Research Article / Araştırma Makalesi

Examination of Lung and Thorax Volume of Patients with Covid 19 Positive

Covid 19 Pozitif Hastaların Akciğer ve Göğüs Hacminin Incelenmesi

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Abstract

Background: We aimed to reveal lung volume, lesion volume and thorax diameters in patients with Covid-19 positive in computed tomography images according to gender and presence of ground glass opacity.
Materials and Methods: We included computed tomography images of 113 people (male;58, female;55) diagnosed with Covid-19 positive in our study. Computed tomography images of each patient were imported the DICOM datasets and thorax diameter measurements were performed by using MicroDicom. Moreover, lung volume and lesion volume parameters were calculated from the computed tomography images using the three-dimensional imaging method (Vitrea). All measurement parameters were compared according to gender and ground glass opacity appearance.
Results: The 113 patients (male;58, female;55) with a mean age of 44.57±14.59 diagnosed with Covid-19 were included in our study. There was a significant difference between the gender in the mean values of lung volume (males; 3530.90±1454.99 ml and females; 3149.92±1335.16 ml) and lesion volume (males; 434.59±664.19 ml and females; 557.10±671.99 ml) parameters. In addition, a significant difference in lung volume and lesion volume was obtained between the groups with ground glass opacity and without ground glass opacity. Moreover, A significant difference in thorax anteroposterior diameter length was obtained between the groups the with/without ground glass opacity. However, there was no significant difference between genders in thorax diameters.
Conclusions: In our study, we found that in the females may have more lung damage from Covid-19. We believe that the findings of our study will contribute to early stages of the pandemic, in which vaccination has not yet, and the long-term effects of post-covid.

Key Words: Covid-19, Thorax diameters, Lung volume

Öz

Amaç: Covid-19 pozitif olan hastalarının bilgisayarlı tomografi görüntülerinde, cinsiyete ve buzlu cam opasitesi varlığına göre akciğer hacmi, lezyon hacmi ve toraks çaplarının incelemesi amaçlanmıştır.
Materyal ve Metod: Çalışmamıza Covid-19 pozitif tanılı 113 kişinin (Erkek;58, Kadın;55) bilgisayarlı tomografi görüntüleri dahil edilmiştir. Her hastanın bilgisayarlı tomografi görüntüleri DICOM veri setlerine aktarılmıştır ve MicroDicom kullanılarak toraks çap ölçümleri yapılmıştır. Ayrıca bilgisayarlı tomografi görüntülerinden üç boyutlu görüntüleme yöntemi (Vitrea) kullanılarak akciğer hacmi ve lezyon hacmi parametreleri hesaplanmıştır. Tüm ölçüm parametreleri cinsiyete ve buzlu cam opaklık görünümüne göre karşılaştırılmıştır.
Bulgular: Çalışmamıza yaş ortalaması 44,57±14,59 olan ve Covid-19 tanısı alan 113 hasta (erkek;58, kadın;55) dahil edildi. Akciğer hacmi (erkek; 3530,90±1454,99 ml ve kadın; 3149,92±1335,16 ml) ve lezyon hacmi (erkek; 434,59±664,19 ml ve kadın; 557,10±671,99 ml) parametrelerinin ortalama değerlerinde cinsiyete göre anlamlı fark elde edilmiştir. Ayrıca buzlu cam opasitesi olan ve olmayan gruplar arasında, akciğer hacmi ve lezyon hacmi parametrelerinde anlamlı fark elde edilmiştir. Buzlu cam opasitesi olan ve olmayan gruplar arasında toraks ön-arka çap uzunluğu parametresinde de anlamlı fark elde edilmiştir. Ancak göğüs çapları ölçümleri açısından cinsiyetler arasında anlamlı bir fark bulunamamıştır.
Sonuç: Çalışmamızda kadınlarda, Covid-19 kaynaklı akciğer hasarının daha fazla olabileceğini bulduk. Çalışmamızın bulgularının aşılamanın henüz yapılmadığı pandeminin erken evrelerine ve uzun vadeli etkilerine katkı sağlayacağına inanıyoruz.

