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ORIGINAL RESEARCH / *ÖZGÜN ARAŞTIRMA*

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CT Measured Cardiovascular and Metabolic Risk Factors in Patients with COVID-19 Infections

COVİD-19 Olgularında BT ile Değerlendirilen Kardiyovasküler ve Metabolik Risk Faktörleri

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ABSTRACT *Objective:* The aim of this study was to document some measurable thoracic computed tomography (CT) parameters investigated as a risk factors for prognosis in patients with coronavirus disease-2019 (COVID-19).
Materials and Methods: We retrospectively analysed the patients with COVID-19 infection in three groups. Group 1 patients were the patients who were treated in the inpatient clinic or at home for COVID-19 pneumonia, group 2 patients consisted of patients who survived after treatment for COVID-19 pneumonia in intensive care unit (ICU), group 3 patients consisted of patients who died during treatment for COVID-19 pneumonia in the ICU. We evaluated the diameter of the aorta (A) and pulmonary artery (PA), PA/A ratio, cardiothoracic ratio (CTR), the fat to muscle ratio, and paraspinal muscle density as CT parameters evaluated as risk factors for COVID-19 infection.
Results: The median age of all patients was 67 (Q1: 58-Q3: 75) and 60,6 % (n=143) of the patients were male. CTR was the only parameter for admission to ICU found statistically significant in multivariate analysis for both men and women. Additionally, it was the only significant risk factor for death in patients with COVID-19 infection. Although not statistically significant, the diameter of PA was found to be high in all groups. The other parameters evaluated did not provide statistically significant results between the groups.
Conclusion: CTR may be taken into consideration as a potential risk factor in the evaluation of the patients with COVID-19 infections The diameter of PA was found to be higher in all groups so it might be an indicator of inflammation of the lungs.
Keywords: CT, COVID-19, metabolic

ÖZ *Amaç:* Bu çalışmanın amacı koronavirüs hastalığı-2019 (COVİD-19) olgularında risk faktörü olabilecek toraks bilgisayarlı tomografi (BT) tetkiki ile değerlendirilen bazı ölçülebilen parametrelerin dökümente edilmesidir.
Gereç ve Yöntem: Çalışmada COVİD-19 olguları retrospektif olarak incelendi ve 3 grup oluşturuldu. Grup 1 COVİD-19 pnömonisi nedeni ile normal servislerde veya evde tedavi olan olgular, grup 2 COVİD-19 pnömonisi olan ve yoğun bakım ünitesine (YBÜ) alınan ve yaşayan olgular, grup 3 ise COVİD-19 pnömonisi sonrası eks olan olgulardan oluştu. BT tetkikinde aorta (A) ve pulmoner arter (PA) çapı, PA/A oranı, kardiyotorasik oran (KTO), yağ kas oranı, paraspinal kas densitesi gibi COVİD-19 enfeksiyonu için risk olarak kabul edilen parametreler değerlendirildi.
Bulgular: Olguların ortanca yaşı 67 yıl idi (Q1: 58-Q3: 75). Olguların %60,6'sı (n=143) erkek hastalardı. Multivariate analizde KTO, erkek ve bayan olgular için YBÜ'ye başvuruda tespit edilen tek risk faktörü idi. Ek olarak COVİD-19'lu erkek olgularda KTÖ ölüm riski ile ilişkili olarak bulunan tek parametre idi. Tüm olgularda PA çapı normalden daha yüksek bulundu. Diğer incelenen parametrelerde gruplar arasında istatistiksel olarak anlamlı bir fark saptanmadı.
Sonuç: KTO, COVİD-19 olgularının değerlendirilmesinde potansiyel bir risk faktörüdür. PA çapı tüm olgularda yüksek olup akciğer enflamasyonunun bir bulgusu olabilir.
Anahtar Kelimeler: BT, COVİD-19, metabolik

Introduction

Coronavirus disease-2019 (COVID-19) is a complicated infectious disease with different organ involvements affecting the lung predominantly. It spread all over the world and became a burden to healthcare systems. The real time reverse transcription polymerase chain reaction (RT-PCR) test is considered the gold standard for the diagnosis of coronavirus. Moreover, the computed tomography (CT) examination is performed with high sensitivity in diagnosis with short acquisition times. It is almost routine in emergency settings in many hospitals in patients evaluation for coronavirus infection. It provides early diagnosis of the disease with great sensitivity and detects its complications that is an advantage for disease management and prognosis (1). It is known that the older age, male sex and additional comorbid diseases such as hypertension and diabetes are associated with bad prognosis and decreased survival in patients with COVID-19 (2,3). Therefore, it is important to detect the possible risk factors affecting disease's prognosis in the first evaluation of the patient for early intervention. It has been demonstrated that imaging-based cardiac indices can predict increased risk of morbidity and mortality in a number of acute and chronic illnesses. In individuals with respiratory disorders, an elevated cardiothoracic ratio (CTR) or increased pulmonary artery-to-aorta (PA/A) ratio is associated with an unfavorable prognosis (4,5); these indices might also be indicative of increased risk of cardiovascular diseases (6,7). In Eslami et al.'s (8) study, the elevated CTR and increased PA/A ratio associated with bad prognosis in patients with COVID-19 pulmonary diseases. Body composition was also evaluated in different CT studies in patients with COVID-19 for detecting muscle mass or visceral obesity [high visceral to subcutaneous adipose tissue (SAT) area ratio] (9-11). They found that increased visceral accumulation of fat is linked to worse COVID-19 severity.

