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Thorax imaging of vaccinated and non-vaccinated Covid-19 patients, how are they different?

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Abstract

Covid-19 is a global pandemic which currently becomes the world's concern. There were various studies to overcome the problem of high mortality due to the infection of the SARS Cov-2 virus. Vaccine is one of the solutions to lessen the global burden. Vaccine is expected to produce immunity for community health. The scientists are investigating the effectiveness of the vaccine. Some vaccinated Covid-19 patients can still be infected by the virus even with moderate or severe symptoms. Chest x-ray is one of the modalities to see clinical progress. This study aims to compare the chest x-ray of hospitalized patients who have been vaccinated and those who have not. There were two groups of 60 hospitalized patients aged 18-50 years, namely the vaccinated and non-vaccinated groups. Patients with type II diabetes mellitus, hypertension, heart failure or autoimmune disease were excluded from the sample. Assessment of severity level through chest x-ray was done by calculating Brixia score. The calculation of Brixia score was carried out by three researchers having parallel levels of competence with a tolerance of differences of less than 5%. Bivariate analysis was conducted to compare Brixia scores between the two groups. A total of 8 male (26,7%) and 22 female (73,3%) patients in the vaccinated group had lower Brixia scores with a mean score of 1,53 + 1,27 compared to 30 patients (60% male, 40% female) in the non-vaccinated group with a mean of 6,0 + 2,61 and p value of 0.001. There were no death cases in all samples. There is a difference in the average Brixia score with a lower tendency of severity in the vaccinated group compared to the non-vaccinated group. Vaccine is useful for raising immunity so that it avoids severe conditions due to the SARS Cov-2 virus infection

Keywords: Vaccine; Covid-19; Brixia Score; Covid-19

1. Introduction

SARS Cov-2 infection is a pandemic which occurred since early 2020, followed by its first spread in Indonesia during February - March 2020. More than a year of the Covid-19 pandemic, there are 3,854,354 positive cases and 117,588 deaths cases until mid-August 2021 [1]. The Covid-19 patients include all ages, ranging from children, adults, and the elderly. For those who have comorbid disease such as diabetes mellitus, hypertension, chronic heart failure, or autoimmune diseases pretend to have worse consequence. Since the Covid-19 outbreak globally, scientists are competing to find solution for the treatment and rehabilitation of Covid-19 patients. Each country allocates a large budget to overcome this global pandemic although economically collapse due to the lockdown policy applied in the country. Vaccination program is the concerning effort from the government to ensure the availability of vaccines, distribution, and its spread among the society. As developed for other diseases before, Covid-19 vaccination is expected to be a solution to raise individual and herd immunity against SARS Cov-2 virus. Besides, Covid-19 vaccination prevents the vaccinated patients experiencing severe symptoms and reducing morbidity.

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As part of the Covid-19 handling team, the radiology department offers solutions by finding various signs on patients imaging and facilitate in handling the evaluation process until post-treatment. Brixia score, a method of quantification of chest x-ray, has a role in determining the severity of the disease and its prognosis. Research on imaging quantification has been previously reviewed through various studies. By determining the score of a chest x-ray using the Brixia score can determine the severity of Covid-19 patients. Compared with the other quantification method, Brixia score has advantages in terms of easy to apply and good sensitivity in predicting the Covid-19 severity with moderate to severe symptoms [2].

Covid-19 vaccination is done by inserting a virus or a component of genetic materials that has been attenuated or deactivated but is still capable of triggering the body's immunological response. The SARS Cov-2 virus infection after vaccination had been found in many cases. Some patients have typical mild respiratory symptoms; others have more severe symptoms. In this case, the dominant manifestations in the respiratory tract could be assessed by chest x-ray. The difference of hospitalized Covid-19 patients between vaccinated and non-vaccinated is an interesting topic to study. Therefore, the author tries to explore more about the phenomenon of vaccination in hospitalized Covid-19 patients by assessing the Brixia score from chest x-ray photos.

2. Material and methods

The subject of the study was 60 patients with Covid-19 who were hospitalized in RSUD Dr. Moewardi Surakarta. This research was conducted through ethical approval from the Ethics Commission of RSUD Dr. Moewardi, who refers to the principles of the Helsinki Declaration. The authors applied purposive sampling to determine the samples by dividing the samples into the vaccinated and non-vaccinated groups. The data was taken in the range of December 2020 to July 2021. The authors set the inclusion and exclusion criteria. Inclusion criterion included Covid-19 patients aged 18 to 50 years with positive PCR test results, being hospitalized in an isolation ward, and taking a chest x-ray in the first 24 hours from hospital admission. The exclusion criteria included the present of comorbid diseases, such as diabetes mellitus, hypertension, chronic heart disease, and autoimmune diseases.

