Original Article

Chest Radiography and CT Scan as Predictor Factors for Long COVID

Reny Luhur Setyani[1], Srie Retno Endah[2], Ana Majdawati[3], Muhammad Hafiz[4], Farsida[5], Rahma Ayu Larasati[6], Tutwuri Handayani[7], Khatarina Setyawati[8]

[1]Department of Radiology, Jakarta Islamic Hospital, Faculty of Medicine Universitas Muhammadiyah Jakarta, Jakarta, Indonesia
[2]Department of Radiology, Budi Asih Hospital, Jakarta, Indonesia
[3]Department of Radiology, Yogyakarta Islamic Hospital, Yogyakarta, Indonesia
[4]Department of Pulmonology, Budi Asih Hospital, Jakarta, Indonesia
[5,6,7,8]Faculty of Medicine Universitas Muhammadiyah Jakarta, Jakarta, Indonesia

Abstract

Background: Long COVID presents a significant challenge in the management of COVID-19 patients, necessitating risk stratification and early intervention to mitigate its impact.

Objective: This retrospective cohort study aimed to establish a predictive link between initial clinical assessments and imaging findings upon COVID-19 diagnosis and the subsequent development of long COVID symptoms at 6-8 weeks post-treatment.

Methods: The study analyzed chest radiography images utilizing the Brixia Score and chest CT scans employing the Severity Score at the time of COVID-19 diagnosis. These findings were then compared with the presence of long COVID symptoms.

Results: Among 54 study participants, 63% were non-elderly and 37% were elderly, with a nearly equal gender distribution. Notably, 74.1% of patients developed long COVID symptoms. The Brixia Score identified 38.9% as mild, 37% as moderate and 24.1% as severe lung involvement. Correspondingly, the Severity Score from chest CT scans revealed 33.3% with mild, 53.7% with moderate, and 13% with severe lung abnormalities. Statistical analysis confirmed strong correlations between both the Brixia Score (r=0.553) and the Severity Score (r=0.733) with the development of long COVID symptoms (*P*=0.0001).

Conclusion: This study underscores the significant predictive value of both the Brixia Score and the Severity Score in identifying COVID-19 patients at risk of developing long COVID. These findings have critical implications for early risk stratification and targeted intervention strategies to prevent long COVID's debilitating effects.

Keywords: Brixia, COVID-19, long COVID, severity score

Corresponding Author:
Rahma Ayu Larasati | Faculty of Medicine University of Muhammadiyah Jakarta, Jakarta, Indonesia | rahmaayularasati@umj.ac.id

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INTRODUCTION

Corona Virus Disease 2019 (COVID-19) is an infectious disease caused by the novel coronavirus, which since December 2019 has spread from China to the rest of the world and was declared a global pandemic by the World Health Organization (WHO) on March 11th, 2020. This infection can cause severe pneumonia and even fatal acute respiratory syndrome.[1]

The spectrum of infection severity ranges from asymptomatic to mild, which is observed in a total of 81% of cases; moderate symptoms (14% of total cases) with shortness of breath, hypoxia, or involvement of more than half of the lung on chest radiograph; severe (5% of cases) with respiratory failure, shock, or multiorgan dysfunction.[2] The mortality rate in the world is 2.38% for reported non-critical cases. Severe disease can occur in healthy people of all ages but is most commonly found in the elderly or patients with co-morbidities such as cardiovascular disease, diabetes mellitus, hypertension, chronic pulmonary disease, lung cancer, malignancy, metastatic disease, chronic kidney disease, obesity and tobacco-related diseases.[2]

Laboratory findings related to severity include lymphopenia, thrombocytopenia, neutrophil-lymphocyte ratio >3.3; increases in aspartate aminotransferase (AST), alanine aminotransferase (ALT) (37%), lactate dehydrogenase (LDH), increases inflammatory markers such as C-Reactive

Protein (CRP), ferritin, D-dimer (>1 mcg/ml), prothrombin time, troponin, creatinine phosphokinase, and acute renal failure.[2] Although chest radiography is considered insensitive for detecting lung involvement in its early stages, in emergencies, standard or bedside chest radiography becomes an important diagnostic tool for monitoring the day-to-day development of unstable lung conditions in COVID-19, especially in critical conditions (ICU patients).[3]