The aim of this study is to document some measurable CT parameters investigated as a risk factors for prognosis in patients treated in intensive care units (ICU) for COVID-19 and to compare the data with patients treated in inpatient clinic, or at home.

Materials and Methods

We retrospectively analysed the patients with COVID-19 infection who had treatments in our ICU founded for COVID-19 pandemic between March 2020 and May 2021. All of the participants in the study had thorax CT scans and real-time reverse transcriptase polymerase chain reaction (RT-PCR) results that were positive. Totally 151 patients were treated. Of all 79 patients were treated successfully, in contrast, 72 patients succumbed because of the disease itself or its complications. The patients with acute coronary syndrome, pulmonary emboli and oxygen dependent chronic obstructive pulmonary disease were excluded from the study. In addition, suboptimal image quality due to motion artefacts and narrow field of view were not included. We also grouped 85 patients with COVID-19 for comparison that had pneumonia of COVID-19 infection and given medical and supportive treatments inpatient unit of our hospital or at home. These patients were chosen randomly from patients that applied our hospital for COVID-19 infection, had positive nasopharyngeal swab for RT-PCR and thorax CT examination. These patients were at the same age and sex. We made three groups of patients; group 1 patients were the patients that were treated in inpatient clinic or at home for COVID-19 pneumonia, group 2 patients consisted of patients that survived after treatment for COVID-19 pneumonia in ICU, group 3 patients consisted of patients that expired during treatment for COVID-19 pneumonia in ICU. We did not note the CT severity scores of the patients because we don't know the exact stage of the disease and different stages may cause faulty evaluation.

All thorax CT examinations were evaluated by one general radiologist with 18 years experience. If the patient had more than one CT only the initial CT was evaluated. CT images were obtained from 128 slice CT scanner (Philips Ingenuity CT scanner, Germany) in supine position, in end inspiration stage. CT exams were performed with low dose protocol and IV contrast material were not given. The scanning parameters were tube voltage: 120 kVp; tube current: 50-90 mAs with automatic exposure control, slice thickness: 1 mm. The fat to muscle ratio (FMR) was calculated from axial CT images at T11-T12 level by dividing the waist circumference to mean muscle circumference. We calculated the waist circumference manually by drawing the abdominal circumference and both paravertebral muscle circumferences at the level of T11-T12th vertebra (Figure 1). The CTR was calculated by dividing the greatest transverse diameter of the heart to the greatest transverse diameter of the inner to inner thoracic cavity (Figure 2). In addition, the diameter of ascending A and main PA were calculated at the level of pulmonary bifurcation (Figure 3). Then PA/A ratio was noted. In addition we calculated the right paraspinal muscle density (PMD) at the level of T11-T12th vertebra. The 1.5 cm^2 sized region of interest was drawn manually and the mean Hounsfield unit (HU) and standard deviation was collected (Figure 4).

Statistical Analysis

We used SPSS (Version 22 for Windows, SPSS Inc, Chicago, IL, USA) programme for analysis of data. The continuous variables were presented as mean ± standard deviation if they are parametric values and presented as median (first quarter-Q1 and third quarter-Q3) if they are nonparametric values. The suitability of variables for normal distribution were evaluated by "Shapiro-Wilk test". The variables that were not normally distributed were evaluated by "Kruskal-Wallis test". Then the variables that were statistically significant were analysed by "Bonferroni corrected Mann-Whitney U test" for detect the group forming statistical difference. The logistic regression analysis were used for evaluation of factors affecting ICU admission and death according to the sex in univariate and multivariate analysis. Statistically significant difference accepted as p<0.05 for Kruskal-Wallis test and logistic regression analysis and p<0.016 for Bonferroni corrected Mann-Whitney U test.

The protocol for this retrospective study received permission from the Ondokuz Mayıs University Clinical Research Ethics Committee (decision no: 2021/393, date: 23.09.2021).

Results

The median age of the all patients was 67 (Q1: 58-Q3: 75) and 60.6% (n=143) of the patients were male. Fifty seven (39.9%) of male patients were treated in service and survived (group 1-m), 45 (31.5%) of them were treated in ICU and survived (group 2-m) and 41 (28.7%) were treated in ICU and died (group 3-m).