The assessment of Brixia score on the chest x-ray was carried out by observing the Picture Archiving Communication System (PACS) by applying interrater reliability. Three raters had at least a year experience in reading chest x-ray. The authors compared and calculated the Brixia score of the main rater and other two raters by setting a tolerance difference of less than 5% through a parametric comparison test. The results of calculating the Brixia score between vaccinated and non-vaccinated patients were compared with a multivariate comparative test with p -values considered to be significantly different if the value was less than 0.05.

3. Findings

The study involved 60 Covid-19 patients hospitalized in the RSUD Dr. Moewardi, consisting of 26 male patients (43%) and 34 female patients (57%). Subjects had a varied age distribution. A total of 29 (48%) patients were aged 18-35 years old, 14 subjects (23%) patients aged 35-40 years old, and the remaining 17 subjects (28%) aged 40-50 years old.

Brixia assessment scores of the main-rater (rater 1) continued to be analysed statistically after being compared to the scores made by rater 2 and 3. The obtained results showed in the table 1 below:

Table 1 Comparison among inter-rater assessment of Brixia scores

Rater	Brixia Score (mean) \pm SD	
	Vaccinated group (n = 30)	Non-vaccinated (n = 30)
Main interrater	1.53 \pm 1.27	6.0 \pm 2.61
Comparing interrater 1	1.8 \pm 1.61	4.83 \pm 3.66
Comparing interrater 2	1.7 \pm 1.53	4.62 \pm 3.41
	p = 0.245	p = 0.181

Based on table 1, the results of comparing Brixia scores among three raters showed a p -value of >0.05 for both the vaccinated and non-vaccinated groups. Thus, calculating the Brixia score from the main-rater (rater 1) could be used for the further analysis.

The comparison between the results of the Brixia score assessment on the chest x-ray of covid-19 patients with vaccinated and non-vaccinated status is presented in the table 2 as follows:

Table 2 Comparison between vaccinated group and non-vaccinated group by inter-rater assessment of Brixia scores

	Brixia Score (mean) \pm SD		p
	Vaccinated group (n = 30)	Non-vaccinated(n = 30)	
Main rater	1.53 \pm 1,27	6.0 \pm 2,61	0.001

The data showed that the mean Brixia score in the vaccinated group patients was 1.53 ± 1.27 . Patients in the vaccinated group had a lower average of Brixia score than patients in the non-vaccinated group. The analysis process was continued by a comparative test using the unpaired t-test with a p -value of <0.05 , which means a significant difference of the Brixia score between vaccinated and non-vaccinated groups of Covid-19 patients

4. Discussion

The infection of SARS Cov-2 virus which successfully invading human cells invites the innate and adaptive immune response. The combination of viral replication, which causes an increase in the number of viruses in the body's cells and the immune response as well, causes macroscopic changes such as the presence of fibrotic tissue in the lung parenchyma, as well as life-threatening abnormalities such as vascular embolism. Therapeutic targets for patients with Covid-19 include several approaches, including efforts to maintain airway patency, oxygen therapy to ensure a safe oxygen supply to peripheral body tissues, and medical therapy to eradicate the virus from the body. Vaccination is an effort to generate immunity through several stages, starting from the initiation stage to the production of antibodies by B lymphocyte cells. The massive Covid-19 vaccination given to the community aims to provide individual and communal protection so that the spread of the virus in the wider community can be rapidly suppressed [3].

A chest x-ray is an essential modality that can be used in a series of Covid-19 handling. Several studies have proven that chest x-ray assessment can be used to determine clinical outcomes and survival [4], predict worsening condition [5], forecast intensive care needs and potential for ventilator use [6]. The validity of the chest x-ray used in determining various prospective condition is influenced by several things, including the quality of the imaging, the method of assessment, and the method of imaging analysis. The quality of x-ray imaging is determined by the tool's modality, the radiographer's ability to take and process the ready-to-read images [7], and the patient's cooperation when taking x-ray images.

On the other hand, the x-ray assessment method also determines its validity. Several x-ray imaging assessment methods have been developed since the Covid-19 pandemic, including the Brixia score, RALE score, and Modified score, which have similarities in determining the severity level of hospitalized Covid-19 patients [2]. Determining the score based on these methods needs to be done carefully in order to minimize bias. In this paper, the authors try to minimize the bias in calculating the Brixia score by using interrater reliability so that the result of Brixia score becomes more reliable with minimal bias.

Brixia score is determined by dividing each lung field (right or left) into three parts, namely upper, middle, and lower, with a range of values between 0 – 3 per part. A score of 0 if there is no infiltrate, a score of 1 if there is an infiltrate not more than 25%, a score of 2 if a dominant infiltrate is found with a minimal consolidation around which covers 25-50%, and a score of 3 if a dominating consolidation is obtained which spread in more than 75% of each part of lung field. The results of all calculations are added up. The higher the score, the more it leads to worse conditions, and *vice versa*. The results of the assessment have the potential for bias and are full of subjectivity. Therefore, the chest x-ray imaging assessment needs to be carried out by three raters with a maximum difference of 5% or the degree of similarity reaching 95%. Thus, the results of the assessment can be more accountable. In addition, all three raters have the same competence, which in this study determined that raters are doctors who have routinely read chest x-ray at least five days a week for at least one year.

