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ORIGINAL ARTICLE

COVID-19 Disease May Change Subcarinal Angle

COVID-19 Subkarinal Açıyı Değiştirebilir

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Abstract

Introduction: Evaluation of the severity of the disease in coronavirus disease 2019 (COVID-19) is important. Chest radiogram and computed tomography are suitable tools for inspecting structural changes in the lung parenchyma. The aim of this study was to evaluate the relationship between subcarinal angles (SCAs) of the left and the right main bronchi and tomography severity score (TSS) and changes in SCA after recovery, assessed with computed tomography among patients with COVID-19.

Methods: This retrospective observational study was conducted between March 2020 and January 2021. A polymerase chain reaction test was used to diagnose COVID-19. All participants were examined with thorax computed tomography both in acute disease episode and 6 months after recovery. SCA of right and left main bronchi and TSS and changes in SCA values after recovery were compared.

Results: The mean of SCA measurements in COVID-19 acute episode was 74.76±12.94 degrees, while it was found to be increased to 82.83±14.09 degrees (p=0.011) 6 months after recovery. There was no association between SCAs of total, right, and left main bronchi and TSS (r=-0.046 and p=0.784, r=-0.024 and p=0.887, and r=-0.056 and p=0.739, respectively). While TSSs were similar between both genders, SCA values were found to be higher in females. The most frequently involved lung lobe was the right lower lobe.

Discussion and Conclusion: SCA values were higher in patients at 6th month after recovery from COVID-19. Due to this finding, it may be proposed that parenchymal changes in lung tissue are long-lasting and may be persistent after recovery from COVID-19.

Keywords: COVID-19; Subcarinal angle; Computed tomography; Severity score

Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), an etiological agent of Coronavirus disease 2019 (COVID-19), is transmitted by respiratory particles such as large droplets and small droplets defined as aerosols in the air mainly through the respiratory tract. The infection rapidly progresses in the lower respiratory tract and results in various degrees of respiratory failure and death of many patients.[1] The initial viral load plays an important role in the disease outcome.[2]

Thorax computed tomography may reveal reliable findings about COVID-19 even in the early disease period compared with chest radiographs.[3] In patients diagnosed with

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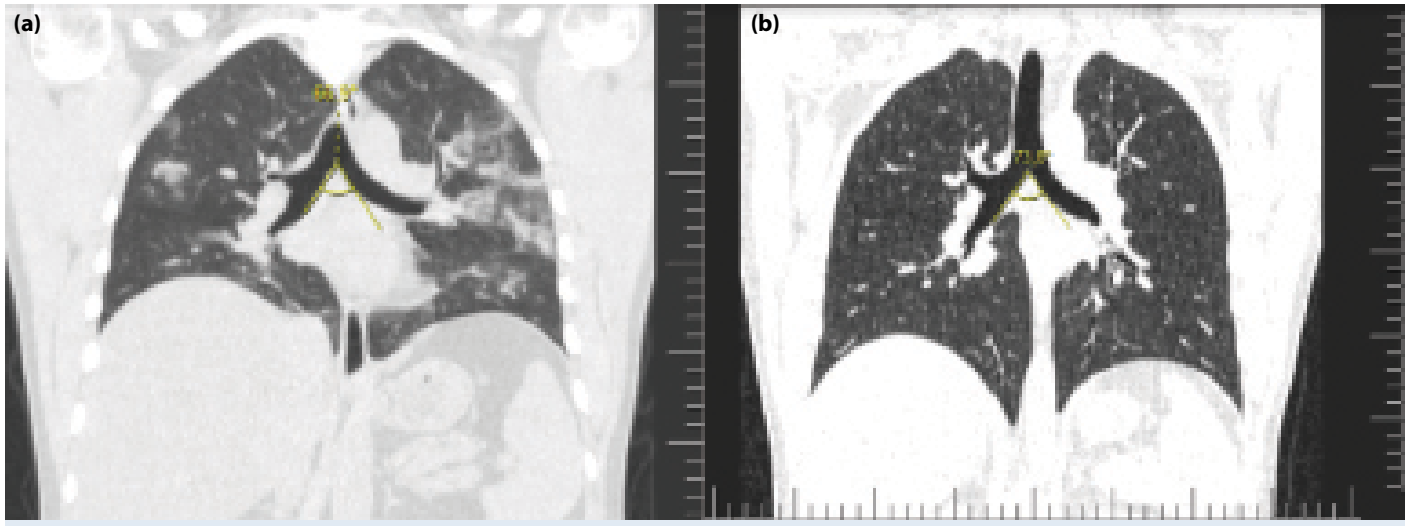

Figure 1. Measurement of subcarinal angles in computed tomography coronal images where right superior lobar bronchus is best visible: during COVID-19 disease **(a)**, six months after recovery **(b)**.