The study parameters of male patients were shown in Table 1. There was statistically significant difference in the median values of age, FMR and CTR between three groups (p=0.001, p=0.033 and p=0.001 respectively).

Of 93 woman 28 (30.1%) were treated in service and survived (group 1-f), 34 (36.6%) were treated in ICU and survived (group 2-f), 31 (33.3%) were treated in ICU and

Table 1. The study parameters of male patients [median (Q1-Q3)]

	Group 1-m (n=57)	Group 2-m (n=45)	Group 3-m (n=41)	p*
Age (year)	66 (57-74)	61 (49-71)	69 (60-76)	0.001 1-2:0.056 1-3:0.36 2-3:0.006
Abdominal cicumference	1026 (977-1072)	1030 (93-1108)	1040 (95-1110)	0.11
Muscle circumference	191 (169-199)	186 (170-192)	183 (161-192)	0.26
Fat to muscle ratio	5.5 (5.0-6.1)	5.6 (5.3-6.0)	5.8 (5.3-6.2)	0.033 1-2:0.013 1-3:0.041 2-3:0.82
Cardiotoracic ratio	0.46 (0.40-0.51)	0.51 (0.46-0.54)	0.52 (0.48-0.55)	0.001 1-2:0.008 1-3<0.001 2-3:0.21
The diameter of pulmonary artery	29 (26-31)	29 (27-33.5)	30 (26.5-32)	0.15
The diameter of aorta	38 (35-41)	36 (33-39)	38 (35.5-40.0)	0.77
Pulmonary artery to aorta ratio	0.75 (0.71-0.81)	0.81 (0.74-0.90)	0.78 (0.71-0.84)	0.17
Paraspinal muscle density	46.9 (35.5-53.0)	49.0 (32.7-57.7)	44.2 (33.7-56.6)	0.48
Standard deviation of paraspinal muscle density	25.4 (19.3-34.0)	27.0 (22.2-32.3)	29.9 (21.6-36.1)	0.06

*The statistical significance was accepted as p<0.05 for Kruskal-Wallis tests and p<0.016 for Bonferroni corrected Mann-Whitney U test

Table 2. The study parameters of female patients [median (Q1-Q3)]

	Group 1-f (n=28)	Group 2-f (n=34)	Group 3-f (n=31)	p*
Age (year)	63.5 (60-70)	65 (60-75)	81 (66-83)	0.021 1-2:0.53 1-3:<0.001 2-3:0.002
Abdominal cicumference	995.5 (938-1118)	1072 (977-1145)	985 (897-1121)	0.96
Muscle circumference	167 (147-179)	164 (147-176)	157 (136-178)	0.31
Fat to muscle ratio	5.9 (5.5-6.5)	6.4 (5.9-7.0)	6.4 (5.9-7.1)	0.30
Cardiotoracic ratio	0.48 (0.46-0.54)	0.54 (0.50-0.56)	0.56 (0.52-0.61)	<0.001 1-2:0.001 1-3:<0.001 2-3:0.102
The diameter of pulmonary artery	27.5 (25.2-30.7)	30.0 (27.7-32.2)	30.0 (27.0-33.0)	0.41
The diameter of aorta	37.0 (34.0-39.0)	36.0 (35.0-40.0)	37.0 (34.0-40.0)	0.019 1-2:0.012 1-3:0.72 2-3:0.019
Pulmonary artery to aorta ratio	0.77 (0.71-0.81)	0.82 (0.75-0.87)	0.79 (0.72-0.88)	0.020 1-2:0.008 1-3:0.55 2-3:0.044
Paraspinal muscle density	38.5 (8.9-45.4)	33.9 (15.4-48.7)	25.1 (4.3-39.1)	0.34
Standard deviation of paraspinal muscle density	36.7 (30.4-44.1)	32.2 (27.8-42.4)	32.1 (29.5-45.4)	0.52

*The statistical significance was accepted as p<0.05 for Kruskal-Wallis tests and p<0.016 for Bonferroni corrected Mann-Whitney U test

