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# RELATIONSHIP BETWEEN PULMONARY VASCULAR THICKENINGS WITH CT-SEVERITY SCORE IN COVID-19-CONFIRMED PATIENTS

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ABSTRACT
**Introduction:** Previous studies have shown pulmonary vascular thickening found in COVID-19 patients. In addition, the CT-Severity Score (CT-SS) scoring system have become a reference in assessing the severity of COVID-19. This study analyzes the relationship between pulmonary vascular thickening on CT-Scan thorax with CT-SS in patients with confirmed COVID-19.**Materials and Methods:** A retrospective cross-sectional study was conducted on 137 patients with confirmed COVID-19 at the Radiology Installation of Doctor Wahidin Sudirohusodo Hospital Makassar. Patients who were eligible and had undergone a chest CT-Scan were then measured for their pulmonary vascular thickness in the intralesional and extralesional areas of the secondary lung lobes. The CT-SS score was assessed to determine the degree of mild or severe disease based on the opacity of the involved lung segment. Independent T-test and Chi- square were used to determine the differences and relationships between the variables studied. **Results:** Based on CT-SS, most subjects were classified as mildly ill (CT-SS < 19.5, 78/137 people). The mean intralesional and extralesional vascular thickening was 2.65 ± 0.48 and 2.17 ± 0.36, respectively. There was a significant difference between vascular thickness between subjects with mild and severe CT-SS categories (intralesion: 2.4 ± 0.33 vs. 2.99 ± 0.47, p=0.001; extralesion: 2.04 ± 0.28 vs. 2.35 ± 0.39),
**Conclusion:** Vascular thickening on CT-Scan chest images is related to the severity of COVID-19 as measured by CT-SS scoring.
**Keywords:** COVID-19, Chest CT-Scan, *CT-Severity Score*, Pulmonary Vascular Thickening

## INTRODUCTION

COVID-19 (Coronavirus Disease 2019) is an infectious disease caused by a species of coronavirus, namely Severe Acute Respiratory Syndrome Coronavirus 2. SARS-CoV-2 has become a worldwide pandemic since it was first discovered in Wuhan, China, at the end of December 2019. The incidence rate until February 10, 2022, global COVID-19 cases has reached 404 million cases and caused 5,783 million deaths.[1]

One of the challenges regarding the disease that causes this pandemic is the difficulty of predicting the complications of respiratory failure caused. Abnormalities found on chest CT scan images effectively predict complications of respiratory failure and mortality in COVID-19 patients, including those who are seriously ill and require intensive care[2,3] Pulmonary vascular thickening on CT-Scan Thorax is the main feature in patients with confirmed COVID-19 concurrently with pneumonia This vascular thickening is also found in 72-78% of patients with COVID-19 This vascular thickening is believed to be a unique feature of COVID-19 pneumonia that has not been previously described and is thought to contribute to respiratory failure in COVID-19 pneumonia.[2-5] The COVID-19 severity scoring system based on the chest CT-Severity Score (CT-SS) has recently been introduced and studied extensively. Yang et al. found an association between higher CT-SS scores and more severe COVID-19 infection. Abbasi et al. found a higher mortality rate in patients with higher CT-SS.[6,7]

## Materials and Methods

### *Population and Sample*

This study used a retrospective cross-sectional design and was approved by the Health Research Ethics Committee, Faculty of Medicine, Hasanuddin University . We took secondary data in medical records from 137 patients (74 males, 63 females, mean age 49.72 ± 14.31 years) who had confirmed COVID-19 through SARS-Cov-2 RT-PCR examination and had undergone CT examination. - Thoracic scan measurement at Wahidin Sudirohusodo Hospital Makassar between July to September 2021. Patients with a history of previous

chronic diseases (e.g., pulmonary hypertension, pulmonary embolism, post-chemotherapy, COPD, malignancy, chronic liver disease, and post-surgery) have an infiltration pattern of lesions only in the form of consolidation in all segments or lobes of the lung, and having a pleural effusion that covers part of the lung lobes were excluded from this study.