Anahtar Kelimeler: Covid-19, Göğüs çapları, Akciğer hacmi

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Introduction

In late December 2019, the Covid-19 pandemic began with several healthcare facilities in Wuhan, China, with patients showing symptoms of viral pneumonia, cough and chest discomfort, and in severe cases, shortness of breath on bilateral lung infiltration (1). In the early stages of the pandemic, humanity was caught much unprepared for Covid-19. In addition to the use of masks, protective equipment and disinfectants, vaccines that have been approved for emergency use since the end of 2020 have been used to prevent spread and transmission of Covid-19. At least one dose of Covid-19 vaccine has been administered to 31.2% of the world's population to date (2). Diseases are tried to be prevented by stimulating acquired immunity with vaccines. Therefore, in order to rule out the effects and side effects of the vaccine, we selected our study population retrospectively from the period when the vaccine was not yet used in Turkey.

Given the worldwide extent of viral spread and transmission of coronavirus, containing the severe acute respiratory syndrome were managed is very difficult (3). Chest X-ray and thorax computed tomography (CT) are the most commonly used radiological methods for imaging for COVID-19. Because CT method is a reliable method for detailed diagnosis, follow-up and staging of pneumonia (4). In the literature, the sensitivity of CT in the diagnosis of Covid-19 was found to be 98%, while the sensitivity of the Polymerase Chain Reaction (PCR) test was found to be 71% in the early period. (5).

We aimed to reveal presence of ground glass opacity appearance, lung volume, lesion volume and thorax diameters in patients with Covid-19 positive in this study. In addition, we compared the parameters in our study according to the presence of a ground glass image and gender. Therefore, with this study, we examined the degree of lung involvement from Covid-19 by evaluating thorax diameters and lung volume. We think that, the findings of our study will be a source of data on the long-term course after vaccination of Covid-19 and other pandemics that may occur. Thus, an important contribution will be made to the management of the pandemic in future pandemics.

Materials and Methods

This study was conducted from January, 2020 to November, 2020 retrospectively. Because the study was retrospective, informed consent was not requested and anonymous archival research findings were used in the evaluation. We included 113 people (male;58, female;55) diagnosed with Covid-19 positive in our study in the Department of Infectious Diseases and Clinical Microbiology at the time when Covid-19 vaccine studies had not started yet. First of all, a list of patients who were diagnosed with COVID-19 in January, 2020-November, 2020 from the Department of Infection And Clinical Microbiology was obtained.

Secondly, CT images were grouped as with and without lesions, and lung volume and lesion volume were analyzed by the same infection specialist with digital workstation. Then, the obtained CT images were transferred to MicroDicom program and thorax diameters were measured by the same anatomist. The relevant guidelines and regulations were strictly followed when conducting the study. Necessary permissions for the study were obtained from Cukurova University Medical Faculty, Non-invasive clinical research Ethic Board with conclusion number 132/30. In addition, necessary permissions were obtained from the collaborated with us in the Department of Infectious Diseases and Clinical Microbiology. The experimental procedures were conducted in accordance with the Declaration of Helsinki.

Measurement Protocol

Firstly, a list of patients who were diagnosed with Covid-19 positive for the period of January 2020- November 2020 was obtained in from the Infection and Clinical Microbiology Department. All CT images were obtained using a 160-slice MDCT scanner (Toshiba Aquilion™ PRIME; Otawara, Japan. Lung volume and lesion volume values were determined using a digital workstation (Vitrea CT workstation, Toshiba; Otawara, Japan). The DICOM datasets for each patient were imported and thorax diameter measurements were performed by using MicroDicom. In addition, the presence of ground glass opacity in CT images was also recorded in our study. Measurement parameters were compared according to gender and ground glass opacity appearance. The following measurements were made on the CT images.

Lung and lesion volume: The volume was calculated from the CT images using the three-dimensional imaging method (Vitrea). For example, the purple area in Figure 1 shows the lung volume and the orange area shows the lesion volume. The system performed volume measurements in these colors for each patient.

Thorax AP (Anteroposterior) diameter: Anteroposterior measurement was taken from the distance between the sternum and the thoracic vertebral corpus, at the widest point of the thorax by using MicroDicom (Figure 2a).

Thorax transvers diameter: Transverse diameter measurement was performed from the widest part of the thorax by using MicroDicom (Figure 2b).

Statistical Methods

Software package program (SPSS version 22.0) was used for all analyses. According to the Kolmogorov-Smirnov test, we accepted as $p>0.05$ is normal distribution and $p<0.05$ is not normal distribution. We found that the findings were not normally distributed. Mann-Whitney U Test which is non-parametric test was selected.

