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Original Article

Significant Relationship between Brixia Score and The Degree of Acute Respiratory Distress Syndrome in Covid 19 Patients

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Abstract

Background : Chest X-ray has an important role in detecting early features of COVID-19. To improve risk stratification, a scoring system in chest x-ray called Brixia Score was developed. The Brixia score is designed to measure the severity of lung abnormalities in COVID-19, with an 18-point severity scale. Deaths in COVID-19 occur mainly due to Acute Respiratory Distress Syndrome (ARDS). ARDS is classified into mild, moderate, and severe degrees. If the degree can be predicted earlier, patients can receive earlier therapy and death rate can be reduced. This study was aimed to analyze relationship between Brixia Score and degree of ARDS in COVID-19 patients.
Methods : the research used an observational analytic method with a cross-sectional approach to 95 subjects who are positive for COVID-19 and diagnosed with ARDS, in January to December 2021. Brixia Score data was collected based on chest X-ray expertise, ARDS degree was based on medical records and blood gas analysis. Analysis of relationship between Brixia score and degree of ARDS was carried out using the Kruskal-Wallis test.
Results : There was a significant difference in Brixia score based on degree of ARDS (*p-value* <0.05). The highest Brixia score was obtained in severe ARDS, while the low Brixia score was obtained in mild ARDS. This proves that there is a relationship between Brixia score and degree of ARDS.
Conclusion : Brixia score has a significant relationship to the degree of ARDS in COVID-19 patients.

Keywords : ARDS, Brixia Score, COVID-19, degree of AR

INTRODUCTION

COVID-19 (*Coronavirus disease* 2019) is an infectious disease caused by the *severe acute respiratory syndrome coronavirus-2* (SARS-CoV-2 virus). The COVID-19 diagnosis is established based on the combination of medical history, contact tracing, physical examination, laboratory examination, radiology examination, and a definitive diagnosis by conducting a *reverse transcriptase polymerase chain reaction* (RT-PCR) test to obtain its result. The chest X-ray and the chest *computed tomography* (CT) scan play crucial roles in the COVID-19 diagnosis, as a modality to detect the imaging features of early COVID-19. In this way, it helps the physician determine the diagnosis before the RT-PCR result is ready.[1–6]

In order to improve risk stratification and help physicians determine the needs of high-risk patients, a chest X-ray scoring system for the COVID-19 lesion has been developed. It is known as the Brixia Score. This is a semi-quantitative scoring system that is designed to measure the degree of lung disease severity in COVID-19, in which the role of the lung is scored on an 18-point severity scale based on the total width and the disorder characteristic of the lungs. [7–11]

Deaths in COVID-19 are mainly caused by *acute respiratory distress syndrome* (ARDS). Based on the ratio of *partial pressure arterial oxygen* (PaO_2) divided by the *fraction of inspired oxygen* (FiO_2), the ARDS is classified into the stages of mild, moderate, and severe. A patient who develops the ARDS is at a higher risk of 45% death rate. When the stages of ARDS are detected earlier, it is expected that a patient will undergo faster and more precise therapy. Furthermore, prognosis improvement can be made to meet the reduction in mortality rate.[12–16]

This research aims to investigate the relationship between the Brixia Score and the stages of ARDS in COVID-19 patients.

METHODOLOGY

This research has been declared as ethically appropriate by the Health Research Ethical Committee (KEPK) of Dr. Kariadi Central General Hospital (RSUP) Semarang.

This research applied the observational analytic method with a retrospective cross-sectional study on 95 research subjects who had been confirmed positive for COVID-19 and had been hospitalized from January to December 2021 and diagnosed with ARDS. The inclusion criteria are as follows: a) the patients who were positive for COVID-19 and had been examined with RT-PCR; b) the chest X-ray examinations and the Brixia score calculations were done on the first day when the patients were hospitalized; c) blood gas analysis were done on the first day when the patients were hospitalized and the ratio of the PaO_2/FiO_2 less than or equal to 300 mmHg; c) during the X-ray processes and blood gas tests, the patients had not received mechanical ventilation assistance; d) The patients' data had been stated in the medical records. The exclusion criteria are patients with congestive heart failure, pleural effusion, severe lung disease history, and tuberculosis.

The research subjects' data were collected from the medical records, chest X-ray examination data, and the radiologist expertise of the patients' chest X-rays. The following step was to make inclusion and exclusion based on the defined criteria. The data that had been obtained was secondary. Next, the analysis of the relationship between the Brixia Score and the stages of the ARDS was conducted with the Kruskal-Wallis test.