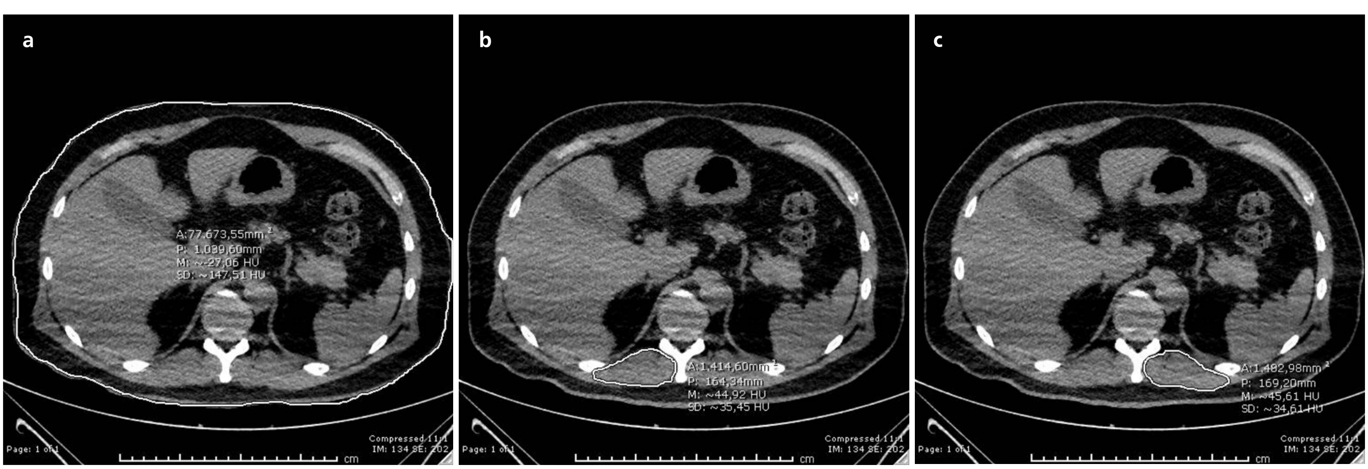

Figure 1. (a-c) The waist circumference were calculated manually by drawing the abdominal circumference and both paravertebral muscle circumferences at the level of T11-T12th vertebra

died (group 3-f). The study parameters of female patients were shown in Table 2. There was statistically significant difference in the median values of age, CTR, diameter of A and the P/A ratio between three groups (p=0.021, p<0.001, p=0.019 and p=0.020 respectively).

We classified the factors according to the sex separately to analyse their impaction on the death in both population. In male population, age and CTR had impaction on the death in univariate analysis. In multivariate analysis, it was seen that the effect of age was disappeared and only CTR [odds ratio (OR)= 11.45 (confidence interval (CI) 95%=2.65-122.2), p=0.002] was detected as risk factor for death. In contrast, it was found that age was only risk factor in woman in both univariate and multivariate analysis (Table 3).

We also classified the risk factors for admission to ICU according to sex separately. We noticed that age and CTR are risk factors for death in male patients in univariate analysis, but the CTR is only risk factor for admission to ICU in male patient in multivariate analysis [OR=17.50 (CI 95%=3.95-182.72), p<0.001] (Table 4). In woman the age was the only risk factor for admission to ICU in univariate analysis [OR=1.09 (CI 95%=1.043-1.146) , p<0,001] in contrast CTR was only risk factor in multivariate analysis [OR=11.7 (CI 95%=8.1-18.39), p=0.017 (Table 4).

Discussion

Normal values of CTR range between 0.42 and 0.50 and a value above 0.50 is accepted as abnormal and may show cardiomegaly. In our study, the CTR was the only parameter for admission to ICU found statistically significant in multivariate analysis for both men and woman. Additionally, it was an only significant risk factor in death for man with COVID-19 infection. In all group median value of CTR was in normal range in patients that not admitted to ICU as expected. In literature, in Eslami et al.'s (8) study he studied cardiac indices in 87 patients with a diagnosis of COVID-19 infection and discovered that in these patients, CTR is a highly effective predictor of mortality. Additionally, they

Table 3. The comparison of risc factors for death in COVID-19 patients in different sexes

	Male		Female
Univariate			
	OR (CI 95%)	**p***	**OR (CI 95%)**
Age (year)	1.03 (1.004-1.069)	0.028	1.09 (1.043-1.146)
Fat to muscle ratio	1.45 (0.83-2.54)	0.185	1.44 (0.88-2.36)
Cardiotoracic ratio	12.41 (3.40-48.64)	0.001	0.86 (0.34-2.18)
Pulmonary artery to aorta ratio	0.24 (0.11-5.23)	0.36	4.66 (0.06-34.61)
Multivariate			
Age (year)	1.02 (0.98-1.06)	0.19	1.09 (1.04-1.15)
Fat to muscle ratio	0.89(0.46-1.72)	0.73	1.44 (0.76-2.73)
Cardiotoracic ratio	11.45 (2.65-122.2)	0.002	0.66 (0.19-2.30)
Pulmonary artery to aorta ratio	0.16 (0.005-5.03)	0.30	4.68 (0.03-652.31)

OR: Odds ratio, CI: confidence interval, COVID-19: coronavirus disease-2019, *The statistical significance was accepted as p<0.05 for Kruskall-Wallis tests and p<0.016 for Bonferronni corrected Mann-Whitney U test

Table 4. The comparison of risk factors for admission to ICU in COVID-19 patients in different sexes

