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Mortality Predictors using Chest Computed Tomography Findings in COVID-19 Patients

COVID-19 Hastalarının Bilgisayarlı Göğüs Tomografisi Bulgularındaki Mortalite Belirteçleri

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ABSTRACT

Objective: The coronavirus disease (COVID) pandemic is still ongoing. Computed tomography (CT) is widely used in coronavirus disease-2019 (COVID-19) patients for lung damage determination. The aim of this study was to investigate the relationship between mortality rates and measurements of intrathoracic anatomical structures using CT images.

Methods: This retrospective study was conducted in a single center and included a total of 322 cases, namely, 147 deceased and 175 surviving patients. All patients were diagnosed with COVID-19 on the basis of a positive polymerase chain reaction test. Total lung volumes, diameters of major vascular structures, comorbidity status, and laboratory blood tests were measured or determined. Total lung volumes were calculated using the range of -1024 to -300 Hounsfield Unit in the Slicer application.

Results: A decrease in total lung volume was associated with a higher mortality rate ($p<0.001$). Increases in right and left pulmonary artery diameters were associated with high mortality rate ($p=0.002$ and 0.001, respectively). Increase in cardiothoracic ratio and decrease in thorax diameter were associated with high mortality rate in female patients ($p=0.013$ and $p<0.001$, respectively). It was found that patients with cardiovascular disease ($p=0.043$), chronic lung disease ($p=0.005$) and renal failure ($p<0.001$) had a significant mortal course. Elevated values of white blood cell count ($p=0.018$), aspartate aminotransferase ($p<0.001$), lactate dehydrogenase ($p<0.001$) and C-reactive protein ($p<0.001$) were found to be associated with high mortality rates.

Conclusion: Total lung volume and intrathoracic main vascular sizes can be obtained from CT images using computer applications, and these measurements can provide an idea of the mortality rate in COVID-19 patients. In addition, comorbidity status and laboratory blood parameters can be used as prognostic markers.

Keywords: COVID-19, tomography, lung volumetry, mortality, pulmonary arteries

ÖZ

Amaç: Koronavirüs hastalığı (COVID) salgını etkilerini sürdürmektedir. Bilgisayarlı tomografi (BT), koronavirüs hastalığı-2019 (COVID-19) hastalarında akciğer hasarının belirlenmesinde yaygın olarak kullanılmaktadır. Bu çalışmanın amacı, BT görüntüleri kullanılarak intratorasik anatomik yapıların ölçümleri ile mortalite oranları arasındaki ilişkinin araştırılmasıdır.

Yöntemler: Bu retrospektif çalışma tek merkezde gerçekleştirildi ve 147'si ölen, 175'i hayatta kalan toplam 322 olguyu içeriyordu. Tüm hastalara pozitif polimeraz zincir reaksiyonu testi temelinde COVID-19 tanısı konuldu. Toplam akciğer hacimleri, ana damar yapılarının çapları, komorbidite durumu ve laboratuvar kan testleri ölçüldü veya belirlendi. Toplam akciğer hacimleri Slicer uygulamasında -1024 ila -300 Hounsfield Birimi aralığı kullanılarak hesaplandı.

Bulgular: Total akciğer hacmindeki azalma, daha yüksek mortalite oranıyla ilişkiliydi ($p<0,001$). Sağ ve sol pulmoner arter çaplarındaki artış mortalite oranıyla ilişkiliydi (sırasıyla $p=0,002$ ve 0,001). Kadın hastalarda kardiyotorasik oranın artması ve toraks çapındaki azalmanın yüksek mortalite oranı ile ilişkili olduğu görüldü (sırasıyla $p=0,013$ ve $p<0,001$). Kardiyovasküler hastalığı ($p=0,043$), kronik akciğer hastalığı ($p=0,005$) ve böbrek yetmezliği ($p<0,001$) olan hastaların yüksek mortalite riskinin olduğu belirlendi. Beyaz küre sayısı ($p=0,018$), aspartat aminotransferaz ($p<0,001$), laktat dehidrojenaz ($p<0,001$) ve C-reaktif protein ($p<0,001$) değerlerindeki artışın, yüksek ölüm oranlarıyla ilişkili olduğu belirlendi.

