

Correlation Between COVID-19 Severity Status and the Thoracic CT-Scan Examination Results: A Cross Sectional Study

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ABSTRACT

Coronavirus Disease 2019 (COVID-19) has been a pandemic for two years after the World Health Organization (WHO) initially announced it on March 11, 2020. The conventional diagnosis of COVID-19 is often made using a reverse transcription polymerase chain reaction (RT-PCR) and supported by radiographic examinations such as chest CT-SCAN which is regarded to be an additional modality to help quantify the severity of COVID-19 disease. This study's objective is to examine the link between the severity of cases and the chest CT-SCAN pictures observed in COVID-19 patients. The study was conducted at the Wahidin Sudirohusodo Hospital in Makassar. To determine the association between the severity of COVID-19 and the CT-SCAN image of the thorax, a cross-sectional study was conducted and statistical analysis was performed using the chi-square test. A study of 382 samples revealed that the majority of COVID-19 case subjects with a significant relationship to the severity of severe cases were male, older than 50 years, smokers, with comorbid diabetes mellitus, hypertension, kidney failure, heart disease, and evaluation of typical chest CT-SCAN images. Tests of statistical significance revealed a correlation between extreme clinical severity and severe CT-SCAN pictures of the thorax. The thoracic CT-SCAN can modalities shown has a benefit to be utilized as a diagnostic and evaluating tool of the patients.

Keywords: Covid-19, case severity status, thoracic CT-scan examination

INTRODUCTION

Coronavirus Disease 2019 (COVID-19) has been a pandemic for 2 years in the world after it was first announced by the World Health Organization (WHO) on March 11, 2020. The peak of COVID-19 cases occurred in January 2021 with the number of daily cases reaching 14,000 new case.(1–3) The diagnosis of COVID-19 is generally assessed using a reverse transcription polymerase chain reaction (RT-PCR) examination as the gold standard of examination. However, this examination has a weakness in the form of not being able to assess clinical symptoms and functional damage to infected organs, especially the lungs.(4,5)

In the early days of the pandemic, CT-SCAN was used as the main tool for detecting and diagnosing COVID-19 in epidemic areas with high sensitivity but low specificity. This is because the CT-SCAN image of the thorax in COVID-19 patients is difficult to distinguish from other viral infections. However, the high sensitivity of thoracic CT-SCAN can be used as a good assessment of the severity of COVID-19 confirmed patients. Thoracic CT-SCAN imaging is an effective method for detecting

lung abnormalities in COVID-19 patients. Several studies have shown that the involvement of lung segment and lobe damage is characterized by the formation of consolidation, GGO and air bronchograms indicating a severe degree of severity.(6–8) The study by Yang et al., proposed the method of chest computed tomography severity score (CT-SS) which divided the lung into 20 sections based on lung segments and assigned an assessment based on the involved parenchymal opacification and had a sensitivity of 83.3% and a specificity of 94%. Kunwei et al., proposed a total severity score (TSS) method based on CT-SCAN abnormalities of 5 lung lobes. This method can identify severe and critical severity with a sensitivity of 82.6% and a specificity of 100%. Minhua et al., conducted a study comparing chest CT-SCAN images of 70 patients with COVID-19 which showed that patients with severe symptoms had more lung lobe involvement than patients with mild symptoms.(4,9,10) Therefore, it can be seen that the assessment of thoracic CT-SCAN images can have an important role in assessing the diagnosis, staging and monitoring of COVID-19 patients. Previous research regarding the relationship between the severity of cases and the CT-SCAN image of the thorax in COVID-19 patients has not had much literature, so on the basis of this thought, this study was conducted with the aim of knowing the relationship between the severity of the case and the CT-SCAN image of the thorax in patients with COVID-19.

METHOD

Design

This type of research is a cross sectional study by taking medical record data from June 2020 - June 2021, COVID-19 patients who meet the inclusion criteria. The research was conducted at Wahidin Sudirohusodo Hospital Makassar by collecting medical record data from April to May 2022.

Study participants

The research sample is the entire affordable population that meets the inclusion and exclusion criteria, by means of random sampling. The inclusion criteria set included patients with confirmed COVID-19, aged 18 - 65 years and had a thoracic CT-SCAN examination with expertise.