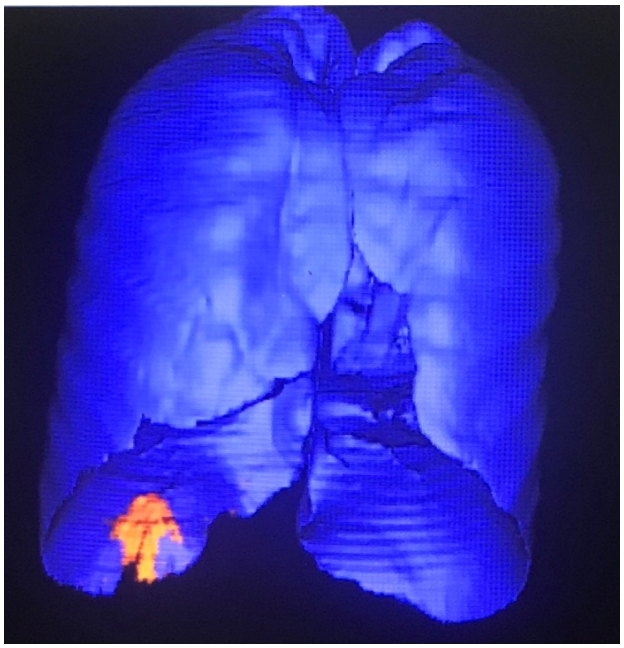

Figure 1. Lung volume and lesion volume in the CT images using the three-dimensional imaging method (Vitrea). (purple area) Lung volume. (orange area) Lesion volume.

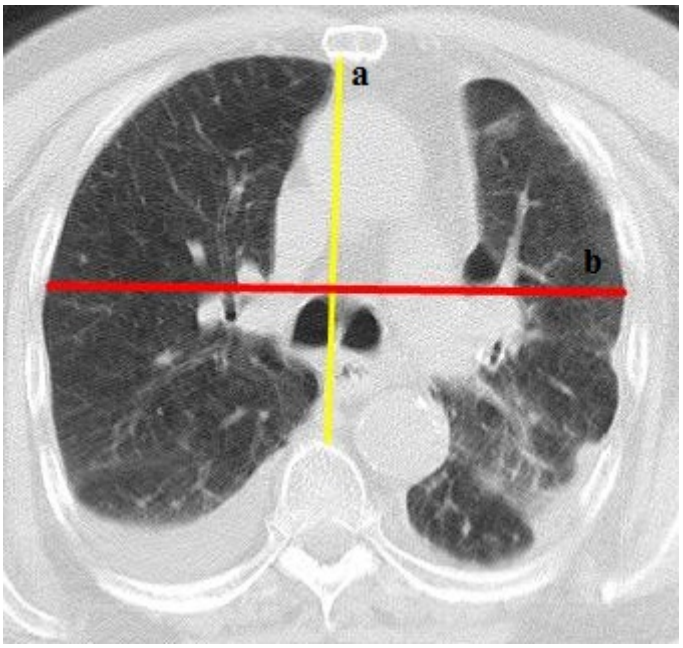

Figure 2. A diagram of the thorax showing each of the thoracic diameter measurements. (a) Anteroposterior diameter. (b) Transverse diameter.

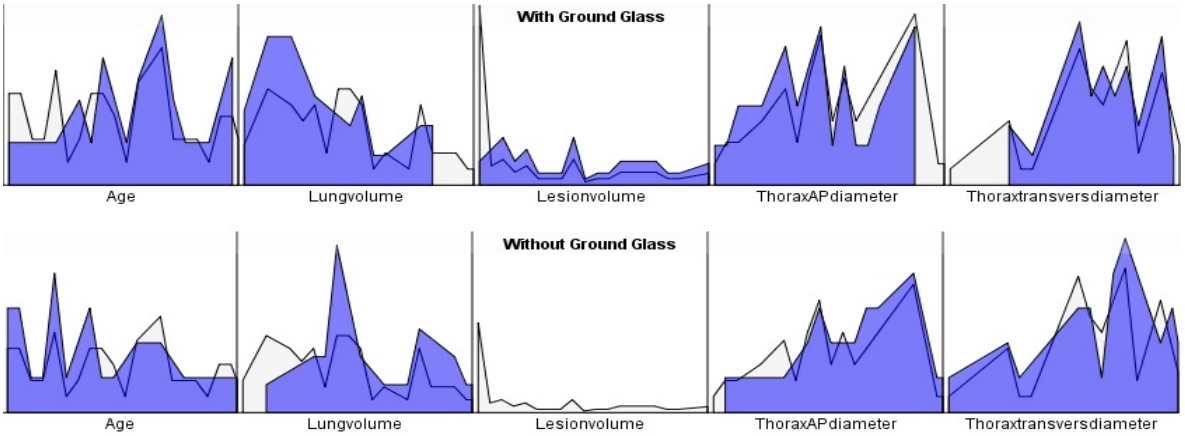

Figure 3. The distribution of the parameters in our study in the groups with and without the ground glass opacity.