Sonuç: Bilgisayar uygulamaları kullanılarak BT görüntülerinden toplam akciğer hacmi ve intratorasik ana damar boyutları elde edilebilmekte ve bu ölçümler, COVID-19 hastalarındaki ölüm oranı hakkında fikir verebilmektedir. Ayrıca komorbidite durumu ve laboratuvar kan parametreleri de prognostik belirteç olarak kullanılabilir.

Anahtar Sözcükler: COVID-19, tomografi, akciğer hacmi, mortalite, pulmoner arterler

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INTRODUCTION

Coronaviruses are a family of viruses with two subgroups belonging to the Nidovirales family and the Torovirina group. Coronaviruses (CoVs) are enveloped RNA viruses with a wide disease network that infect mammals and birds. Human pathogens generally affect the respiratory tract. There are six known subgroups that affect humans (1). Four of them, 229E, OC42, NL63, and HKU1, cause common cold, whereas the remaining two types, severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) and middle east respiratory syndrome-coronavirus (MERS-CoV), can cause serious and in some cases fatal infections (2). In December 2019, a new type was identified in the Wuhan region of China, which was different from MERS-CoV and SARS-CoV and was named SARS-CoV-2 (2). The diagnosis of coronavirus disease-2019 (COVID-19) infection is mainly based on the detection of the virus in respiratory samples by reverse transcriptase polymerase chain reaction (PCR) (3). Chest computed tomography (CT) has become a powerful method for the diagnosis of COVID-19 (4). The aim of this study was to determine whether there are some differences in mortality rates between deceased and surviving patients using chest CT. In the case of obtaining meaningful data, chest CT may be useful in determining prognosis or prompt management such as treatment.

MATERIALS AND METHODS

Study design: This study was conducted with the approval of the Ethics Committee of Recep Tayyip Erdoğan University Faculty of Medicine (approval number: 2021/73, date: 26.04.2021). Because the study was conducted retrospectively, no volunteers were used.

Data sources: The study was retrospectively conducted on 147 deceased and 175 surviving patients, aged 50 and over, who visited the adult COVID polyclinic of Recep Tayyip Erdoğan University Faculty of Medicine Training and Research Hospital between March 2020 and May 2021. Patients who were diagnosed with COVID-19 on a positive PCR test and had lung involvement on CT imaging were included in the study. Patients with pleural effusion, pneumothorax, intrathoracic mass, and pulmonary hypertension were not included in the study. In addition, patients diagnosed with non-COVID pneumonia or lacking chest CT imaging at the first admission to the hospital were excluded. Blood parameters obtained at the time of admission or, if hospitalized, the blood parameters within the first 24 hours were included in the study. The measured parameters included leukocytes, neutrophils, lymphocytes, hemoglobin, alanine aminotransferase (ALT), aspartate aminotransferase (AST), lactate dehydrogenase (LDH), C-reactive protein (CRP), D-dimer, fibrinogen, international normalized ratio (INR), and neutrophil-to-lymphocyte ratio (NLR). AST in one patient, LDH in five patients, CRP in one patient, D-dimer in 23 patients, fibrinogen in 34 patients, and INR in 21 patients were observed to be deficient. The comorbidity status of the cases, cardiovascular system disease, diabetes mellitus (DM), chronic lung disease, malignancy, renal failure, and hepatic failure, was determined and recorded (5). Patients were allocated into the deceased and surviving groups. For the survivor group, patients with a history of intensive care unit admission were not included.

Chest CT and quantitative analysis: The images were taken with a 16-detector tomography device (Toshiba Alexion, Japan) in the hospital emergency unit, in the supine position, and in deep inhalation. The drawing characteristics were as follows: tube current (50-300 mA), voltage (120 kV), and cross-sections (between 0.625 and 5 mm). CT images of the patients were taken from the radiology system as DICOM files. Later, these images were opened on the application Slicer (ver 4.11.20210226) (6). By selecting the range of -1024 to -300 Hounsfield unit on the slicer application, the three-dimensional shape of the lungs was extracted, and the volume of the lungs was calculated by deleting the large airways (Figure 1) (6-8). Then, the images of the patients were opened through the application called RadiAnt DICOM viewer (ver 2020.2.3), and their vascular, tracheal, and cardiothoracic measurements were made through this program. The diameters of the right pulmonary artery (RPA), left pulmonary artery (LPA), ascending aorta (AA), and pulmonary trunk (PT) were measured from the bifurcation point of the PT (Figure 2) (9-11). The ratio of the diameter of the PT to that of the AA was also recorded. Transversely, thoracic diameters were measured from the widest measurable distance between the inner walls of the thorax, and cardiac diameters were measured from the outer surface of the heart where the widest value was captured (Figure 3) (12). Transverse and anteroposterior diameters of the trachea were measured along the inner lumen of the trachea