Data collection

All medical record status of confirmed COVID-19 patients was collected from June 2020 – June 2021 at Wahidin Sudirohusodo Hospital, Makassar. The data contains information regarding clinical information and the results of laboratory examinations that are tested for correlation with the results of radiological examinations in the form of a CT-scan of the thorax. Data obtained from medical records were entered into master tables and matrices using Microsoft excel program, then processed using SPSS for windows ver.21 for further analysis.

Objective Criteria

In this study, the severity of cases was assessed based on the WHO criteria as written in the medical record. Severe is a COVID-19 patient with one of the following signs, namely oxygen saturation <90% in an ordinary room, signs of pneumonia (fever, cough, shortness of breath, rapid breathing), signs of severe respiratory distress (use of accessory muscles of respiration, inability to pronounce 1 complete sentences, respiratory rate > 30 breaths per minute), ARDS, sepsis, septic shock or other conditions requiring life support therapy such as mechanical ventilation or vasopressors. Meanwhile, non-severe is defined as not including severe criteria. The objective criteria for the results of a thoracic CT-SCAN examination are divided into: 1) Typical is the result of a chest CT-SCAN reading that shows bilateral Ground glass opacities (GGO) with or without consolidation with peripheral distribution or there is a crazy paving pattern, multifocal GGO with a round shape with or without consolidated and reversed halo sign. Has lobe involvement 2 lobes. 2) Indeterminate is unilateral, peripheral GGO

with or without consolidation with an unspecified distribution. Lobe involvement 1 lobe. 3) Atypical are lobar or segmental consolidation, nodules, cavities, interlobar septal thickening and pleural effusion with involvement of 1 lobe.

Data analysis and interpretation

The normality test of the data used the Komogorov-Smirnov/Shapiro-Wilk. Numerical data analysis used unpaired T-test with alternative Mann-Whitney test. To see the correlation between CT-SCAN images and the severity of cases, the Spearman correlation test was performed. Analysis of the relationship on categorical variables was carried out by using the Chi-Square test. The research data are presented in the form of narration, tables and pictures/graphics. Presentation in narrative form is used to explain tables or pictures.

RESULTS

This study was conducted at the Wahidin Sudirohusodo Hospital Makassar to assess the relationship between the clinical severity of COVID-19 cases and the CT-SCAN of the thorax. Sampling was carried out on medical records of COVID-19 patients who were treated during the period June 2020 – June 2021 who had met the inclusion and exclusion criteria. Total subjects who met the inclusion criteria were 382 subjects consisting of 255 degrees of severity of non-severe cases and 127 subjects of severe severity. This research is guided by the approval of the Ethics Committee of the Faculty of Medicine, Hasanuddin University with the number: 207/UN4.6.4.5.31/PP36/2022. This study looked at the medical records at the time the patient was admitted to the hospital.

Table 1. Basic Characteristics of Research Subjects

Charachteristic	Total sample (N=382)	Percentage (%)	Case Severity	
			Odd Rasio	Confidence Interval 95%
Gender				
Man	218	57.1	1.21	1.01-1.43
Woman	164	42.9	0.75	0.58-0.99
Age				
50 years	170	44.5	0.55	0.41-0.75
> 50 years	212	55.5	1.48	1.48-1.25
Smoking History				
Not a smoker	152	39.8	0.74	0.67-0.90
Smoker	230	60.2	1.50	1.17-1.90
Comorbid diseases				
Diabetes mellitus	70	18.3	1.69	1.11-2.57
Hypertension	174	45.5	1.52	1.23-1.87
COPD	6	1.6	0.40	0.47-3.40
Pulmonary TB	27	7.1	0.57	0.23-1.38
Kidney failure	42	11.0	2.67	1.51-4.74
Heart disease	79	20.7	2.94	1.98-4.38
Malignancy	51	13.4	1.40	0.83-2.35
CT-SCAN classification				
Atypical	63	16.5	0.33	0.17-0.65
indeterminate	143	37.4	0.55	3.97-0.78
Typical	176	46.1	1.96	1.59-2.40
Case Severity				
Non-severe	255	66.8		
Severe	127	33.2		