	Male		Female
Univariate			
	OR (CI 95%)	**p**	**OR (CI 95%)**
Age (year)	1.03 (1.004-1.069)	0.028	1.09 (1.043-1.146)
Fat to muscle ratio	1.45 (0.83-2.54)	0.185	1.44 (0.88-2.36)
Cardiotoracic ratio	12.41 (3.40-48.64)	0.001	0.86 (0.34-2.18)
Pulmonary artery to aorta ratio	0.24 (0.11-5.23)	0.36	4.66 (0.06-34.61)
Multivariate			
Age (year)	0.96 (0.92-0.99)	0.040	1.03 (0.98-1.08)
Fat to muscle ratio	1.35 (0.69-2.62)	0.36	1.88 (0.92-3.87)
Cardiotoracic ratio	17.50 (3.95-182.72)	<0.001	11.7 (8.1-18.39)
Pulmonary artery to aorta ratio	8.39 (0.25-265.43)	0.28	47.5 (0.18-1214)

OR: Odds ratio, CI: confidence interval, COVID-19: coronavirus disease-2019

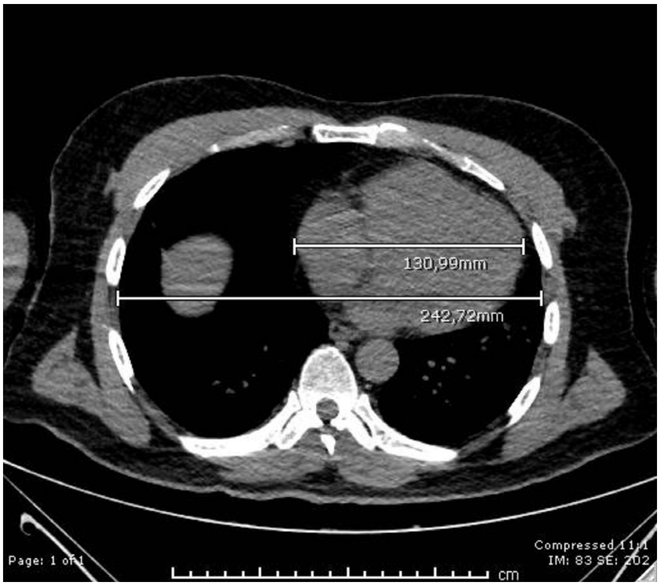

Figure 2. The cardiothoracic ratio was calculated by dividing the greatest transverse diameter of the heart to the greatest transverse diameter of the inner to inner thoracic cavity

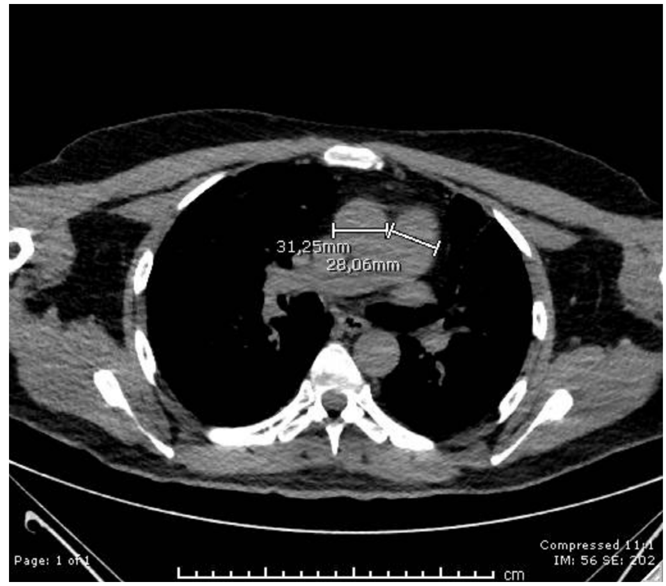

Figure 3. The diameter of ascending aorta and main pulmonary artery were calculated at the level of pulmonary bifurcation

observed a strong correlation between elevated CTR, which was found in 76% of patients who ultimately died and more than 50% of patients who were hospitalized, and poor illness outcomes (8). Our result supported the importance of CTR in prognosis of COVID-19 patients.

In routine radiology practice, chest X-ray is used for measurement of CTR. Miller showed that thorax CT is also can be used for the measurement of CTR and the results showed no statistically significant difference between CT and chest radiography in the evaluation of CTR (12). However, this study did not investigate the correlation between CTR and with other measures of cardiac function or structure at echocardiography (ECHO) or nuclear scintigraphy. The other study by Gollub et al. (13) supported this study by finding that these ratios are equivalent. They showed that there was moderate ability of CT CTR to identify left ventricular hypertrophy [area under the receiver operating characteristic curve (AUC)= 0.70; 95% CI, 0.51Y0.90]. The CT left ventricular short diameter showed a moderate correlation with the ECHO left ventricular internal diameter (r=0.49) and left ventricular mass (r=0.37). But their study was in cancer patients and their prevalence of cardiac disease was very low in the group. Mean age of the patients was 58 years and mean CTR measured at CT was 0.46±0.05. So larger studies were needed for older ages with a high prevalence of cardiac disease.