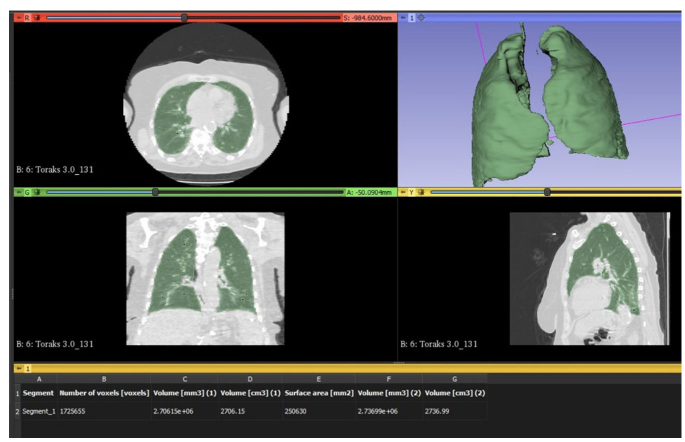

Figure 1. Lung volume measurement with slicer application.

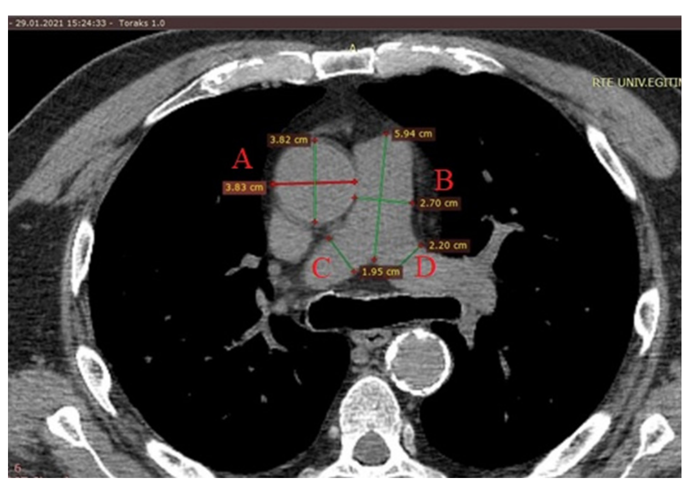

Figure 2. Vascular measurements. (A) Ascending aorta, (B) pulmonary trunk, (C) right pulmonary artery, (D) left pulmonary artery (measurements were made at the bifurcation level of the pulmonary artery).

from axial sections passing 2 cm above the apex of the arcus aorta in the sagittal images. The ratio of the transverse diameter to the anteroposterior diameter was also recorded (Figure 4) (12,13). Because the imaging of 13 of the cases was taken in external centers on the same day, they could not be recorded in the computer environment and their measurements could not be made. These cases were evaluated using only laboratory parameters. In addition, an error was encountered while calculating the volumes of 12 cases using DICOM images, and the Slicer application and volume measurement could not be performed. The imaging thickness of cross-sections: one case 0.625 mm, six cases 5 mm, and all the remaining cases 1 mm.

Statistical Analysis

IBM SPSS Statistics 25.0 (New York, USA) program was used for statistical calculations. For parametric tests, it was first checked whether it showed a normal distribution using the Kolmogorov-Smirnov test. Then, those with normal distribution were evaluated using the independent samples t-test, whereas those without normal distribution were evaluated using the Mann-Whitney U test. Non-parametric tests were evaluated using the chi-square test. Pearson's chi-square test or Fisher's test was used according to the number of cells. Normally distributed parameters are given as mean ± standard deviation. Those that do not fit the normal distribution are given as the median value and the 25% and 75% percentile values in parenthese. SPSS receiver operating characteristic (ROC) curve analysis was used to determine the cut-off value for the parameters. Any p-value of <0.05 was considered statistically significant.