COVID-19, a novel scoring system known as tomography severity score (TSS) was used previously.[4] TSS is a reliable tool to evaluate disease severity in COVID-19.[5]

Previous studies about the role of tracheobronchial tree in exposure or progression of the etiologic agent in pulmonary diseases revealed that anatomical structural differences in the right and the left main bronchi and the angle of main bronchi with the theoretical coronal plane were important. The narrow angle of the right lung bronchus may result in increased exposure to carcinogenic inhalants and foreign body inhalation.[6,7]

Subcarinal angle (SCA) may change according to age and gender.[8] In different studies, SCA was reported to be narrower in males compared with females.[9,10] In a study, with advancing age, SCA was found to be narrower in males, whereas it was widening in females.[9]

This study was designed to evaluate the effect of COVID-19 disease on SCA. To evaluate any relationship between SCAs of the right and the left main bronchi and TSS, assession with computed tomography in COVID-19 was also planned.

Materials and Methods

Study Setting, Place, Population, and Duration

This single-center, retrospective observational study was conducted in a tertiary university hospital. This study was approved by local ethics committee (Approval no.: 20210113). This study was conducted in compliance with Helsinki Declaration and Good Clinical Practices directives.

The patients who visited the hospital between March 2020 and June 2021 with complaints of COVID-19, who were between 18 and 90 years of age, whose reverse transcriptase polymerase chain reaction (RT-PCR) test for SARS-CoV-2 were positive, and who were examined with thorax computed tomography imaging in 72 h after coming to the hospital and 6 months after recovery from COVID-19 were included in the study.

Patients who did not have any pulmonary involvement due to COVID-19 in thorax computed tomography, who had diseases that might affect SCA such as chronic obstructive pulmonary disease, interstitial pulmonary disease, thoracic neoplastic diseases, thickening of pleura, and history of tracheobronchial surgery, and who were treated in intensive care unit were excluded. Patients who could not be examined with 6th-month control tomography were also excluded.

Data Collection

All participants were examined with Siemens Somatom Emotion 16 computed tomography device (Siemens Healthineers, Germany, 2010), with COVID-19 protocol (low density x-ray, 4 mm slicing, no contrast). The volume rendering method, as described previously, was used to evaluate the images in axial, coronal, and sagittal planes.[11]

SCA was determined by measuring the angle between the main bronchus and theoretical vertical line passing through from the middle of the trachea in coronal computed tomography images, both during COVID-19 disease and 6 months after recovery (Fig. 1). To ensure standardization of measurement, the most appropriate image that best demonstrates the right superior lobar bronchus was chosen. Total TSS was calculated by adding right and left TSS. SCAs of the right and left main bronchi and TSS were compared.

