to screen asymptomatic COVID-19 patients, the study of Ai et al.[3] has suggested that there is a mean delay of around 5 days for serial RT-PCR test to turn from initial negative to positive. As a delay in diagnosis could translate into a delay in proper patient management, a swift and accurate diagnostic tool is desperately needed, especially in a pandemic such as this. Nevertheless, as essential of a modality CT is, the safety and health of the radiographers, radiologists, healthcare workers and patients are of the utmost importance, as per

the current statement from the American College of Radiology. Therefore, precautionary steps should be taken to limit the spread of COVID-19 and to ensure minimal radiation exposure to both patients and healthcare workers.

The authors are aware that there are still limitations to this study. First, the population of this study was small, and might not represent a genuine condition in a natural environment. The inclusion of more patients would naturally paint a more comprehensive picture of the importance of chest CT findings in COVID-19 patients. Second, this study only fixated on the baseline chest CT findings that the physicians first encountered, without including findings from follow-up CT scans. The inclusion of follow-up CT scans could potentially highlight the importance of chest CT in following disease progression. Third, this study only included the baseline laboratory results of the patients on admission, excluding other laboratory exams that the physicians initially deemed unnecessary before the confirmation of the diagnosis of COVID-19. More comprehensive laboratory findings could give a more vivid understanding of the overall condition of the patients, and insight to prognosis.

CONCLUSION

From this case series, we highly suggest the use of non-contrast chest CT to diagnose COVID-19 in patients showing moderate symptoms with any vague findings from chest x-ray despite a negative outcome for RT-PCR. The decision to use CT to confirm inconclusive findings from chest x-ray should be deliberately taken by the responsible physician based on established clinical pathways and guidelines.

REFERENCES

1. Guo YR, Cao QD, Hong ZS, et al. The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak - an update on the status. Mil Med Res. 2020;7(1):11.

2. Organization WH. Laboratory testing for coronavirus disease 2019 (COVID-19) in suspected human cases: interim guidance, 2 March 2020. World Health Organization; 2020.

3. Ai T, Yang Z, Hou H, et al. Correlation of chest CT and RT-PCR testing in coronavirus disease 2019 (COVID-19) in China: a report of 1014 cases. Radiology. 2020:200642.

4. Fang Y, Zhang H, Xie J, et al. Sensitivity of chest CT for COVID-19: comparison to RT-PCR. Radiology. 2020:200432.

5. Shi H, Han X, Jiang N, et al. Radiological findings from 81 patients with COVID-19 pneumonia in Wuhan, China: a descriptive study. Lancet Infect Dis. 2020;20(4):425-34.

6. Guan WJ, Ni ZY, Hu Y, et al. Clinical characteristics of Coronavirus disease 2019 in China. N Engl J Med. 2020.

7. Wang D, Hu B, Hu C, et al. Clinical characteristics of 138 hospitalized patients with 2019 Novel Coronavirus-infected pneumonia in Wuhan, China. JAMA. 2020.

8. Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet. 2020.

9. Zhang JJ, Dong X, Cao YY, et al. Clinical characteristics of 140 patients infected with SARS-CoV-2 in Wuhan, China. Allergy. 2020.

10. Chen N, Zhou M, Dong X, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet. 2020;395(10223):507-13.

11. Zhao X, Liu B, Yu Y, et al. The characteristics and clinical value of chest CT images of novel coronavirus pneumonia. Clin Radiol. 2020.