RESULTS

This research included 95 research subjects, consisting of 60 males (63.2%) and 35 females (36.8%). The mean of the subjects' ages is 57.31, with the youngest at 22 years old and the oldest at 83 years old, and the median is 58 years old. The treatments resulted in 56 recovered subjects (59%) and 39 dead subjects (41%). Out of 95 subjects, there are 23 subjects (24.2%) with hypertension as the comorbidity, and 46 subjects (48.4%) with diabetes mellitus as the comorbidity (Figure 1).

Based on the chest X-ray evaluations on the first day the subjects were hospitalized, the average number of Brixia Score is 9.6 out of the 95 research subjects, with the median of the Brixia Score at 10 (Table 1). Furthermore, this research found that there are subjects with Brixia score at 0 and marked it as the minimum score, and there are subjects with Brixia score at 18 and marked it as the maximum score. The analysis of the chest X-rays was aimed at finding lesion characteristics in the subjects. Nevertheless, it discovered 1 subject with a normal chest X-ray (1.05%) and 94 subjects with abnormalities on the chest X-rays (98.95%). These abnormalities consist of 85 subjects with bilateral lesion distributions (89.4%), 67 subjects with dominant interstitial infiltrate lesion patterns (71.2%), and the majority of subjects (86 subjects) with lesion zonation on the left lower lung fields (91%) (Table 2).

Based on the *ratio of partial pressure arterial oxygen to fraction of inspired oxygen* (PaO_2/FiO_2) calculation, the result obtained the mean value at 167.97, followed by the median value at 99.50, the minimum value at 29.50, and the maximum value at 284.69 (Table 3). The result shows that out of the 95 research subjects, there are 13 samples (13.7%) with mild ARDS, 26 samples (27.4%) with moderate ARDS, and 56 samples (58.9%) with severe ARDS (Table 4).

Table 5 shows the correlation test between the Brixia Score and the *ratio of partial pressure arterial oxygen to fraction of inspired oxygen* (PaO_2/FiO_2) resulted in a *p-value* equaling 0.015, which means that the p-value is less than 0.05 ($p < 0.05$) and the correlation coefficient equals -0.248

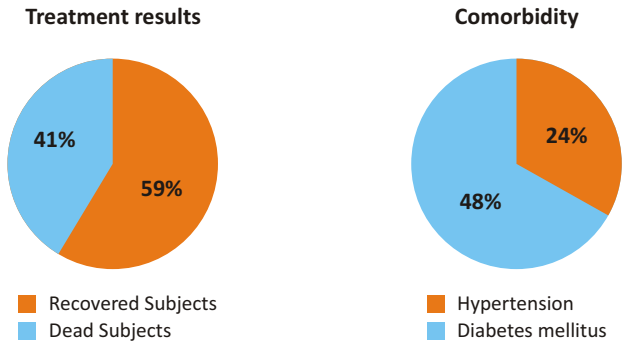

Figure 1. Treatment results and Comorbidities of the Subjects

TABLE 1
Brixia Score Descriptions of the Chest X-rays

Variable	Mean ± SD	Median (min – max)
Brixia Score	9.60 ± 5.61	10.00 (0–18)

TABLE 2
Lesion Characteristics on the Chest X-rays

Findings of the Chest X-rays		n; Percentage (%)
Lung images (n = 95)	Normal	1; (1.05%)
	Abnormal	94; (98.95%)
Distribution of lung lesions (n abnormal = 94)	Unilateral	9; (9.4%)
	Bilateral	85; (89.4%)
Zonation (n abnormal = 94)	Right upper lung fields	44; (46%)
	Left upper lung fields	38; (40%)
	Right middle lung fields	81; (86%)
	Left middle lung fields	78; (82.9%)
	Right lower lung fields	84; (89%)
	Left lower lung fields	86; (91%)
Lesion patterns (n abnormal = 94)	Dominant interstitial infiltrates	67; (71.2%)
	Dominant alveolar infiltrates	27; (28.7%)

(r = -0.248). These values show a significant negative relationship between the Brixia Score on the chest X-rays and the ratio of partial pressure arterial oxygen to the fraction of inspired oxygen.

