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Original Article

Clinical severity and mortality predictors in COVID-19 intensive care patients: CTSS and CO-RADS

COVID-19 yoğun bakım hastalarında klinik şiddet ve mortalite predüktörleri: CTSS ve CO-RADS

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Abstract

Aim: Chest computed tomography (CT) plays an important role in the diagnosis of coronavirus infection disease 2019 (COVID-19) in patients with negative polymerase chain reaction (PCR) test but with clinical findings. The aim of this study was to determine whether the disease can predict clinical severity and/or mortality with CO-RADS and/or CTSS in intensive care COVID-19 patients.

Material and Methods: In the study retrospectively, COVID-19 intensive care patients with PCR positive and chest CT between 23 March - 31 December 2020 were included. CTs were evaluated by two independent radiologists without providing the clinical information of the patients. CO-RADS and CTSS were calculated for each CT, and pathological features were recorded. Demographic, clinical characteristics and mortality rates of the patients were recorded. Patients were divided into three groups [mild (nasal/mask oxygen), severe (noninvasive mechanichal ventilator (NIMV) or high flow nasal oxygen (HFO)), critically severe (invasive mechanichal ventilation (IMV))] according to the clinical severity of COVID-19. Mortality and clinical severity markers were determined by logistic regression analysis.

Results: Four hundred seventy three patients were included in the study. Patients were divided into three groups according to clinical severity, mild (34.7%), severe (11.8%), and critically severe (53.5%). The mean CTSS of all patients was 19.58 and the rate of patients in the CO-RADS 5 group was 50.7%. The mortality rate was 41.2%. APACHE II score and CTSS were predictors of clinical severity; age, female gender and CO-RADS were found as mortality predictors. The CO-RADS cut-off value predicting mortality was 5. Ground glass appearance was the most common pathological finding with a rate of 84.4%.Receiver operating characteristic (ROC) curves were drawn for mortality markers CO-RADS and APACHE II, and the area under the curve (AUC) values were 0.580 and 0.881, respectively. AUC was found to be 0.697 in the ROC curve drawn for CTSS, which is a clinical indicator of severity. The mortality cut-off value was found to be 16.5 with 77% sensitivity and 79% specificity for the APACHE II score (LR:3.7). The clinical severity cut-off value was found to be 18.5, with 61% sensitivity and 66% specificity for the CTSS.

Conclusion: CO-RADS can be used to predict mortality and CTSS can be used to predict clinical severity in COVID-19, which are radiological-based scoring systems.

Keywords: COVID-19; intensive care; CO-RADS; CTSS; mortality predictor; clinical severity predictor.

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Öz

Amaç: Coronavirus disease 2019 (COVID-19)'un tanısınında polimeraz zincir reaksiyon (PCR) testi negatif fakat klinik bulguları olan hastalarda toraks bilgisayarlı tomografi (BT) önemli rol oynar. Bu çalışmanın amacı; yoğun bakım COVID-19 hastalarında CO-RADS ve/veya BT şiddet skoru (CTSS) ile hastalığın klinik şiddetinin ve/veya mortalitesinin predikte edilip edilemeyeceğini belirlemektir.

Gereç ve Yöntemler: Çalışmaya retrospektif olarak, 23 Mart - 31 Aralık 2020 tarihleri arasındaki PCR pozitif toraks BT'si olan COVID-19 yoğun bakım hastaları dahil edildi. BT'ler bağımsız iki radyolog tarafından hastaların klinik bilgileri verilmeden değerlendirildi. Her bir BT için CO-RADS ve CTSS hesaplandı, patolojik özellikler kaydedildi. Hastaların demografik, klinik özellikleri ve mortalite oranları kaydedildi. COVID-19'un klinik şiddetine göre hastalar üçe ayrılarak (orta (nazal/maske oksijen), ağır (noninvasive mekanik ventilatör (NIMV)veya yüksek akımlı nazal oksijen (YNO)), çok ağır (invaziv mekanik ventilatör (IMV))) karşılaştırıldı. Mortalite ve klinik şiddet belirteçleri logistic regresyon analizi ile belirlendi.