In our study, except for female patients that didn't need ICU, measurement of PA was ≥29 mm in all groups. A cut-off value of 29 mm for PA diameter is accepted as highly indicative of pulmonary hypertension, while a PA/A ratio >0.9 has been found to be progressively correlated with pulmonary vascular impairment. But in Truong et al.'s (14) study, they

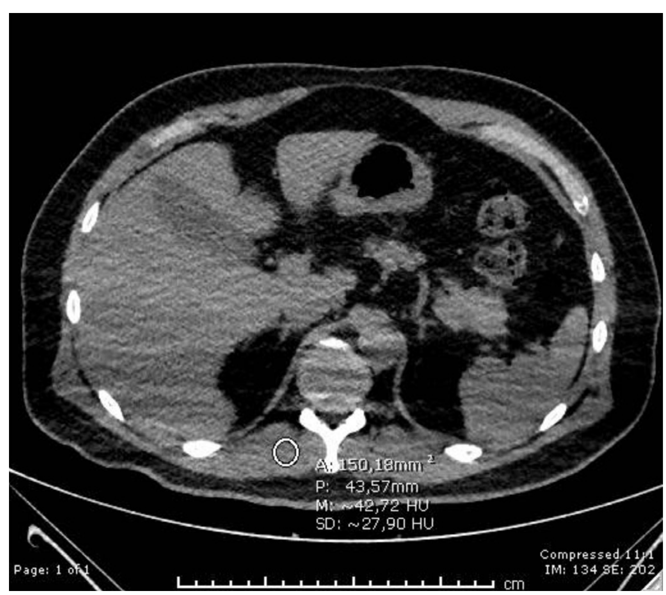

Figure 4. PA to A ratio was noted. The right paraspinal muscle density were noted at the level of T11-T12th vertebra. The 1.5 cm^2 sized ROI was drawn manually and the mean Hounsfield unit and standard deviation was collected

ROI: Region of interest

established sex-specific normative reference values for mPA of 29 mm in males and 27 mm in women, and 0.9 for ratio PA. Therefore, the median of PA was higher in all groups in our study. We don't know it was because of disease itself or was present before. As we consider the PA/A ratio, we found the statistically significant difference between the female patients treated in inpatient clinics or at home and the female patients lived in ICU. When compared to findings obtained from earlier chest CTs that were conducted for any reason other than cardiovascular illnesses, Spagnolo discovered that COVID-19 patients had greater median PA maximal diameter and median PA/A ratio values (median 36 months) (15). They hypothesized that the inflammatory state brought on by the severe acute respiratory syndrome coronavirus-2 infection may be connected to an increase in pulmonary vascular pressure. Patients with good and adverse outcomes differed significantly in terms of PA maximum diameter. In their study, median age was 75 years old and was older compared to our study. In Eslami et al.'s (8) study, they noted a nonsignificant increase in the odd of the death in patients with PA/A>1 that is a possible marker of pulmonary hypertension. These results combined with ours may show that diameter of PA is a finding deserving further investigation as a potential effect of COVID-19 inflammation on it.

It was known that age is an important known prognostic factor in COVID-19 infection. Our study supported this finding yet we found it as a significant risc factor in both admission to ICU and death in male and female patients with COVID-19 infection in univariate analysis. Moreover it was also a risc factor for death in woman with COVID-19 infection in multivariate analysis.

In addition to several cardiac indices, we assessed FMR to comprehend its role in COVID-19 infection prognosis. After studying FMR, Kottlors et al. (16) discovered that it might be used to predict whether a patient would require ICU treatment after being admitted. They suggested it is an important factor next to age and gender within a logistic regression analysis. Examining the logistic regression graphics, the possibility of a potential ICU treatment decrease below 50% at a FMR of 5.5 and is going down in the range of less than 10% at a FMR of under 5. However, the possibility of the requirement for an ICU treatment increases to about 80% at a FMR of 7 and higher. In our study, although FMR was lower in patients in group 1 in both genders which were not admitted to ICU, there were no difference between three groups in terms of FMR in female. Although it was statistically different in male patients between group 1 and 2 and between group 1 and 3, it was not noted as a risk factor in statistical analysis. The paravertebral skeletal muscle mass on both sides of the spine, which includes the skeletal muscle mass of the erector spinae muscle, longissimus thoracis muscle, spinalis thoracis muscle, and iliocostalis lumborum muscle, was found to be independently associated with ICU admission and in-hospital mortality by Schiaffino et al. (17). Ufuk discovered that in adult COVID-19 patients, pectoralis muscle area (PMA) and pectoralis muscle index [= PMA/patient's height square (m^2)] are strongly related with a number of unfavorable outcomes (18). Giraudo et al. (19) looked at whether low muscle mass-defined as HU values below 30-was a reliable indicator of ICU admission and/or unfavorable results. They emphasized that the severity and progression of the disease may be significantly impacted by the early symptoms of muscle loss (19). We found no significant difference in PMD in all groups. Although we noted the HU values <30 (mean: 25.1) in female patients that expired during treatment for COVID-19 pneumonia in ICU, it was not statistically significant. The age of woman was older in that group and the reason may be related to it. At the level of the T7-T8 vertebrae, Besutti investigated the density of the pectoralis muscles and the total, visceral (VAT), and intermuscular adipose tissue (20). They discovered that in COVID-19, VAT was specifically linked to an inflammatory response, whereas all other indices, including pectoral muscle density, were linked to parenchymal involvement. Low muscle quality appears to be one mechanism for the powerful effect of age on COVID-19 mortality.