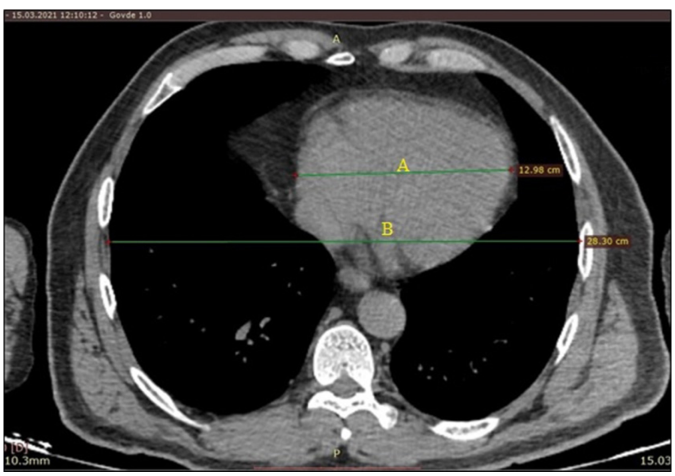

Figure 3. Thorax and cardiac diameters. (A) Cardiac diameter, (B) Thorax diameter, (A, B) Cardiothoracic ratio.

RESULTS

Patient characteristics: The characteristics, comorbidities, and laboratory findings of the patients are listed in Tables 1, 2. A total of 322 people, 147 deceased and 175 surviving patients, were included in the study. The age range was 51-89, with a mean of 71.07±10.88 and a median value of 71. The age range of the deceased group was between 53-96, with a mean of 74.39±10.24 and a median of 75, while the age range of the surviving group was 51-95, with a mean of 68.28±10.64 and a median value of 66. The mortality rate increased with age and was found to be statistically significant (p<0.001). While there were 97 (66%) men and 50 (34%) women in the deceased group, there were 93 (53.1%) men and 82 (46.9%) women in the surviving group. There was a significant difference in favor of males between those who died and surviving patients

Figure 4. Tracheal measurements. (A) Trachea transverse diameter, (B) Trachea anteroposterior diameter, (C) detecting the level 2 cm above the aortic arch, (A, B) Tracheal index.

Table 1. Clinical features and comorbidities of patients

Parameters		Patients			
		All, (n=322)	Deceased, (n=147)	Survived, (n=175)	p-value
Age	All	71.07±10.88	74.39±10.24	68.28±10.64	<0.001*
	Male	69.96±10.26	71.86±9.68	67.99±10.53	0.009*
	Female	72.67±11.57	79.32±9.58	68.61±10.82	<0.001*
Gender	Male	190	97	93	
	Female	132	50	82	0.02*
Comorbidity status	Cardiovascular disease	225 (69.8%)	111 (75%)	114 (65%)	0.043*
	Diabetes mellitus	108 (33.5%)	54 (26%)	53 (30%)	0.22
	Chronic lung disease	39 (17.5%)	26 (17.6%)	13 (7.4%)	0.005*
	Renal failure	41 (12.7%)	30 (20.4%)	11 (6.2%)	<0.001*
	Malignancy	32 (9.9%)	19 (12.9%)	13 (7.4%)	0.101
	Hepatic failure	3 (0.1%)	2 (1.3%)	1 (0.6%)	0.594

*p<0.05 indicates a significant difference.

(p=0.02). It was found that patients with cardiovascular system disease (p=0.043), chronic lung disease (p=0.005), and renal failure (p<0.001) had a more mortal course. No significant difference was observed between the deceased and surviving groups for DM, malignancy, and hepatic failure.

Laboratory findings: Increased white blood cell (p=0.018), increased neutrophil (p<0.001), decreased lymphocyte (p<0.001), increased NLR (p<0.001), increased AST (p<0.001), increased LDH (p<0.001), increased CRP (p<0.001), high D-dimer (p=0.003) and high INR (p<0.001) were found to be associated with mortality rate. There was no significant difference between the two groups for platelet, ALT, hemoglobin, and fibrinogen values. Details are given in Table 2.