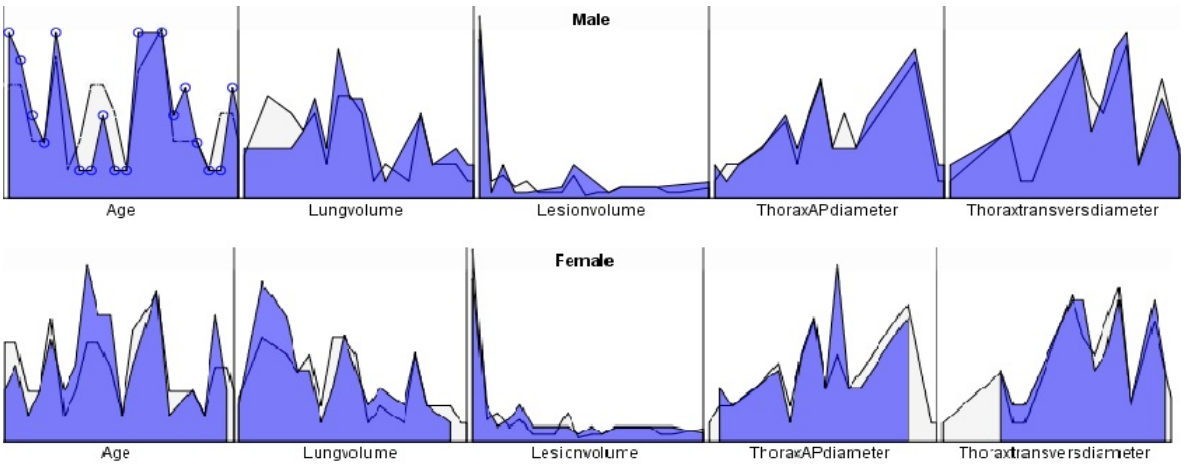

Figure 4. The distribution of the parameters in our study according to gender.

Results

The 113 patients (male;58, female;55) with a mean age of 44.57±14.59 diagnosed with Covid-19 were included in our study. Ground glass opacity was found in 61 of the patients. We found that there were 25 males and 36 females with ground glass opacity, and 33 males and 19 females without a ground glass opacity. When we compared the parameters in our study according to the with/without ground glass opacity, a significant difference was obtained except for the thorax transverse diameter (p=0.836) parameter (Table 1) (Figure 3). Moreover, when we compared the parameters in our study according to gender, no significant difference was found except for the lesion volume (p=0.044) parameter (Table 2). Lesion volume value was found to be significantly higher in females (Figure 4). Moreover, we found significant different except thorax transvers diameter in parameters in this study between groups with and without ground glass opacity according to gender (Table 3).

Table 1. Distribution of age, lung volume, lesion volume and thorax diameters according to ground glass opacity

Parameters	With Ground Glass (n=61) Mean ± SD	Without Ground Glass (n=52) Mean ± SD	p
Age	48.82±13.49	39.58±14.37	0.001
Lung volume (ml)	2835.17±1299.65	3944.08±1292.25	<0.001
Lesion volume (ml)	902.52±681.24	15.25±14.61	<0.001
Thorax AP diameter (mm)	259.90±13.08	267.99±12.68	0.001
Thorax transvers diameter (mm)	141.81±15.06	140.23±20.35	0.836

AP, anteroposterior; n, value of people; SD, standard deviation.

Table 2. Distribution of age, lung volume, lesion volume and thorax diameters according to gender

Parameters	Male (n= 58) Mean ± SD	Female (n= 55) Mean ± SD	p
Age	44.31±15.99	44.84±13.08	0.872
Lung volume (ml)	3530.90±1454.99	3149.92±1335.16	0.196
Lesion volume (ml)	434.59±664.19	557.10±671.99	0.044
Thorax AP diameter (mm)	264.58±14.83	262.62±11.92	0.542
Thorax transvers diameter (mm)	141.56±18.40	140.59±16.92	0.542

AP, anteroposterior; n, value of people; SD, standard deviation.