Obesity is recognized as a risk factor for hospitalization as well as the need for mechanical ventilation in patients with COVID-19. (21). Additionally, it is regarded as a low-grade inflammatory state, with various inflammatory products secreted by adipose tissue (22). VAT, which secretes inflammatory cytokines, is metabolically more active than SAT, which is more passive. The metabolic syndrome, heart disease, and an elevated risk of infection and septic shock are all associated with VAT. Bioelectrical impedance analysis is a method used for assessing skeletal muscle mass. They are used for defining the patients with sarcopenia and cachexia. But in clinical practice, it is difficult to use this technique, especially in emergency conditions in patients with COVID-19. Therefore, it is logical to use a method routinely used for evaluating COVID-19 patients for investigating obesity. CT is used in some studies for measuring the visceral fat. Chandarana et al.'s (11) studied visceral and subcutaneous fat tissue in patients with COVID-19 patient. In contrast to outpatients, hospitalized COVID-19 patients had higher levels of VATL3, and Chandarana et al.'s (11) study with 51 patients found that adding VATL3 to the clinical model increased AUC in separating hospitalized from outpatients. Body mass index (BMI) differences between the two groups of patients were not statistically significant. Other risk factors for hospitalization and severe illness have also been found, including diabetes mellitus, hypertension, a history of cardiac disease, and an immunocompromised state. In our study there were no difference between CT measured abdominal crcumference between groups that include subcutanous and visceral fat. But we don't know the BMI of the patients.

Our study has some limitations. First there was a statistically significant difference between the age of the woman with COVID-19 infection died in ICU was compared to other groups. But we could not find the patients of the same age and sex for woman that not admitted to ICU for COVID-19 treatment in our hospital. The second limitation is the BMI of the patient, which is important in body composition and was not known. The third, as a part of national CT guidelines, non-contrast and non-gated chest CT was used in all patients, decreasing accuracy in measurements of vessels and ratios, especially in obese patients. Further studies with larger study groups with BMI values available and with additional cardiac studies such as ECHO were needed to evaluate CT parameters.

Conclusion

In summary, the evaluation of some CT parameters in our study showed the CTR may be taken into consideration as a potential risk factor in the evaluation of the patients with COVID-19 infection. High CTR values increase the risk of ICU admission and also death of the patient with COVID-19 infection. It supports the other studies in the literature. The diameter of PA is found higher in all groups so it might be an indicator of inflammation of lungs. But if the previous CT values were known, it would be more concise decision. FMR and PMD are not found as a risk factor in admission to ICU or death of the patient in our study, which differed from other studies. The reason is not known. The further studies with larger groups with known BMI indexes may be more accurate.

Ethics

Ethics Committee Approval: The protocol for this retrospective study received permission from the Ondokuz Mayıs University Clinical Research Ethics Committee (decision no: 2021/393, date: 23.09.2021).

Informed Consent: Retrospective study.

Peer-review: Internally and externally peer-reviewed.

Authorship Contributions

Concept: E.M.K.U., Design: E.M.K.U., Data Collection and Process: E.M.K.U., Ö.T., Analysis or Interpretation: Ö.T., Literature Search: E.M.K.U., Ö.T., Writing: E.M.K.U., Ö.T.

Conflict of Interest: No conflict of interest was declared by the authors.