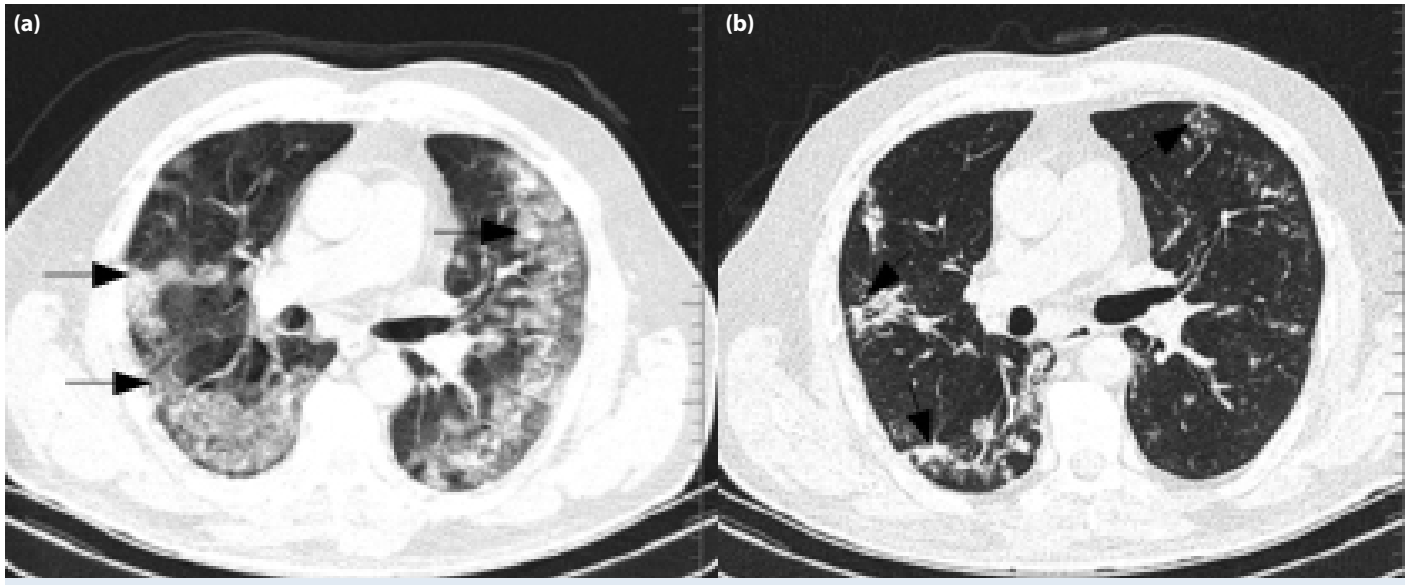

Figure 2. Images of axial sections in the thorax computed tomography during COVID-19 disease **(a)** and the same patient 6 months after recovery **(b)** in the parenchymal window.

Table 1. Mean tomography severity scores according to lung lobes and subcarinal angles of right and left main bronchi in COVID-19

Parameter	Mean±SD
Right subcarinal angle (degrees)	35.31±6.95
Left subcarinal angle (degrees)	39.45±7.67
Total subcarinal angle (degrees)	74.76±12.94
Right tomography severity score	3.45±2.77
Left tomography severity score	3.21±2.6
Total tomography severity score	6.66±5.05
Right superior lobe tomography severity score	1.08±1.12
Right middle lobe tomography severity score	0.82±1.01
Right lower lobe tomography severity score	1.61±1.17
Left superior lobe tomography severity score	1.05±0.96
Left lingula tomography severity score	0.79±0.93
Left lower lobe tomography severity score	1.37±1.08

SD: Standard deviation.

Computed tomography images were evaluated separately by two radiologists possessing 12 and 14 years of experience. When there was a disagreement between the two radiologists about the patient's images, those images were evaluated for the third time by both radiologists and an agreement was reached. TSSs were measured by the evaluation of tomography images. The score was determined by measuring the percentage of involved lobe; no involvement was accepted as 0, up to 25% involvement as 1, 26%–50% involvement as 2, 51%–75% involvement as 3, and 76%–100% as 4, as mentioned in a previous study.[12] Pathological findings in computed tomography, such as ground glass opacifications, crazy paving pattern, and existence of consolidations, were recorded for each patient. Each participant was examined with control thorax tomography 6 months after recovery from COVID-19 (Fig. 2).

Statistical Analysis

The data were analyzed using SPSS for Windows 15.0 statistical software package (SPSS, Inc., Chicago, IL, USA). Data distributions or normality tests were evaluated by the Shapiro–Wilk test. The data were presented as mean±standard deviation for normally distributed variables. The comparisons between groups were evaluated using an independent t-test and the Chi-squared test. Association between variables was inspected by Pearson's correlation test. A value of $p < 0.05$ was considered significant.

Results

The study inspected 38 patients who had positive PCR test results for COVID-19. The mean age of 38 participants was 51.61±17.0 years (males 46.65±16.09 and females 55.62±17.02, p=0.107). Of the patients, 21 (55.3%) were females and 17 (44.7%) were males. While the mean of SCA measurements in COVID-19 episode was 74.76±12.94 degrees, 6 months after recovery, it was found to increase to 82.83±14.09 degrees (p=0.011). There was no association between SCAs of total, right, and left main bronchi and TSSs (r=-0.046 and p=0.784, r=-0.024 and p=0.887, and r=-0.056 and p=0.739, respectively). The mean TSSs according to lung lobes and SCAs of right and left main bronchi in COVID-19 are shown in Table 1.

Table 2. Comparison of subcarinal angle measurements and tomography severity scores of patients who had COVID-19 according to gender

	Males (n=17)	Females (n=21)	p*
Right subcarinal angle (degrees)	33.28±6.66	36.95±6.90	0.106
Left subcarinal angle (degrees)	36.01±6.82	42.24±7.31	**0.011**
Basal total subcarinal angle (degrees)	69.29±12.57	79.19±11.72	**0.017**
Control total subcarinal angle (degrees)	78.86±14.22	86.05±13.46	0.119
Right lung tomography severity score	3.29±2.14	3.57±3.23	0.763
Left lung tomography severity score	3.24±2.33	3.19±2.86	0.959
Total tomography severity score	6.53±4.27	6.76±5.70	0.890

*: Independent samples T-test.