Table 3. The examination of parameters in our study between groups with and without ground glass according to gender.

Parameters	With Ground Glass		Without Ground Glass		p
	Male Mean ± SD	Female Mean ± SD	Male Mean ± SD	Female Mean ± SD	
Age	49.72±14.42	48.19±12.98	40.21±16.12	38.47±10.99	0.026* 0.005**
Lung volume (ml)	2811.98±1291.29	2851.27±1323.46	4075.53±1345.60	3715.77±1194.07	0.001* 0.034**
Lesion volume (ml)	991.70±692.31	840.58±676.24	12.54±12.57	19.97±16.94	0.000* 0.000**
Thorax AP diameter (mm)	259.59±14.53	260.12±12.19	268.35±14.11	267.37±10.06	0.021* 0.010**
Thorax transvers diameter (mm)	141.53±16.29	142.01±14.38	141.57±20.11	137.90±21.11	0.632* 0.790**

*AP, anteroposterior; n, value of people; SD, standard deviation; *, significant value between with and without ground glass in males; **.*

Discussion

CT is an early clinical marker in determining the prognosis of COVID-19 infection. Also, assessment of pathologic lung volumes is important for accurate staging of disease and prognosis. We evaluated the total lesion volume and total lung volume in patients with Covid-19 in our study. Ground glass opacity was observed in 61 images of 113 images in our study. In group with ground glass opacity, 36 belonged to female and 25 belonged to male. Also, we found of the 52

images without ground glass opacity, 33 belonged to male and 19 belonged to female. We found that the mean age of male (49.72±14.42) and female (48.19±12.98) with ground glass opacity was significantly higher than male (40.21±16.12) and female (38.47±10.99) without ground glass opacity. In addition, while lung volume parameter was found to be significantly higher in both male (p=0.001) and female (p=0.034) in group without ground glass opacity, the lesion volume parameter was found to be significantly higher in both male (p=0.000) and female (p=0.000) in the group with ground glass opacity. Moreover, the mean lung volume of 113 Covid-19 positive patients in our study was found to be 3345.47±1404.80 ml and the mean lesion volume was 494.22±667.85 ml. The lung volume of 61 patients with the presence of ground glass opacity was 2835.17±1299.65 ml, and the mean was 2811.98±1291.29 ml in males and 2851.27±1323.46 ml in females. Likewise, in the same patients, the lesion volume was 902.52±681.24 ml, and it was found to be 991.70±692.31 ml in males and 840.58±676.24 ml in females. There was no significant difference between genders in lung volume (p=0.994) and lesion volume (p=0.336). Moreover, the lung volume of 52 patients without the presence of ground glass opacity was 3944.08±1292.25 ml, and the mean was 4075.53±1345.59 ml in males and 3715.77±1194.07 ml in females. Likewise, in the same patients, the lesion volume was 15.25±14.61 ml, and it was found to be 12.54±12.57 ml in males and 19.97±16.94 ml in females. There was no significant difference between genders in lung volume (p=0.648) and lesion volume (p=0.254). In line with these results, there was no significant difference between the sexes in lung volume and lesion volume parameters between the groups with ground glass opacity and without ground glass opacity. We think that this may be due to the small number of people in the subgroups. Because, there was a significant difference between the gender in the mean values of lung volume (males; 3530.90±1454.99 ml and females; 3149.92±1335.16 ml) and lesion volume (males; 434.59±664.19 ml and females; 557.10±671.99 ml) parameters. According to our findings, the lesion volume, which is found to be significantly higher in females, shows that females are more affected by Covid-19. The fact that the mean lung volume in males is higher than in females also supports this result. Gender is an important determination of health (7). In the literature, it is reported that women benefit from preventive care services more than men. In particular, it has been stated that women have worse outcomes than men in diseases such as asthma, diabetes and myocardial infarction (8). Xu et al., Li et al., and Silveyra et al. when they examined the effect of Covid-19 on the lungs, they stated that number of female patients were more (9-11). In our study, it was revealed that the health status of the female population was more affected. Therefore, gender can be a determining factor in being affected by the Covid-19 process. In addition, a significant difference in lung volume (p<0.001) and lesion volume (p<0.001) was obtained between the groups with ground glass opacity and without ground glass opacity. In this finding, it was revealed similar to the literature that grounded glass opacity is an important factor in determining the degree of exposure to Covid-19.