The difference in chest x-ray using Brixia score between vaccinated and non-vaccinated patients was significantly different. If it is associated with an immunological mechanism, vaccination will trigger antibodies more quickly to overcome many viruses that enter the body in the early stages of infection. The viral population is suppressed rapidly [8]. Therefore, the potential for producing more potent inflammatory mediators will be minimal, while inflammatory mediator and other humoral and cellular immunological components have a significant role in causing abnormalities in the lung parenchyma, such as the presence of fibrotic tissue [9]. The consolidation was dominated in non-vaccine patients. The area of ground glass opacity in non-vaccine patients was wider than the vaccine ones. Furthermore, non-vaccine patients had more frequent to be affected in both right and left lung [10]. Thus, there was a significant difference between the severity level of chest x-ray imaging of vaccinated and non-vaccinated patients as showed in the figure 1.

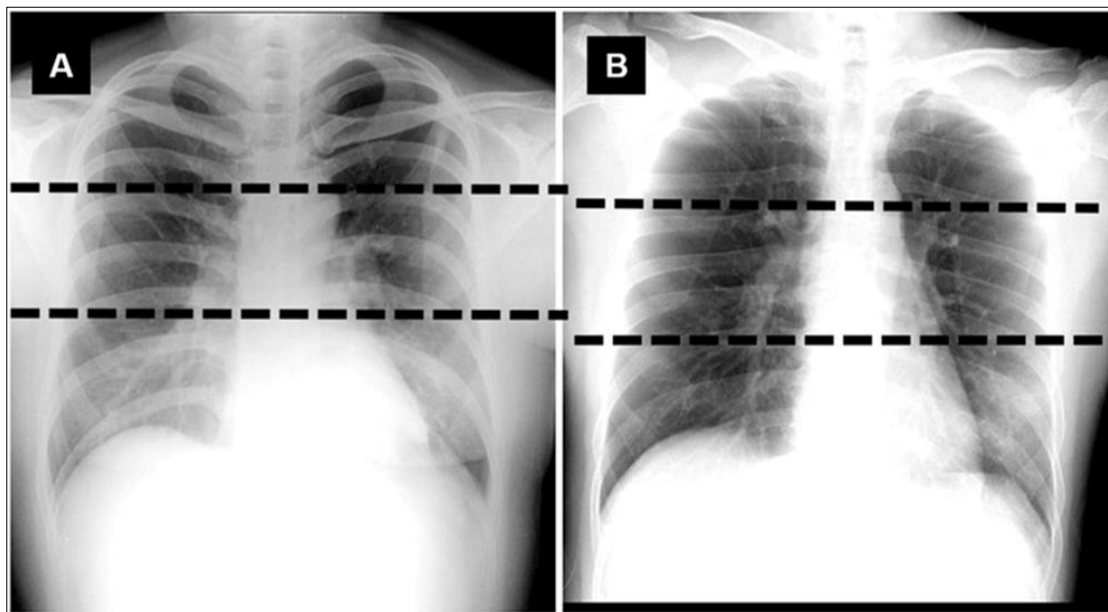


Figure 1 The upper, middle and lower zone chest x ray of (A) non vaccinated covid patient and (B) vaccinated covid-19 patient

Besides, this study was an analytical comparative study with secondary data, sample selection with strict inclusion and exclusion criteria, and an interrater assessment method in assessing chest x-ray using the Brixia scores. Researchers did not take samples from patients with comorbidities so that the pathological processes that occur in Covid-19 patients with comorbid diseases such as type 2 diabetes mellitus, hypertension, chronic heart disease, and autoimmune diseases are not discussed further. This study also did not examine the damage that occurs to organs outside the lungs that are likely to contribute to the worsening condition of Covid-19 patients. Researchers also did not examine the antibody status of samples that had been vaccinated. Thus, a more comprehensive study is needed to explain the effect of vaccination on the body's resistance to SARS Cov-2 infection in various patient conditions, both without and with comorbid diseases.

5. Conclusion

Covid-19 patients who have received two doses of the vaccine have better resistance to the SARS Cov-2 virus than patients who have not been vaccinated. We can assess the evidence of the pulmonary manifestation through chest x-ray imaging with severity level assessment using Brixia scoring system.

Compliance with ethical standards

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Disclosure of conflict of interest

By this statement, all authors who consist of Muchtar Hanafi, Endang Linawati and Widiastuti Soewondo have no conflict of interest regarding this manuscript publication.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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