A comparison of SCA measurements and TSS of patients who had COVID-19 according to gender is shown in Table 2. While TSS were similar between both genders, SCA values were found to be higher in females. The mean TSS in the right lung was 3.45±2.77 and in the left lung was 3.21±2.6 (p=0.702).

An analysis of computed tomographies of the patients who had COVID-19 revealed that 17 (44.7%) had ground glass opacifications, 15 (39.4%) had crazy patterns, and 6 (15.7%) had consolidations.

The patients who had COVID-19 disease were inspected according to the involvement of lung lobes. The most frequent involvement was in the right lower lobe (81.6%), followed by the left lower lobe (78.9%), left superior lobe (71.1%), right superior lobe (60.5%), right middle lobe (50%), and left lingular lobe (50%) in decreasing order.

Discussion

This study documented the increase in SCA values after COVID-19. In female participants, both left and right bronchi SCA values were greater compared with male participants. Interestingly, TSS values were similar in female and male participants. There was no association between SCA and TSS.

Changes in SCA values in COVID-19 are yet to be clarified. There are few studies inspecting this subject. SCA measurements in COVID-19 may reflect changes in the anatomical structure of the lung, and studies inspecting the changes in SCA in COVID-19 may help to understand acute and chronic pathophysiologic underlying mechanisms. Some diseases and conditions are already reported to affect SCA. A study reported that the narrowing of SCA was associated with increased mortality in chronic obstructive pulmonary diseases.[13]

Cardiomegaly and pleural effusions were reported to be the reason for an increase in SCA.[10,14] To negate affecting factors that may change SCA, recording the values in the acute disease period and some reasonable time after recovery in the same individual may be more beneficial. In a study reported from Türkiye, with 92 patients who were confirmed with PCR test, there was no relationship between SCA and severity of disease and clinical outcomes.[15] In the presented study, SCA values were measured in both acute disease episode and 6 months after recovery from the disease, which is distinctive compared with the aforementioned studies.

Measurement of SCA in the same patient eliminated many confounding factors that could affect SCA values. SCA values in the 6th month after recovery were found to be greater in patients with COVID-19. Due to this finding, one may conclude that COVID-19 causes chronic and perhaps persistent changes in the lung parenchyma.

TSS was shown to reflect the severity of COVID-19 previously.[16] The presented study evaluated the existence of any relationship between SCA and TSS, but no statistically significant relationship was observed. If a relationship between SCA and TSS could have been documented, SCA might have been used to predict disease progression, and preventive measures could have been taken early in the disease period.

In a study inspecting patients who had lung cancer, it was reported that the right lung was more prominently exposed to inhaled carcinogenic particles, and in the right lung, risk for cancer was reported to increase 1.5-fold.[7] A study regarding the influenza virus H7N9, reported that the right lung was dominantly affected, and this was explained by shortness and straightness of the right main bronchus, which resulted in more extensive exposure to the virus compared with the left lung.[17] The right lung was more frequently involved in COVID-19 patients in a study.[18] Contrary to these studies, in this study, right and left lung TSSs were similar.

SCA was found to be greater in females in previous studies.[9,10] The present study revealed that female patients had greater SCA values concordantly. In a study evaluating computed thorax tomographies of 919 patients who had COVID-19 disease, peripheral localization and bilateral involvements were the most frequently documented findings.[19] Concordantly, peripheral involvement was found to be the most frequent tomography finding in the present study. As this study documented that the most frequent involved lung lobe was the right lower lobe in COVID-19, it may be proposed that novel coronavirus can reach the right lung more easily and extensively, resulting in more severe disease in the right lung. Moreover, this study could not document a significant difference in SCA of right and left main bronchi due to the existence of ground glass opacifications, crazy paving patterns, or consolidations.

The severity of COVID-19 disease may differ according to patient age and gender. Males were mentioned to be more severely affected by the disease.[20] One other study about COVID-19 reported that the severity of the disease worsened with advancing age.[21] Discordantly, in the present study, TSSs were similar in males and females.

Limitations of this study are its retrospective design and relatively small sample size. In conclusion, this study revealed that total SCAs increased in patients after recovery from COVID-19. During the acute episode, the right lung and especially the right lower lobe were more frequently involved. Female patients had larger SCA values than male patients. SCA values were higher in patients in the 6th month after recovery from COVID-19. Due to this finding, it may be proposed that the bronchial changes persist for at least 6 months after COVID-19. In addition, no association could be documented between SCA and TSS, according to these findings. Further studies are necessary to evaluate chronic and persistent changes in lung parenchyma after recovery from COVID-19 disease.

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