Bulgular: Çalışmaya 473 hasta dahil edildi. Hastalar klinik şiddetine göre orta (%34,7), ağır (%11,8) ve çok ağır (%53,5) üç gruba ayrıldı. Tüm hastaların CTSS ortalaması 19,58 ve CO-RADS 5 grubundaki hasta oranı %50,7 idi. Mortalite oranı %41,2 idi. APACHE II score ve CTSS klinik şiddet belirleteçleri; yaş, kadın cinsiyet ve CO-RADS ise mortalite belirteçleri olarak bulundu. Mortaliteyi öngören CO-RADS cut-off değeri 5 idi. Buzlu cam görünümü %84,4 oranı ile en sık saptanan patolojik bulgu idi. Mortalite belirteci olan CO-RADS ve APACHE II için ROC eğrisi çizdirildi ve eğri altındaki alan (EAA) değerleri sırasıyla 0.580 ve 0.881 idi. Klinik şiddet belirteci olan CTSS için EAA 0.697 olarak saptandı. APACHE II skoru için %77 sensitivite ve %79spesifite ile mortalite cut-off değeri 16.5 olarak bulundu (LR:3.7). CTSS için %61 sensitivite ve %66 spesifite ile klinik şiddet cut-off değeri 18.5 olarak bulundu.

Sonuç: CO-RADS mortaliteyi, CTSS ise klinik şiddeti predikte etmede kullanılabilen radyolojik temelli skor sistemleridir.

Anahtar kelimeler: COVID-19; yoğun bakım; CO-RADS; CTSS; mortalite predüktörü; klinik şiddet predüktörü.

Introduction

Coronavirus disease-2019 (COVID-19), which is caused by Severe acute respiratory virus -2 (SARS-CoV-2), has been continuing all over the world since December 2019 [1]. COVID-19, which occurs most frequently with respiratory symptoms, can create different clinical situations from flu-like symptoms to respiratory failure.

The diagnosis of COVID-19 is confirmed by the real time-polymerase chain reaction (rt-PCR) method in the nasopharyngeal swab sample. However, even with clinical compatibility, the PCR test may be negative. Although the diagnosis of COVID-19 is confirmed by PCR testing, COVID-19 pneumonia is detected by radiological imaging. The cause of hypoxemia requiring hospitalization in the intensive care unit (ICU) in COVID-19 is lung involvement. Chest X-ray evaluated in two dimensions may be insufficient to show lung pathology. On the other hand, chest CT is another imaging method in which the lung is evaluated in three dimensions and gives more detailed information. Therefore, chest CT may be one of the best indicators of the clinical severity, morbidity and mortality of COVID-19. Chest CT is scored for COVID-19 with the COVID-19 Reporting and Data System (CO-RADS) scoring system reported by The Radiological Society of Netherlands (NVvR) (Table 1) [2]. In addition, CT severity score (CTSS), which is a semiquantitative scale, is another scoring method used to show disease severity.

The aim of this study is to determine whether radiological scoring such as CO-RADS and/or CTSS can predict clinical severity and mortality in intensive care COVID-19 patients.

Table 1: Overview of CO-RADS Categories and the corresponding level of suspicion pulmonary involvement in COVID-19

CO-RADS Category	Level of suspicion for pulmonary involvment of COVID-19	Summary
0	Not interpretable	Scan technically insufficient for assiggning a score
1	Very low	Normal or noninfectious
2	Low	Typical for other infection but not COVID-19
3	Equivocal/unsure	Features compatible with COVID-19 but also other disease
4	High	Suspicious for COVID-19
5	Very high	Typical for COVID-19
6	Proven	RT-PCR positive for SARS-CoV-2

CO-RADS; COVID-19 Reporting and Data System, RT-PCR; real time-polymerase cahin reaction

Material and Methods

The study was carried out in accordance with the Declaration of Helsinki Principles, after obtaining the ethics committee approval (Ethics committee no: E1-20-667). It was planned as a retrospective observational study in which patients with a diagnosis of COVID-19 hospitalized in the ICU between 23 March 2020 and 31 December 2020 were included. Patients aged ≥18 years, with positive PCR test and CT (chest CT performed two days before or 2 days after ICU admission), were included in the study. Patients aged <18 years and without CT or with CT outside the specified range were excluded from the study. CTs were evaluated by two independent radiologists without providing the clinical information of the patients. A CT was evaluated only by a radiologist. CO-RADS and CTSS were calculated for each CT.