***Imaging Technique***

CT Scan equipment brand Light speed VCT 64 Slice GE with the technique of taking Scan from the tip of the lung to the costophrenic angle with the following scan parameters: tube voltage 120 kV, tube current-exposure time 50-150 mAs, scan thickness 5 mm with reconstruction thickness 1.5mm.

***Imaging Interpretation***

Analysis of the characteristics of the patient's chest CT scan was performed on the lung window (width 1500 HU; level -700 HU) and mediastinal (width 350 HU; level 40 HU) to measure the vascular thickness. The mean values for intralesional and extralesional secondary pulmonary lobe vascular thickening were then calculated. Further confirmation will be carried out by 2 (two) radiology specialists who have more than 10 years of clinical experience.

***CT Severity Score***

The CT severity score (CT-SS) for assessing the severity of COVID-19 was adapted from the CT-SS by Yang et al. This assessment uses lung opacification in each segment to assess the extent of the lesion and is evaluated by giving a score of 0, 1, and 2 if parenchymal opacification involvement is found to be 0%, <50% or 50%. CT-SS is determined from the number of scoring for each segment, with a range of 0-40 points. Patients are categorized as mild if the total score is < 19.5 and severe if the total score is 19.5.

***Statistical Analysis***

Vascular thickness data are numerical measurement scales expressed in mean ± standard deviation or median ± interquartile range (IQR) if not normally distributed. Other categorical data, both demographic status, CT-SS expressed in percentage and frequency (n, percent). The Statistical Program for Social Science (SPSS) software version 23.0 (IBM, USA) was used to perform data analysis. An Independent T-test was used to find the mean intralesional and extralesional vascular thickness difference between the two categories obtained from CT-SS scoring. Then a Chi-square test was performed to analyze the relationship between CT-SS and. A significant value is stated if the p-value < 0.05 is obtained.

## RESULTS

***Baseline Characteristics***

The baseline characteristics of this study can be seen in Table 1. In the 137 subjects studied, the mean age of the patients was 49.72 ± 14.33 years, with the majority aged 56-65 years (29.2%) followed by 46- 55 years (24.1%). In addition, the majority of patients were male (54%), had a CT-SS score < 19.5 (56.9%). The mean intralesional and extralesional vascular thickening measured on CT-Scan Thoracic results was 2.65 ± 0.48 and 2.17 ± 0.36, respectively.

**Table 1:** Sample distribution based on baseline characteristics

| Characteristic | n = 137 | % |
|---|---|---|
| **Age (years)** | 49.72 ± 14.331 | |
| **0 - 5** | 0 | 0.0% |
| **5 - 11** | 0 | 0.0% |
| **12 - 16** | 2 | 1.5% |
| **17 - 25** | 4 | 2.9% |
| **26 - 35** | 21 | 15.3% |
| **36 - 45** | 20 | 14.6% |
| **46 - 55** | 33 | 24.1% |
| **56 - 65** | 40 | 29.2% |
| **> 65** | 17 | 12.4% |
| **Gender** | | |
| Male | 74 | 54 |
| Female | 63 | 46 |
| **CT Severity Score** | | |
| <19.5 | 78 | 56.9 |
| ≥19.5 | 57 | 41.6 |
| **Vascular thickening (mm)** | | |
| Intralesion | 2.65 ±0.48 | |
| Extralesion | 2.17 ± 0.36 | |

**Table 2:** Comparison of intralesional and extralesional vascular thickness with CT Severity Score

| | Mean ± Standard Deviation of Vascular Thickness | | p |
|---|---|---|---|
| **Location** | **CT-SS <19.5** | **CT-SS ≥19.5** | |
| Intralesion | 2.4 ± 0.33 | 2.99 ± 0.47 | 0.001 |
| Extralesion | 2.04 ± 0.28 | 2.35 ± 0.39 | 0.001 |

Independent T -test

**Intralesional and Extralesional Vascular Size Comparison Based on CT-SS Score**

Table 2 shows the results of comparing intralesional and extralesional vascular sizes based on CT-SS scoring. It was found that the mean intralesional vascular size in patients with CT-SS < 19.5 was 2.40 ± 0.33, and in patients with CT-SS ≥ 19.5 was 2.99 ± 0.47. Based on the independent T-test results between the intralesional vascular sizes of the two CT-SS categories, a statistically significant difference was found between the two (P = 0.001). In addition, the mean extralesional vascular size in patients with CT-SS < 19.5 was 2.04 ± 0.28, and in patients with CT-SS ≥19.5 was 2.35 ± 0.39. Based on the independent T-test results between the intralesional vascular sizes of the two CT-SS categories, a statistically significant difference was found between the two (P = 0.001).