Table 6 shows the result of the Kruskal-Wallis test shows a significant difference in the Brixia Score based on the stages of the ARDS, with a *p-value* less than 0.05 (p <0.05). The highest Brixia Score was obtained from the severe stage of the ARDS. On the other hand, the lowest Brixia Score was obtained from the mild stage of the ARDS. Accordingly, the results show scientific evidence of the relationship between the Brixia Score and the stages of the ARDS.

DISCUSSION

The results of this research show that out of the 95 research subjects, there are 13 samples (13.7%) with mild ARDS, 26 samples (27.4%) with moderate ARDS, and 56 samples (58.9%) with severe ARDS. This is in

TABLE 3
The Ratio of Partial Pressure Arterial Oxygen to the Fraction of Inspired Oxygen (PaO_2/FiO_2)

Variable	Mean ± SD	Median (min – max)
The ratio of PaO_2/FiO_2	167.97 ± 83.95	99.50 (29.5 – 284.69)

TABLE 4
Stages of the ARDS

The ratio of PaO_2/FiO_2	n; Percentage (%)	Description
300 mmHg ≥ X > 200 mmHg	13 (13.7%)	Mild ARDS
200 mmHg ≥ X > 100 mmHg	26 (27.4%)	Moderate ARDS
≤ 100 mmHg	56 (58.9%)	Severe ARDS

TABLE 5
The Correlation Test between the Brixia Score and the Ratio of Partial Pressure Arterial Oxygen to the Fraction of Inspired Oxygen (PaO_2/FiO_2)

Variable	Brixia Score		Description
	p	*R*	
The ratio of PaO_2/FiO_2	0.015	-0.248	Significant, negative

TABLE 6
Test of Difference between the Brixia Score and the Stages of the ARDS

Variable	Stages of the ARDS						*p-value* Kruskal -Wallis test)
	Mild (N=13)		Moderate (N=26)		Severe (N=56)		
	Mean	Median (Min–Max)	Mean	Median (Min–Max)	Mean	Median (Min–Max)	
Brixia Score	4.08 ± 4.6	1.00 (0–15)	7.92 ± 4.9	8.00 (1–18)	11.66 ± 5.0	12.00 (2–18)	< 0.05

Description: Statistical Method of the Kruskal–Wallis Te

accordance with the previous study by Gibson *et al*. (2020), in which the ARDS occurred in 42% of the COVID-19 patients, and around 81% of those patients would fall into the severe stage of the ARDS, and thus intensive care was recommended.[12,14,17]

Later, the result of the Spearman's rank correlation test shows a significant negative relationship between the Brixia Score and the ratio of partial pressure arterial oxygen to the fraction of inspired oxygen. The scientific evidence here shows that the higher the Brixia Score, the lower the ratio of partial pressure arterial oxygen to the fraction of inspired oxygen. This is in accordance with the previous study by Fogante *et al*. (2021), in which the findings showed that there is a relationship between the Brixia Score and the gas exchangeboth the increase and the declinein the alveoli, plus the severity of the pathological process inside the lungs.[12,18,19]

The following result of the Kruskal-Wallis test shows that there is a significant difference in the Brixia Score based on the stages of the ARDS. The highest Brixia Score was obtained from the severe stage of the ARDS, while the lowest Brixia Score was obtained from the mild stage of the ARDS. This is in accordance with the previous research by Zhichao Feng *et al*. (2020) by studying the CT-scan modality, thus finding that the high CT severity score is the independent risk factor for COVID-19 patients with the mild stage of the ARDS to develop into the severe stage of the ARDS. Research conducted by

Balbi *et al*. (2021) concluded that the Brixia Score is the independent predictive factor for deaths in COVID-19 patients. Furthermore, research conducted by Maroldi *et al*. (2020) found that the Brixia Score of the dead COVID-19 patients was higher than that of the recovered COVID-19 patients.[11,12,20,21]

This research has limitations that should be highlighted. This research does not conduct an analysis of the subjects who were positive for COVID-19 without ARDS. Also, this research does not investigate the relationship between the Brixia Score of the chest X-rays and the stages of the ARDS during the inpatient care of the subjects. Furthermore, this research does not study the subjects' comorbidities, which are probable to be the factor that would affect the research results.

CONCLUSION

This research shows the scientific evidence of the significant relationship between the Brixia Score and the stages of the *acute respiratory distress syndrome* (ARDS) in COVID-19 patients. Furthermore, these research results are expected to be a reference for physicians in determining the most accurate therapy for COVID-19 patients, specifically those who have high Brixia scores, so it would prevent complications and improve the prognosis.

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