CTSS was calculated by evaluating each of the 5 lobes and 20 segments in both lungs separately. Stratification was made as 0 (lung involvement 0%), 1 (lung involvement <50%), and 2 (lung involvement >50%). Scoring was calculated separately for each hemithorax and for the total CTSS. The CTSS range was 0-40. In addition, the characteristics of the lesions on CT were also recorded (ground glass, consolidation, air bronchogram, pleural effusion, linear opacity, crazy paving, pleural thickening, cavitation-reverse halo, pericardial effusion, bronchial enlargement, vascular enlargement, atelectasis, lymphadenopathy (LAP), acinar nodule, cardiomegaly). Demographic characteristics of patients (age, gender), APACHE II (Acute Physiological and, Chronic Health Evaluation) score, nasal/mask oxygen, noninvasive mechanical ventilation (NIMV), high flow nasal cannula oxygen (HFO), need for invasive mechanical ventilation (IMV), IMV duration length of stay in ICU and mortality rate were recorded. Intensive care patients were stratificated three groups according to the clinical severity of COVID-19; mild (nasal/mask oxygen), severe (NIMV or HFO), critically severe (IMV). Demographic, clinical and radiological characteristics of the groups were compared. Mortality and clinical severity predictors were determined by logistic regression analysis. Further, cut-off values that determine mortality and clinical severity were determined. Receiver operating chareacteristic (ROC) curve was drawn for to predict predictore of clinical severity and mortality and area under the curve (AUC) was calculated

Radiological technique

Chest CTs were obtained with 2 devices with multidetector-128 slices specially reserved for patients with suspected SARS-CoV-2 (GE Revolution EVO 128 Slice CT Scanner, GE Medical Systems, Milwaukee, WI, USA). During inspiration, shots were taken in the supine position without the use of intravenous contrast material. As CT acquisition parameters, section thickness was chosen as 1.3 mm, pitch factor 0.98, tube voltage average 100 kV, mA 90-300, collimation width 0.625.

Statistical Analysis

Statistical analyzes of the data obtained in the study were performed using the "SPSS for windows 26.0" Statistical Package Program. Continuous variables were expressed as mean±SD. The conformity of the numerical data to the normal distribution was evaluated with the Shapiro-Wilk test, and then the One-Way ANOVA test or t test was used to compare the numerical data with the normal distribution, and the result was evaluated according to the equality of variances. The Kruskal-Wallis or Mann-Whitney U test was used to compare the numerical data that did not fit the normal distribution. Categorical data were given as numbers and percentages. Pearson Chi-square test was used to compare categorical data. Logistic regression analysis was performed to detect mortality predictors. AUC values were calculated by plotting ROC curves for APACHE II and CORADS scores, which are predictors of mortality. In addition, the cut-off values of the scores were found. $P<0.05$ was considered significant.

Results

A total of 473 patients with PCR positive and chest CT (±2 days from ICU admission) were included in the study. The mean age of the patients was 70.61 years, 59% were male, and the mean APACHE II score was 17.92. 53.48% of the patients required IMV and the mean duration of IMV was 8.5 days. The mean length of stay in the ICU of all patients was 10.61 days, the mean CTSS 19.58 and the rate of patients in the CO-RADS Category-5 was 50.7%. The mortality rate of all patients was 41.2%. Patients were divided into three groups according to clinical severity, mild (34.7%), severe (11.8%), and critically severe (53.5%). There was a significant difference between the mean ages of the groups, and the mean age (73.21) was the highest in the critically severe group ($p<0.001$). The genders were similar in all three groups. The APACHE II score was