Furthermore, we also evaluated thorax diameters (thorax AP diameter and thorax transvers diameter) in CT images of patients with Covid-19 in our study. The mean thorax AP diameter of 113 Covid-19 positive patients in our study was found to be 263.63±13.47 mm and the mean thorax transvers diameter was 141.08±17.63 ml. The thorax AP diameter of 61 patients with the presence of ground glass opacity was 259.90±13.08 mm, and the mean was 259.59±14.53 mm in males and 260.12±12.19 mm in females. Likewise, in the same patients, the thorax transvers diameter was 141.81±15.06 mm, and it was found to be 141.53±16.29 mm in males and 142.01±14.38 mm in females. There was no significant difference between genders in thorax AP diameter (p=0.889) and thorax transvers diameter (p=0.764). Moreover, the thorax AP diameter of 52 patients without the presence of ground glass opacity was 267.99±12.68 mm, and the mean was 268.35±14.10 mm in males and 267.37±10.06 mm in females. Likewise, in the same patients, the thorax transvers diameter was 140.23±20.35 mm, and it was found to be 35141.57±20.11 mm in males and 137.90±21.10 mm in females. There was no significant difference between genders in thorax AP diameter (p=0.746) and thorax transvers diameter (p=0.361). However, a significant difference (p=0.001) was found between groups with and without the ground glass opacity appearance in the thorax AP diameter length parameter. According to this finding, we can say that patients with narrower thorax AP diameters may be more prone to Covid-19 induced lung damage. In the literature, Bekir et al. found the right lung volume to be 2642 ml and the left lung volume to be 2355.7 ml in Chronic Obstructive Pulmonary Disease (COPD) patients, while they found the right lung volume to be 2346.6 ml and the left lung volume to be 2037.3 ml in the control group. There was no significant difference in right (p=0.264) and left (p=0.292) lung volumes between COPD patients and the control group. However, a significant difference (p<0.001) was found between the COPD patients (414.2 ml) and the control group (60.6) in the volumes of emphysema in the right and left lungs (12). In another study, Heussel et al. found the mean value of the right and left total lung volume in COPD patients to be 7200 ml, while they also found the mean value of the total emphysema volume to be 3200 ml (13). Similar to our study, pulmonary lesion volumes were found to be high in patients with COPD. Ippolito et al. found that total lung volume was 3861.79±1241.72 and lesion volume was 860.01±427.45 in patients with SARS-CoV-2-associated pneumonia (14). These results may indicate that thorax diameters will be a factor in being affected by Covid-19. We suggest that thorax diameters should be taken into consideration in patient follow-up.

Since there is no study in the literature examining the thorax diameters of Covid-19 patients, we were able to compare

our results with other recent literature studies. In the study of Obikili et al. on 303 Nigerians, they found that the length of the thorax transverse diameter in men; 29.00 cm and women; 27.1 cm (15). In addition, Ümit et al., in their study in which they examined the relationship between thoracic diameter and chest compression-related thoracoabdominal injury, found the average thorax anteroposterior diameter to be 126.40±18.80 mm and the average of thorax transverse diameter to be 245.70±20.10 mm (16). In an another study revealed that the mean thorax AP diameter was 174.0 mm in the 2005 group and 175.4 mm in the 2010 group (17). Moreover, Pickard et al., were found that the mean of thorax AP diameter in adults in the United Kingdom was 253 mm in males, and 235 mm in females (18). The results in these studies show that the thorax AP diameter depth in the severe injury group was smaller. These results support our study result. In our study, the thorax AP diameter was found to be significantly narrower in the group with ground glass appearance.

Conclusion

As a result, we think that the lungs of people with a narrower thorax AP diameter and women may be more affected by Covid-19. However, one of the limitations of our study is that we included only patients diagnosed with Covid-19 before vaccination to rule out the effect of the vaccine. Therefore, we recommend that studies comparing the post-vaccination period should be conducted. Moreover, we recommend that similar studies including after the vaccination process with similar parameters and a higher number of CT images with Covid-19 positive.

Ethical Approval: Ethical agreement was acquired from Cukurova University Medical Faculty, Non-invasive clinical research Ethic Board (Project number: 132/30).

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Literature Review: A.G.K
Design : A.G.K, Y.T., M.G.B
Data acquisition: A.G.K, Y.T
Analysis and interpretation: A.G.K, Y.T., M.G.B
Writing manuscript: A.G.K
Critical revision of manuscript: A.G.K, Y.T., M.G.B
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