Lung volumes and morphometric measurements: Details of the measurements are given in Table 3. Total lung volumes were found to be lower in deceased patients than in surviving patients in both sexes (p<0.001). Right and LPA diameters were found to be greater in deceased female patients than in surviving female patients (p<0.001). In male patients, there was no significant difference in the right and LPA diameters between the deceased and surviving patients, unlike female patients. No significant difference was observed between the deceased and surviving patients in terms of PT diameter, AA diameter, ratio of PT to AA, cardiac diameter, transverse tracheal diameter, and tracheal index values. Thorax diameters were found to be significantly lower in the deceased than in the surviving female patients (p<0.001). The cardiothoracic ratio was found to be significantly higher in the deceased than in the surviving female patients (p=0.013). All numerical parameters considered in the study were evaluated with ROC analysis in terms of death and survival status, and only the total lung volumes of female patients were found as the parameter providing area under the curve (AUC) >0.70. According to the statistical analysis, the cut-off value was found to be 2547 mL, but the sensitivity was 70% and the specificity was 61%. In the ROC analysis for male patients, AUC=0.69 was calculated, and the cut-off value was 3961 mL. The sensitivity value was 68% and the specificity was 60%. Running ROC analysis for the remaining parameters did not yield an AUC >0.7.

DISCUSSION

The COVID-19 pandemic, which emerged toward the end of 2019, persists at the time of writing, even after the introduction of specific vaccines. Although the gold standard diagnosis of the disease is based on PCR, thoracic imaging methods are frequently used to provide an early treatment approach, especially in patients with respiratory distress, because of their long-term observations. At the same time, blood tests from patients are also studied, and their clinical course is arranged accordingly.

Jin et al. (14) reported that male patients showed a worse prognosis in their study on gender factors. Colombi et al. (5) did not find patients with chronic lung disease to have a more mortal course, unlike our study. Eslami et al. (12) did not find patients with hypertension and cardiovascular system disease to have a poor prognosis, unlike our study. Although there are differences between studies, in general, patients with cardiovascular system disease, DM, chronic lung disease, and renal failure have a poor prognosis. The different interpretations of comorbidity conditions among studies may be related to the small number of cases included.

Liao et al. (15) found platelet counts and fibrin degradation products to predict the severity and prognosis of patients with COVID-19. While the decrease in platelet counts was not found to be significant regarding mortality rate in our study, there are many studies in the literature that find the decrease to be significant. According to the meta-analysis study of Henry et al. (16), the increase in white blood cell counts and the decrease in platelet counts were found to be significant. While the increase in ALT value was found to be significant in some studies, it was found to be insignificant in our study. It should be noted that in other studies, blood parameters were categorized as normal, decreased, or increased. In our study, these parameters were handled as direct numerical values, and a

Table 2. Laboratory findings of the patients

Parameters	Deceased	Survivor	Total	p-value
WBC ($x10^3/\mu L$)	6.77 (5.04/9.61)	6.03 (4.8/7.7)	6.26 (5.0/8.51)	0.018*
Neutrophil ($x10^3/\mu L$)	4.93 (3.56/7.93)	4.07 (3.2/5.61)	4.33 (3.32/6.67)	<0.001*
Lymphocyte ($x10^3/\mu L$)	0.88 (0.62/1.42)	1.3 (0.92/1.66)	1.1 (0.76/1.6)	<0.001*
NLR (%)	6 (3.24/9.38)	3.21 (2.23/4.9)	4.2 (2.46/6.89)	<0.001*
Platelet ($x10^3/\mu L$)	166 (137/224)	184 (150/235)	175 (143/231)	0.051
Hemoglobin (mg/dL)	12.94±1.94	13.21±1.49	13.09±1.71	0.153
AST (IU/L)	40 (28/58)	31 (23/39)	33 (25/51)	<0.001*
ALT (IU/L)	22 (16/33)	21 (14/32)	22 (15.8/32.3)	0.252
LDH (IU/L)	361 (260/519)	275 (218/343)	300 (233/418)	<0.001*
CRP (mg/L)	122.8 (59/193.6)	60.5(18.9/119.5)	81.9 (27.2/147.8)	<0.001*
D-Dimer (µgFEU/mL)	0.79 (0.44/1.82)	0.67 (0.37/0.91)	0.68 (0.40/1.14)	0.003*
Fibrinogen(mg/dL)	498 (439/610)	490 (415/580)	492 (422/659)	0.176
INR	1.05 (0.97/1.15)	0.99 (0.94/1.08)	1.01 (0.95/1.12)	<0.001*

WBC: White blood cell, NLR: Neutrophil-to-lymphocyte ratio, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, LDH: Lactate dehydrogenase, CRP: C-reactive protein; INR: International normalized ratio, *p<0.05 indicates a significant difference.

comparison was performed between the two groups. The difference in the significance of blood parameters between our study and other studies may be due to the statistical methodused.