highest in the critically severe group (23.92) and there were differences between the groups (p<0.001). The length of stay in the ICU was the shortest in the mild group (8.43 days), and there was a difference between the groups (p=0.002). There was a difference between the three groups in terms of CTSS mean and CO-RADS stratification (p<0.001) (Table 2). The CO-RADS cut-off value predicting mortality was 5. When the patients were grouped according to the determined cut-off value (CO-RADS <5 and CO-RADS=5), CTSS and mortality rates were higher in the group with CO-RADS=5 (p<0.001 and p=0.015, respectively) (Table 3). In Chest CT, ground glass was the most common pathological finding with a rate of 84.4% in all patients. There was a statistical difference between the groups in terms of ground glass, air bronchogram, pleural effusion, crazy paving, pleural thickening, bronchial enlargement, and lymphadenopathy (LAP), and these findings were most common in the critically severe group (Table 4). While APACHE II score and CTSS are clinical severity predictors; age, female gender and CO-RADS-category 5 were found as mortality predictors (Tables 5 and 6). ROC curves were drawn for mortality predictors CO-RADS and APACHE II, and the area under the curve (AUC) value was 0.580 and 0.881,respectively (Figures 1 and 2). AUC was found to be 0.697 in the ROC curve drawn for CTSS, which is a clinical severity predictor (Figure 3). The mortality cut-off value was found to be 16.5 with 77% sensitivity and 79% specificity for the APACHE II score (LR:3.7). The clinical severity cut-off value was found to be 18.5 with 61% sensitivity and 66% specificity for CTSS (LR:1.8).

Table 2: Comparison of clinical and demographic characteristics by groups

Variables	Total n=473	Mild n=164	Severe n=56	Critically severe n=253	p
Age (mean±SD)	70.61±13.8	68.78±14.6	64.21±13.5	73.21±12.8	<0.001
Female n(%)	194 (41)	66 (40.2)	25 (44.6)	103 (40.7)	0.838
Male n(%)	279 (59)	98 (59.8)	31(55.4)	150 (59.3)	
APACHE II score (mean±SD)	17.92±10.5	11.12±5.4	10.7±5.2	23.92±10.3	<0.001
IMV n (%)	253 (53.48)	-	-	253 (53.48)	-
Duration of IMV (day) (mean±SD)	8.5±12.7	-	-	8.5±12.7	-
Lenght of stay ICU(day)(mean±SD)	10.61±10.5	8.43±6.8	11.55±6.5	11.82±12.7	0.002
CTSS (mean±SD)	19.58±11	14.63±9.7	22.75±10.6	22.09±10.9	<0.001
CO-RADS					
1 n(%)	33 (7)	23 (14)	2 (3.6)	8 (3.2)	<0.00
2 n(%)	88 (18.6)	39 (23.8)	5 (8.9)	44 (17.4)	
3 n(%)	69 (14.6)	26 (15.9)	1 (1.8)	42 (16.6)	
4 n(%)	43 (9.1)	10 (6.1)	7 (12.5)	26 (10.3)	
5 n(%)	240 (50.7)	66 (40.2)	41 (73.2)	133 (52.6)	
Mortalite n(%)	195 (41.2)	-	-	195 (77.1)	-

APACHE II; Acute Physiological and, Chronic Health Evaluation, IMV; invasive mechanichal ventilation, ICU; intensive care unit, CTSS; CT severity score, CO-RADS; COVID-19 Reporting and Data System,

Table 3: Classification according to the CO-RADS cut-off value

Variables	CO-RADS <5 n=233	CO-RADS 5 n=240	p
Age (mean±SD)	74.6±13.4	71.95±12.1	<0.001
Female n(%)	100 (42.9)	94 (39.2)	0.407
Male n(%)	133 (57.1)	146 (60.8)	
APACHE II score (mean±SD)	24.37±10.2	23.51±10.3	0.200
IMV n (%)	120 (51.5)	133 (55.4)	0.393
Duration of IMV (day) (mean±SD)	8.42±13.8	8.58±11.6	0.068
Lenght of stay ICU(day)(mean±SD)	11.84±14.2	11.8±11.2	0.256
CTSS (mean±SD)	15.78±9.8	27.8±8.3	<0.001
Mortalite n(%)	83 (35.6)	112 (46.7)	0.015