Long COVID is a condition where the patient does not recover after several weeks or months after getting the initial symptoms of COVID-19, regardless of whether they are examined or not.[4] Many COVID-19 patients who are hospitalized still experience further symptoms such as shortness of breath, coughing, fatigue, and mental disorders. In many cases, not only severe COVID-19 cases but also mild cases have recurring symptoms including constant fatigue, headaches, chest pains, myalgias, palpitations, and even cognitive impairments such as poor memory and concentration.[4]

WHO defines "long COVID" or "post-COVID-19 syndrome" as characterized by the persistence of symptoms in individuals who have had confirmed or probable SARS-CoV-2 infections. This condition is defined as the presence of symptoms lasting for at least two months, with an initial onset occurring within three months of the acute COVID-19 infection.[5]

Commonly reported symptoms include fatigue, an altered sense of smell (anosmia), and anxiety, although other symptoms have also been documented. These lingering symptoms significantly affect daily functioning, impacting areas such as eating habits, physical activity, behavior, academic performance, social interactions with friends and family, and developmental milestones.[5]

Symptoms may either appear anew after initial recovery from acute COVID-19 or continue from the initial illness, exhibiting fluctuations or relapses over time. It is worth noting that while further diagnostic investigations may identify additional medical conditions, the presence of such conditions does not negate the diagnosis of post-COVID-19 conditions, underscoring the complexity of managing these cases and the need for ongoing research and clinical care.[5]

In the majority of patients recovering from severe COVID-19, significant pulmonary fibrosis is found. Chest radiography is used to diagnose and evaluate disease progression in the lungs. However, follow-up chest radiography did not correlate with abnormal CT findings or permanent functional impairment. Chest radiography is an independent risk factor for poorer prognosis in COVID-19 patients, where 86% have an abnormal Chest CT after 3 months. In this study, changes in Chest radiography findings were correlated with recovery time, and abnormal findings were reported to be significantly correlated with COVID-19 severity.[6]

METHODS

This study was conducted at Budhi Asih Hospital between December 2021 and May 2022. We enrolled 54 consecutive patients (28 males and 26 females) in a retrospectively designed study. The inclusion criteria were adults over 18 years old with a history of hospitalization due to moderate, mild, or severe COVID-19 conditions, a current PCR of negative result, and a complete Chest X-ray and Chest CT when admitted to the hospital. Patients with massive pleural effusion and pneumothorax were excluded.

All data from the study sample were identified and recorded, including all symptoms for 6-8 weeks after hospitalization. Initial chest radiographs were analyzed using the Brixia score, while initial chest CTs were analyzed using the severity score. This study was designed as a retrospective cohort to analyze chest radiography using the Brixia score and chest CT scan using the severity score from the initial findings. The result will be used as a predictor of long COVID.

Chest radiography was performed on a mobile digital x-ray machine (Mobilett Elara Max, Siemens, Forchheim, Germany). The patient is positioned upright or supine, with the trachea centered and equidistant from the clavicular heads on either side,

the spine visible as a transparent structure through the cardiac shadow, and a full inspiratory effort if possible. Standard exposure parameters are 80 kVp and 2 mAs.

Chest CT was performed without contrast administration on a 128-multislice detector CT system (Revolution Maxima, GE, Waukesha, Wisconsin). All patients were positioned supine (headfirst, arms above head) right at the isocenter of the gantry. The scanning range extends from the level of the tracheal bifurcation to the diaphragm. The following scan parameters were used: 2x64x0.625 mm detector collimation with resulting slice acquisition of 2x128x0.625 mm via a z-flying focal point, 280 msec gantry rotation time, and 3.4 pitch. This study was approved by the local ethical committee, and informed consent was obtained from all patients.

RESULTS

Table 1 depicts an almost equal proportion of age, gender, and comorbid characteristics. However, the proportion of characteristics based on lab results shows a greater proportion of abnormal lab results.

Table 1. Frequency Distribution of Patient Characteristics

Characteristics	n	%
Age		
Non-elderly	34	63.00
Elderly	20	37.00
Gender		
Women	26	48.10
Man	28	51.90
Comorbid		
No	29	53.70
Yes	25	46.30
Lab Result (PCR, NLR)		
Normal	2	3.70
Abnormal	52	96.30

Table 2. Frequency Distribution of Variable

Variable	n	%
Brixia Score		
Mild	21	38.9
Moderate	20	37.0
Severe	13	24.1
Severity Score		
Mild	18	33.3
Moderate	29	53.7
Severe	7	13.0
Long COVID symptoms		
No	16	29.6
Yes	38	70.4

Whereas in Table 2, it was observed that most subjects had mild Brixia Score (38.9%), moderate Severity Score (53.7%), and long COVID symptoms (70.4%) people with a severe Severity Score (13.0%).