Li et al. (17) stated that a decrease in the total lung volume indicated a poor prognosis, which is consistent with our study. Lanza et al. (6) found that the total lung volumes in COVID patients were lower in those who needed intubation. Carvalho et al. (18) showed that the severity of the disease increased as lung volume decreased. Contrary to most studies, Ippolito et al. (19) did not find the decrease lung volumes to be associated with poor prognosis. There may be technical differences in the three-dimensional applications and devices used in these studies conducted at different centers.

Table 3. Measurements of the intrathoracic structures

Parameters	All (n=309)		Deceased (n=134)	Survivor (n=175)	p-value
TLV (mL)	All	3177 (2467/4185)	2847 (2227/3773)	3399 (2637/4398)	<0.001*
	Men	3998 (3028/4820)	3408 (2771/4316)	4228 (3531/5177)	<0.001*
	Women	2574 (2108/3078)	2253 (1830/2668)	2775 (2304/3301)	<0.001*
PT (cm)	All	2.89 (2.64/3.13)	2.89 (2.68/3.11)	2.89 (2.63/3.14)	0.571
	Men	2.89 (2.67/3.10)	2.87 (2.64/3.1)	2.92 (2.67/3.09)	0.918
	Women	2.89 (2.63/3.17)	2.93 (2.73/3.13)	2.87 (2.6/3.21)	0.318
RPA (cm)	All	2.01 (1.81/2.23)	2.06 (1.87/2.27)	1.96 (1.76/2.19)	0.002*
	Men	2.04 (1.86/2.25)	2.03 (1.87/2.27)	2.06 (1.83/2.23)	0.483
	Women	1.93 (1.76/2.20)	2.08 (1.83/2.29)	1.87 (1.68/2.08)	0.001*
LPA (cm)	All	2.09 (1.91/2.29)	2.14 (2.01/2.38)	2.05 (1.89/2.23)	0.001*
	Men	2.1 (1.94/2.28)	2.11 (1.98/2.36)	2.07 (1.94/2.24)	0.142
	Women	2.1 ± 0.34	2.23±0.32	2.03±0.33	0.001*
AA (cm)	All	3.72±0.41	3.73±0.39	3.72±0.43	0.707
	Men	3.76±0.41	3.74±0.41	3.79±0.41	0.460
	Women	3.67±0.42	3.73±0.39	3.64±0.43	0.255
PT/AA (%)	All	0.78 (0.71/0.86)	0.79 (0.72/0.86)	0.78 (0.71/0.86)	0.696
	Men	0.78 (0.71/0.85)	0.78 (0.71/0.86)	0.79 (0.7/0.84)	0.440
	Women	0.78 (0.73/0.88)	0.79 (0.73/0.90)	0.78 (0.73/0.87)	0.903
Cardiac diameter (cm)	All	13.32±1.61	13.5±1.67	13.2±1.56	0.12
	Men	13.7±1.56	13.85±1.44	13.59±1.65	0.30
	Women	12.8±1.56	12.87±1.9	12.77±1.33	0.724
Thorax diameter (cm)	All	25.52±2.35	25.43±2.63	25.59±2.13	0.557
	Men	26.87±1.83	26.78±1.91	26.95±1.75	0.538
	Women	23.63±1.59	22.92±1.79	24.05±1.31	<0.001*
CTR (%)	All	0.53±0.07	0.53±0.07	0.52±0.07	0.065
	Men	0.51±0.07	0.52±0.06	0.51±0.08	0.279
	Women	0.54±0.06	0.56±0.07	0.53±0.06	0.013*
TTR (cm)	All	1.83±0.31	1.84±0.27	1.82±0.33	0.534
	Men	1.99±0.27	1.95±0.27	2.02±0.27	0.064
	Women	1.61±0.21	1.65±0.2	1.59±0.22	0.139
TAP (cm)	All	2.22 (1.82/2.58)	2.34 (1.86/2.65)	2.14 (1.8/2.53)	0.034*
	Men	2.5 (2.24/2.77)	2.5 (2.25/2.79)	2.49 (2.17/2.75)	0.606
	Women	1.84±0.31	1.87±0.36	1.82±0.28	0.350
TTR/TAP (TI %)	All	0.83 (0.74/0.93)	0.82 (0.7/0.92)	0.83 (0.76/0.93)	0.167
	Men	0.8 (0.71/0.88)	0.8 (0.66/0.88)	0.81 (0.75/0.89)	0.179
	Women	0.88 (0.76/0.98)	0.92 (0.75/1)	0.87 (0.78/0.98)	0.606

TLV: Total lung volume, PT: Pulmonary trunk, LPA: Left pulmonary artery, RPA: Right pulmonary artery, AA: Ascending aorta, CTR: Cardiothoracic ratio, TTR: Trachea transverse diameter, TAP: Trachea anteroposterior diameter, TI: Tracheal index, *p<0.05 indicates a significant difference.