CO-RADS; COVID-19 Reporting and Data System, APACHE II; Acute Physiological and, Chronic Health Evaluation, IMV; invasive mechanichal ventilation, ICU; intensive care unit, CTSS; CT severity score

Table 4: Chest CT findings

Variables	Total n=473	Mild n=164	Severe n=56	Critically severe n=253	p
Ground Glass	399	128	51	220	0.017
Consolidation	295	90	38	167	0.128
Air bronchogram	235	75	19	141	0.006
Pleural effusion	164	54	9	92	0.014
Linear opacity	212	72	27	113	0.852
Crazy paving	240	69	29	142	0.019
Pleural thickning	280	89	27	164	0.021
Cavitation-Reverse halo	28	3	3	22	0.15
Pericardial effusion	100	27	13	60	0.192
Bronchial enlargement	151	37	17	97	0.003
Vascular enlargement	173	53	23	97	0.348
Atelectasis	377	123	45	209	0.167
LAP	153	38	19	96	0.007
Acinar Nodule	91	34	4	53	0.05
Cardiomegaly	296	102	40	154	0.333
Mosaic pattern	57	27	4	26	0.081

LAP; lymphadenopathy

Tablo 5: Clinical severity predictors

Variables	B (coefficient)	SE	Confidence interval	Odds ratio	p
Constant	-3.198	0.719		0.041	0.000
Age	0.005	0.018	0.987-1.023	1.155	0.589
APACHE II	0.144	0.012	1.115-1.197	1.072	0.000
CTSS	0.070	0.719	1.047-1.098	0.041	0.000

APACHE II; Acute Physiological and, Chronic Health Evaluation, CTSS; CT severity score

Tablo 6: Mortality predictors

Variables	B (coefficient)	SE	Confidence interval	Odds ratio	p
Constant	-4.708	0.906		0.009	0.219
Age	0.013	0.011	0.992-1.034	1.013	0.000
APACHE II	0.195	0.018	1.172-1.259	1.215	0.100
CTSS	0.024	0.015	0.995-1.055	1.025	0.320
Duration of ICU	-0.012	0.012	0.964-1.012	0.988	0.668
Gender	-0.115	0.267	0.528-1.505	0.892	0.011
CORADS Category-5	-0.808	0.317	0.240-0.829	0.446	0.000

APACHE II; Acute Physiological and, Chronic Health Evaluation, CTSS; CT severity score, ICU; intensive care unit, CO-RADS; COVID-19 Reporting and Data System