Based on table 1, it is known that the prevalence of patients with COVID-19 status increases in the population, male sex has a 1.21-fold risk, age 50 years has a 1.48-fold risk, smokers have a 1.5-fold risk, comorbid diabetes mellitus has a 1.69-fold risk., hypertension had a 1.52-fold risk, kidney failure had a 2.67-fold risk, heart disease had a 2.94-fold risk, malignancy had a 1.4-fold risk and typical chest CT-SCAN

images had a 1.96-fold risk. In this study, 66.8% of patients had non-severe status and 33.2% patients had severe status.

The most common abnormalities were Consolidation as many as 261 subjects (68.3%), GGO as many as 252 subjects (66%), Fibrosis as many as 82 subjects (21.4%), Pleural Effusion as many as 60 subjects (15.7%), Cavity with 15 subjects (3.9%), Nodules as many as 14 subjects

(3.6%), bronchiectasis as many as 6 subjects (1.5%) this is illustrated in table 2.

Table 2. Types of Abnormalities of Thoracic CT-SCAN

Characteristics	Total sample (N=382)	Percentage (%)
GGO	252	66.0
Consolidation	261	68.3
Pleural Effusion	60	15.7
Fibrosis	82	21.4
Cavity	15	3.9
Nodules	14	3.6
Bronchiectasis	6	1.5

Table 3. Analysis of Severity with CT-SCAN of the COVID-19 Thoracic Image

Severity level	CT-Scan classification				OR	95% CI
	Atypical	Indeterminate	Typical	p-value		
Severe	21 (16.5%)	20 (15.7%)	86 (67.7%)	≤0.001	2.54	1.85-3.49
Non-severe	79 (31%)	61 (23.9%)	115 (45.1%)		0.62	0.53-0.73

In table 3, the most common chest CT-SCAN images with typical status are 46.1% cases, 37.4% indeterminate and 16.5% atypical. In this study, the severity of WHO was statistically significant with a CT-SCAN of the thorax COVID-19 ($p < 0.05$). The degree of clinical severity was not severe and had atypical CT-SCAN findings in 79 subjects 79 (31%), indeterminate as

many as 61 subjects (23.9%), typical as many as 115 (45.1%). The severity of clinical severity had atypical chest CT-SCAN as many as 21 subjects (16.5%), 20 subjects (15.7%) indeterminate, and typical 86 subjects (67.7%). From the results of this study, it was found that severe severity had a 2.54-fold risk of having a typical thoracic CT-SCAN image.

Table 4. Analysis of Severity with Comorbid

Comorbid disease	Severity level		Total	P-value	Odd Ratio	Confidence interval 95%
	Mild	Severe				
Diabetes mellitus	38(14.9%)	32 (25.2%)	70 (18.3%)	0.017	1.69	1.11-2.57
Hypertension	99(38.8%)	75 (59.1%)	174 (45.5%)	≤0.001	1.52	1.23-1.87
COPD	5(2%)	1(0.8%)	6(1.6%)	0.660	0.40	0.47-3.40
Pulmonary TB	21(8.2%)	6(4.7%)	27 (7.1%)	0.280	0.57	0.23-1.38
Kidney failure	18(7.1%)	24 (18.9%)	42 (11.0%)	0.001	2.67	1.51-4.74
Malignancy	30(11.8%)	21 (16.5%)	51 (13.4%)	0.200	1.40	0.83-2.35
Heart disease	32(12.5%)	47(37%)	79 (20.7%)	≤0.001	2.94	1.98-4.38

In table 4, we found that some comorbid diseases were present in covid-19 patients and has an association with CT-SCAN image. The chest CT-SCAN images obtained from this study have been grouped according to the type of abnormality, distribution of lesions and lobe involvement. Thoracic CT-SCAN images that did not include the typical features of COVID-19 were included in the atypical group, so the results of the typical thoracic CT-SCAN were not influenced by comorbid subjects but were purely COVID-19 features.