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References

1. Karam M, Althuwaikh S, Alazemi M, Abul A, Hayre A, Alsaif A, et al. Chest CT versus RT-PCR for the detection of COVID-19: systematic review and meta-analysis of comparative studies. JRSM Open 2021;12:20542704211011837.
2. Richardson S, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW, et al. Presenting Characteristics, Comorbidities, and Outcomes Among 5700 Patients Hospitalized With COVID-19 in the New York City Area. JAMA 2020;323:2052-9.
3. Guan WJ, Liang WH, Zhao Y, Liang HR, Chen ZS, Li YM, et al. Comorbidity and its impact on 1590 patients with COVID-19 in China: a nationwide analysis. Eur Respir J 2020;55:2000547.
4. Zouk AN, Gulati S, Xing D, Wille KM, Rowe SM, Wells JM. Pulmonary artery enlargement is associated with pulmonary hypertension and decreased survival in severe cystic fibrosis: A cohort study. PLoS One 2020;15:e0229173.
5. Wells JM, Morrison JB, Bhatt SP, Nath H, Dransfield MT. Pulmonary Artery Enlargement Is Associated With Cardiac Injury During Severe Exacerbations of COPD. Chest 2016;149:1197-204.
6. Ogata H, Kumasawa J, Fukuma S, Mizobuchi M, Kinugasa E, Fukagawa M,et al. The cardiothoracic ratio and all-cause and cardiovascular disease mortality in patients undergoing maintenance hemodialysis: results of the MBD-5D study. Clin Exp Nephrol 2017;21:797-806.
7. Okute Y, Shoji T, Hayashi T, Kuwamura Y, Sonoda M, Mori K, et al. Cardiothoracic Ratio as a Predictor of Cardiovascular Events in a Cohort of Hemodialysis Patients. J Atheroscler Thromb 2017;24:412-21.
8. Eslami V, Abrishami A, Zarei E, Khalili N, Baharvand Z, Sanei-Taheri M. The Association of CT-measured Cardiac Indices with Lung Involvement and Clinical Outcome in Patients with COVID-19. Acad Radiol 2021;28:8-17.
9. Gualtieri P, Falcone C, Romano L, Macheda S, Correale P, Arciello P, et al. Body Composition Findings by Computed Tomography in SARS-CoV-2 Patients: Increased Risk of Muscle Wasting in Obesity. Int J Mol Sci 2020;21:4670.
10. Yang Y, Ding L, Zou X, Shen Y, Hu D, Hu X, et al. Visceral Adiposity and High Intramuscular Fat Deposition Independently Predict Critical Illness in Patients with SARS-CoV-2. Obesity (Silver Spring) 2020;28:2040-8.
11. Chandarana H, Dane B, Mikheev A, Taffel MT, Feng Y, Rusinek H. Visceral adipose tissue in patients with COVID-19: risk stratification for severity. Abdom Radiol (NY) 2021;46:818-25.
12. Miller J, Singer A, Hinrichs C, Contractor S, Doddakashi S. Cardiac Dimensions Derived From Helical Ct: Correlation With Plain Film Radiography. The international journal of radiology 1999;1:1-6.
13. Gollub MJ, Panu N, Delaney H, Sohn M, Zheng J, Moskowitz CS, et al. Shall we report cardiomegaly at routine computed tomography of the chest? J Comput Assist Tomogr 2012;36:67-71.
14. Truong QA, Massaro JM, Rogers IS, Mahabadi AA, Kriegel MF, Fox CS, et al. Reference values for normal pulmonary artery dimensions by noncontrast cardiac computed tomography: the Framingham Heart Study. Circ Cardiovasc Imaging 2012;5:147-54.
15. Spagnolo P, Cozzi A, Foà RA, Spinazzola A, Monfardini L, Bnà C, et al. CT-derived pulmonary vascular metrics and clinical outcome in COVID-19 patients. Quant Imaging Med Surg 2020;10:1325-33.
16. Kottlors J, Zopfs D, Fervers P, Bremm J, Abdullayev N, Maintz D, et al. Body composition on low dose chest CT is a significant predictor of poor clinical outcome in COVID-19 disease - A multicenter feasibility study. Eur J Radiol 2020;132:109274.
17. Schiaffino S, Albano D, Cozzi A, Messina C, Arioli R, Bnà C, et al. CT-derived Chest Muscle Metrics for Outcome Prediction in Patients with COVID-19. Radiology 2021;300:E328-36.
18. Ufuk F, Demirci M, Sagtas E, Akbudak IH, Ugurlu E, Sari T. The prognostic value of pneumonia severity score and pectoralis muscle Area on chest CT in adult COVID-19 patients. Eur J Radiol 2020;131:109271.
19. Giraudo C, Librizzi G, Fichera G, Motta R, Balestro E, Calabrese F, et al. Reduced muscle mass as predictor of intensive care unit hospitalization in COVID-19 patients. PLoS One 2021;16:e0253433.
20. Besutti G, Pellegrini M, Ottone M, Cantini M, Milic J, Bonelli E, et al. The impact of chest CT body composition parameters on clinical outcomes in COVID-19 patients. PLoS One 2021;16:e0251768.
21. Kalligeros M, Shehadeh F, Mylona EK, Benitez G, Beckwith CG, Chan PA, et al. Association of Obesity with Disease Severity Among Patients with Coronavirus Disease 2019. Obesity (Silver Spring) 2020;28:1200-4.
22. Ellulu MS, Patimah I, Khaza'ai H, Rahmat A, Abed Y. Obesity and inflammation: the linking mechanism and the complications. Arch Med Sci 2017;13:851-63.