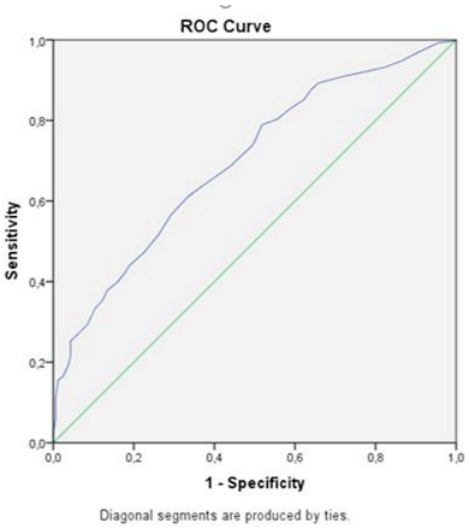

Figure 1. ROC curve for CTSS as a clinical severity predictor

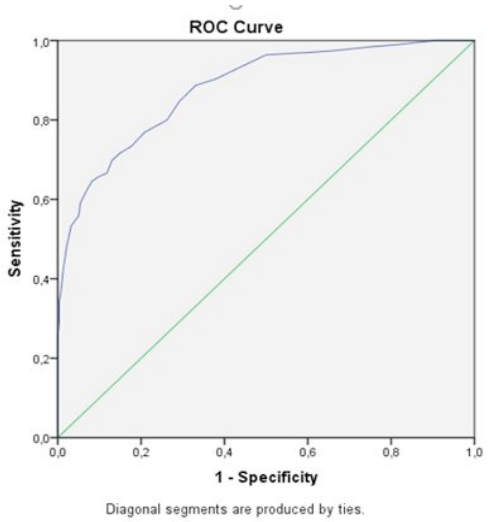

Figure 2. ROC curve for APACHE II score as a mortality predictor

Discussion

In this study, an answer was sought to the question, "Can chest CT be a diagnostic tool that can predict clinical severity and mortality in COVID-19 intensive care patients?". The diagnosis of COVID-19 is confirmed by detecting the SARS-CoV-2 agent in the PCR test. However, there is no objective laboratory or imaging method that gives precise information about how the disease will progress. Although the PCR test is negative, chest CT is helpful in confirming the diagnosis in symptomatic patients [3,4]. The World Health Organization (WHO) do not recommend routine chest imaging in asymptomatic COVID-19 patients. For patients with suspected or confirmed COVID-19, not currently hospitalized and with moderate to severe symptoms, WHO suggests using chest imaging in addition to clinical and laboratory assessment to decide on regular ward admission versus ICU admission [5]. In line with this information, chest CTs of COVID-19 patients with positive PCR test who required ICU admission were evaluated in this study. CTs taken within 2 days before and after admission to the ICU were scored by two radiologists to standardize the CT performed time. In the literature, studies have been reported on how effective CTs performed in the emergency room are in predicting hospitalization in the service or ICU or in predicting the need for intubation [8].The difference of this study; all patients were admitted to the ICU and the validity of CT scores was demonstrated in predicting the course of the clinic in the ICU and mortality.

In CO-RADS stratification, 7 different stratifications are made between 0-6. According to the CO-RADS stratification, RT-PCR is classified as positive for SARS-CoV-2 Category-6. In fact, all patients in this study had a positive PCR test and thus could be included in Category-6. However, since the PCR test results of the patients were not reported to the radiologists who evaluated the CTs, they were excluded from Category-6 stratification. Accordingly, 50.7% of the patients were in the CO-RADS Category-5 group, that is, they had typical COVID-19 findings. 9.1% were in the Category-4, that is, Suspicious for COVID-19 group. 14.6% were Category-3; features compatible with COVID-19 but also other disease, and 18.6% were in the Category-2; typical for other infection but not COVID-19 group. Therefore, 93% of all patients had lung involvement. Hence, patients were often admitted to the ICU due to hypoxemia and/or respiratory failure. Although 33 patients in Category-1 without lung involvement do not have primary respiratory failure or need for oxygen; were admitted to the ICU for reasons related to other system involvements of COVID-19 such as myocarditis, myocardial infarction, cerebrovascular event.

CO-RADS Category-5 was higher in severe and critically severe group than mild group. This is a finding that supports the clinical findings of patients with radiologically typical CT for COVID-19 may be more severe. Although CO-RADS Category-5 was the highest in the severe group, no mortality was observed in this group. The reasons for this are; it can be explained by the younger mean age of the patients in this group, the lower mean APACHE II score, which is a predictor of mortality, and no IMV requirement. In patients whose symptom onset times could not be determined, the time between symptom onset and CT performed may also be shorter in the mild group. That's because the sum of CO-RADS Category 1, 2, and 3 (53.7%) was highest in the mild group. Previous studies have also reported that chest imaging might be negative in the earlier phase of COVID-19 due to it has not involved the lung paranchyma yet [7].