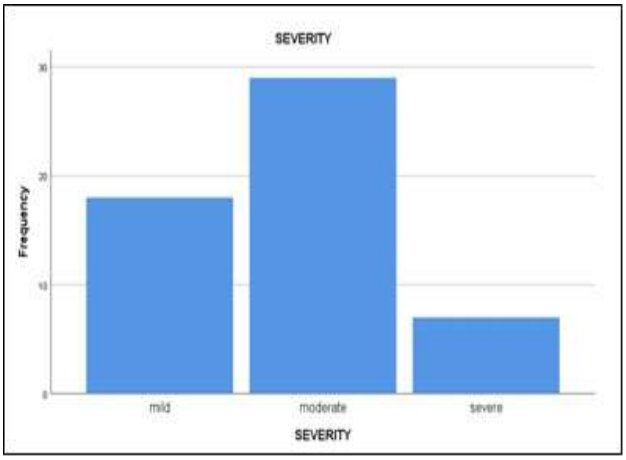

Figure 1. Severity Score

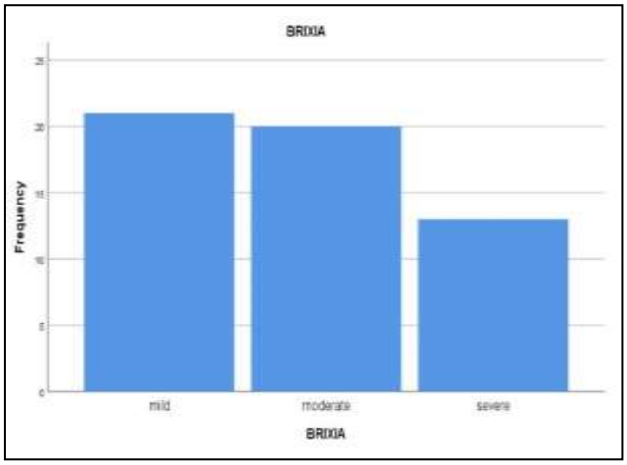

Figure 2. Brixia Score

Figure 1 shows that there are more moderate Severity Scores than mild and severe. Figure 2 shows that the mild Brixia Score is higher than the moderate and severe.

Table 3. Brixia Score and Severity Score for Long COVID Symptoms (N=54).

Variable	Long COVID symptoms		Total	r	*P*
	No	Yes			
Brixia Score					
Mild	13	8	21		
Moderate	3	17	20	0.553	0.0001
Severe	0	13	13		
Severity Score					
Mild	15	3	18		
Moderate	1	28	29	0.733	0.0001
Severe	0	7	7		

In Table 3, it can be concluded that the correlation between the Brixia score and long COVID

symptoms has r=0.553 with a strong relationship, and *P*=0.0001 which means there is a correlation. The correlation between severity score and long COVID symptoms has r=0.733 with a strong relationship, and *P*=0.0001 which means there is a relationship. It can be concluded that the higher the results of the Brixia score and severity score, the higher the long COVID symptoms.

DISCUSSION

The correlation between the Brixia score and severity score for long COVID symptoms shows a strong relationship (Table 3). The Brixia score correlates strongly with disease severity and outcome and also can support clinical decision-making.[7] It can even determine the fatality of a disease that results in death if the score is higher than 12.[8] Although the Brixia score can predict mortality, it cannot predict the length of stay of confirmed COVID-19 patients who are hospitalized.[9,10]

LIMITATION

This study used retrospective data so the data obtained was less comprehensive. There was a potential for bias in the data because the patient's symptoms were subjective. There was also the possibility of other co-morbidities outside those studied, thus disguising the symptoms of long COVID itself.

CONCLUSION

There is a significant relationship between Brixia score based on chest radiography and long COVID symptoms. There is also a significant correlation between severity scores based on chest CT scans and long COVID symptoms. Researchers feel the need to dig deeper into the symptoms of long COVID patients, supplemented by radiological images with chest CT scan modalities and chest radiography, which can be used to predict long COVID patients.

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CONFLICT OF INTEREST

There is no conflict of interest.

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