**DISCUSSION**

This study showed a difference in vascular thickness between patients with mild and severe confirmed COVID-19 symptoms based on CT-SS scoring. It was found that distal blood vessel vascular thickening was more than average in intralesional and extralesional, and vascular thickening on CT-SS mild/severe intralesional was greater than extralesion. These results provide clinical implications that Covid 19 does not only involve respiratory organs, but systemic or multiorgan abnormalities occur. This result agrees with a previous study by Yang et al., who found an association between higher CT-SS scores and more severe COVID-19 infection. said that this feature of pulmonary vascular thickening is thought to contribute to respiratory failure in COVID-19 pneumonia. Vascular thickening is also associated with an increased prevalence of ARF, and the area of the lung parenchyma is affected. Several other investigators, Abbasi et al., found higher mortality rates in patients with higher CT-SS. The study by Provencher et al. showed that hospitalized COVID-19 patients presenting with pulmonary vascular thickening were the primary pulmonary abnormality in confirmed COVID-19 patients.[6,8,7,9]

On a normal chest CT scan, the subsegmental vessels distal to the lung should be inconspicuous in the subpleural region. According to Lang et al., pulmonary vascular thickening is defined as a larger diameter blood vessel characterized by: (a) the diameter of the blood vessel is more significant than that of the adjacent part of the lung that is not affected, (b) the diameter of the vessel is more significant than that of the adjacent lung. In a comparable area of the unaffected contralateral lung, or (c) focal dilatation or non-tapping of blood vessels as they travel to theperiphery of the lung. According to Tsujikawa et al., their study found the normal size value of the secondary pulmonary lobular vascular diameter to be +/- 0.5 - 1 mm. This study showed the pulmonary vascular wall thickening above the normal value.[10,11]

This vascular thickening is thought to be due to the role of endothelial cells and the mechanism of endothelial cell dysfunction in COVID-19. SARS-CoV-2 infects endothelial cells via angiotensin-converting enzyme 2 (ACE2)-mediated viral entry, facilitated by TMPRSS2, which triggers the SARS-CoV-2 spike glycoprotein. Endothelial cell infection can lead to downregulation of ACE2, leading to an imbalance between ACE2 and angiotensin II (AngII) levels, increasing Ang II. In addition, infection of endothelial cells or pericytes will interfere with crosstalk between these two cells, thereby contributing to endothelial cell dysfunction. In severe cases of COVID-19, activated macrophages release a variety of cytokines (e.g., soluble interleukin 2 receptors [IL-2R], interleukin-6 [IL-6], and Tumor Necroting Factor [TNFs]), which are associated with Cytokine Storm. It is mediated by the immune system and can cause vascular inflammation (endothelitis) due to increased adhesion molecules' expression on endothelial cells and inter-endothelial spaces, thereby increasing vascular hyperpermeability This rapid spike in proinflammatory cytokines triggers inflammatory infiltration by lung tissue that causes lung damage to the epithelium and endothelium.[8,12-15]

In this study, it was found that there was a relationship between the appearance of pulmonary vascular thickening and the CT severity score in patients with confirmed COVID-19, where the appearance of vascular thickening increased with the presence of mild or severe CT-severity seen on the test.[16-18]

**CONCLUSION**

There is a relationship between pulmonary vascular thickening and CT Severity score on a CT scan of the thorax of patients with confirmed COVID-19. The more severe the CT Severity score in patients with confirmed COVID-19, the higher the findings of pulmonary vascular thickening on a chest CT scan.

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Nothing to declare

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