Lung volumes can also be affected by parameters such as height, weight, orthopedic problems, and ethnic characteristics, which were not included in our study. Considering that the patient population we studied was the patient group with respiratory distress, the patients may not have been able to inhale deeply enough during the extraction, and this may be one of the factors that may have affected our measurements. In the literature, different parameters such as well-ventilated lung volume and the ratio of this volume to the total volume have been studied, and more meaningful data may have been obtained.

Hayama et al. (10) stated that the diameter of the PT and the PT/AA ratio were higher in severe patients. Spagnolo et al. (9) reported that increased PT diameter and increased PT/AA ratio were associated with poor prognosis. Eslami et al. (12) found no significant effect of the PT and PT/AA ratio on the mortality rate. Esposito et al. (20) found the increases in PT, LPA, and RPA diameters to be significant regarding mortality rate. Yildiz et al. (21) found the increase in PT diameter to be significant, whereas the increase in the diameters of the AA, LPA, and RPA was not found to be significant. Erdoğan et al. (22) found that increased PT diameter, AA diameter, and PT/AA ratio were all associated with poor prognosis. Planek et al. (23) did not find the PT/AA ratio to be clinically significant, which is similar to our study. Spagnolo et al. (9) showed that an increase in the diameter of the PT and PT/AA were significantly associated with death. In general, many studies have found vascular measurements to be meaningful. However, none focused on gender. In our study, the increase in the diameters of the right and LPA was found to be significant regarding mortality rate when gender factor was not considered. However, it was found to be significant only in female cases when the gender factor was considered.

In addition, the increase in the diameters of the PT and AA was found to be significant in most studies, which is not similar to our study.

Eslami et al. (12) stated that an increase in CTR was significantly associated with mortality, whereas the tracheal index was not significant. In the study by Ünlü et al. (24), which classified 326 patients according to the percentage of pneumonic lung involvement, a significant relationship was found between the percentage of lung involvement and the diameter of the trachea. They stated that the percentage of lung involvement in patients increased along with the increase in both the transverse and anteroposterior diameters of the trachea, and this could indicate a poor prognosis (24). Tai et al. (25) reported that tracheal measurements were affected by height, gender, and race. In our study, information about height was not recorded. In our study, the thorax diameters were found to be significantly lower in the deceased than in the surviving female patients. There are very few studies on mortality rate in COVID-19 infection related to thorax diameter or cardiothoracic ratio in the literature.

Study Limitations

In our study, height and weight values, which may affect our measurements, could not be included. Adding a third group of non-COVID-19 patients would have yielded more efficient results.

CONCLUSION

In other studies, the mortality rate in COVID-19 patients was associated with some blood parameters and comorbidity status, unlike our study. Similarly, in other studies, some main intrathoracic vascular sizes were associated with mortality rate, unlike in our study. However, the number of cases in most of these studies was less than that in our study. In addition, in most of these studies, the examination according to gender has not been accomplished. Therefore, increasing the number of cases and examining by gender may yield new results, as in our study.

Ethics

Ethics Committee Approval: This study was conducted with the approval of the Ethics Committee of Recep Tayyip Erdoğan University Faculty of Medicine (approval number: 2021/73, date: 26.04.2021).

Informed Consent: Because the study was conducted retrospectively, no volunteers were used.

Authorship Contributions

Concept: A.Y.U., Y.Ü., N.H., Design: Y.Ü., A.Y.U., N.H., Resources: N.H., F.B.Ç., Materials: N.H., F.B.Ç., Data Collection or Processing: A.Y.U., N.H., Analysis or Interpretation: A.Y.U., N.H., Z.Y., Literature Search: A.Y.U., Z.Y., Y.Ü., Writing: A.Y.U., Z.Y., Y.Ü., Critical Review: A.Y.U., Z.Y., Y.Ü.

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