DISCUSSION

In this study, it was found that the most common types of thoracic CT-SCAN abnormalities with consolidation were 261 subjects (68.3%), GGO as many as 252 subjects (66%), Fibrosis as many as 82 subjects (21.4%), Pleural effusion as many

as 60 subjects (15.7%), Cavity with 15 subjects (3.9%), Nodules as many as 14 subjects (3.6%), Bronchiectasis with 6 subjects (1.5%). Several studies reported that the typical or typical abnormality found on CT-SCAN COVID-19 was GGO with or without consolidation with peripheral, posterior and diffuse locations in the lower lung. The picture of GGO can be in the form of a round or multifocal shape called the crazy paving pattern. Other features are indeterminate, i.e., non-specific features of pneumonia such as GGO with or without consolidation with a non-specific or unilateral distribution. Other features are atypical or atypical, that is, there are no features mentioned in typical and indeterminate, such as no GGO or consolidation without GGO. A meta-analysis study from Bao et al. reported that the incidence of GGO in COVID-19

patients was 83.31%, consolidation was 43.97%, GGO with consolidation was 58.42%, crazy paving was 14.81%, pleural effusion was 5.88%, bronchiectasis was 5.42%. (11,12)

Subjects with the non-severe cases had the most thoracic CT-SCAN images in the form of typical as much as 45.1%, atypical 31% and indeterminate 23.9%. On the other hand, the severe cases had the most chest CT-SCAN images in the form of typical in 67.7%, atypical 16.5% and indeterminate 15.7%. The results of this study indicate that there is a statistically significant relationship with $p < 0.05$. A meta-analysis study by Hashemi et al. reported that bronchial wall thickening was associated with an 11.64-fold association with severe severity. The crazy paving pattern has a risk of 7.60 for severe severity, linear opacity has a 3.27-fold risk for severe severity and GGO has a 1.37-fold risk for severe severity. While the consolidation itself was not significantly related to the severity of the severity. Bilateral distribution of lesions also had a 3.44-fold risk for severe severity. In this study, it was found that severe severity had a 2.21-fold risk of finding GGO and 2.48-fold of finding consolidation on chest CT-SCAN images.(13)

The study by Salehi et al. reported a significant association between chest CT-SCAN images and clinical manifestations based on the number of lobes, distribution of lesions, presence of consolidation, total severity score, and lesion volume.(14) Bilateral, multilobar GGO with peripheral distribution, mainly in the lower lobe is the most common chest CT-SCAN manifestation of COVID-19. The more progressive a COVID-19 case is, the more visible consolidation distributed in the peripheral, central, and all lobes of the lung will be seen. In addition, the total severity score and lung lesion volume were higher in the severity of the severe cases. The study of Lyu et al. reported that the dominant chest CT-SCAN abnormality in COVID-19 patients was GGO and bilateral and peripheral consolidation.(15)

This thoracic CT-SCAN image is due to the initial alveolar damage due to viral invasion of the lung interstitium such as alveolar edema, exudate, and interlobular thickening that progresses to diffuse alveolar damage with fibromyxoid cellular exudate as the disease progresses. The involvement of lung segments and lobes increases as the disease progresses. Severe severity had more segment and lobe involvement than nonsevere severity and increased consolidation and GGO features.(16,17)

In this study, the degree of severe clinical severity had the most CT-SCAN abnormalities in the form of GGO (77.2%) and consolidation (84.3%). In this study, the dominant types of CT-SCAN images were consolidation and GGO with bilateral distribution. The same thing was also reported by Shen et al., and Shi et al., who showed septal thickening, crazy paving patterns and consolidation in severe severity.(18)

CONCLUSION

The severity of the clinical manifestation was shown to correlate with the extent of the chest CT-SCAN abnormalities. Male gender, age >50 years, smokers, concomitant diabetes mellitus, hypertension, kidney failure, heart disease, and typical chest CT-SCAN pictures were significantly associated with severity. Non-severe severity typically displays an intermittent CT-SCAN image, whereas severe COVID-19 status displays a typically chest CT-SCAN image. Severe clinical status was associated with a 2.54-fold increased likelihood of having a Typical CT-SCAN image.

Conflict of Interest: None

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