In this study, we found the mortality cut-off value for CO-RADS to be CO-RADS=5. The study of Zayed et al. reported that if CO-RADS <4.5, severe COVID-19 can be ruled out at a rate of 97%, and that CO-RADS is significantly higher in the severe/critically ill group (4.86) than in the mild/moderate group (2.33) [8]. So CO-RADS>4.5 clinically severely supports COVID-19. In our study, unlike the Zayed et al study, the mortality cut-off value was determined for CO-RADS in intensive care COVID-19 patients. The fact that the mean CTSS and mortality were significantly higher in the group with CO-RADS=5 indicates that the lung involvement rate of COVID-19 is also higher in this group. The mean of CTSS, another scoring system, was the lowest in the mild group. In the severe and critically severe groups, the CTTS mean was similar. Although all patients were positive for PCR, with CTSS, which is a semi-quantitative method that shows lung involvement rates, the mean CTSS scores were higher in these two groups, where the disease was more severe, hypoxemia and oxygen support systems were needed more, such as HFO, NIMV or IMV. In addition, CTSS, which is a clinical severity predictor in our study, was reported to have the strongest positive correlation with the clinical status of patients in the study of Mruk et al. [9].

In the study of Lieveld et al in which they used CO-RADS and CTSS, the mean CTSS of patients admitted to the ICU was determined as 14.8[8].In this study, the mean CTSS of all patients (19.58) and clinical severity cut-off value (18.5) were found higher than the study of Lieveld et al [6]. The reasons for this are; it may be that all the patients in our study were PCR positive and had a higher sample size (88 vs 473 ICU

patients). At the beginning of the pandemic, Yang et al. study reported similar results to our study. In the reported study, the optimal CTSS threshold for identifying severe COVID-19 was 19.5 [10]. In the study of Bellos et al, the CTSS of patients with ICU admission was 12.6 [11].The small number of patients in this previous study may be the reason for having a lower CTSS mean than our study. Abbasi et al compared survived and deceased COVID-19 patients and reported a CTSS of 14.5 in the deceased group [12]. Further, this value was lower than the mean CTSS of all patients in our study. The differences between the two studies; Abbasi et al. may have carried out their studies with a small number of patients at the beginning of the pandemic (February-March 2020) and the population in their study included patients admitted not only to the ICU but also to the hospital [12]. In the study, which included only COVId-19 patients in the intensive care unit, CTSS was reported as >15 as a mortality predictor [13].

It has been reported in the literature that peripheral ground glass and consolidation are the most common CT findings of COVID-19 [14]. In this study, the most common lesions were ground glass and consolidation areas, and the results were similar.

The difference of this study from the others is that only the PCR positive COVID-19 patients followed in the ICU were included and their radiological findings were compared. Cause studies comparing the radiological features of PCR positive and negative patients for CO-RADS have been reported in the literature [15]. For CTSS, it has been reported that there is a significant relationship between emergency to hospital admission, ICU admission and 30-day mortality [6]. In this study, both CO-RADS and CTSS were scored, and which parameter predicted mortality and clinical severity of the disease was evaluated separately.

In the study of Zayed et al, it was reported that both CO-RADS and CTSS can predict severe COVID-19 [8]. In our study, CO-RADS, which predicts the mortality of COVID-19 patients in intensive care, and CTSS, which predicts clinical severity, were found to be two different radiological-based scoring systems.

As a mortality predictor, the AUC in the ROC curve plotted for APACHE II was greater than the AUC calculated for CO-RADS. While the APACHE II score, which has been used as a mortality predictor for a long time, is calculated with clinical and laboratory parameters, CO-RADS includes only radiological findings. Therefore, the AUC determined for CO-RADS may not be as high as the AUC of APACHE II. It was found as the clinical severity predictor of CTSS, which calculates how much of each segment of the lung is affected together with the radiological findings.

Although COVID-19 causes disease in all age groups and in both genders, previous studies in the literature have reported that male gender and elderly individuals are more affected by the disease or have the disease more severely [16,17]. In this study, similar to the literature data; the ratio of male patients was predominant, and the mean age of the critically severe group was the highest.

Limitations of the study; a single-center, retrospective study, with one CT evaluated only by a radiologist. Therefore, the compatibility between radiologists could not be evaluated. In addition, the time between the onset of symptoms and the time the CT was performed could not be determined.

Conclusion

Thoracic CT has an important role in predicting clinical severity and mortality, as well as confirming the diagnosis in COVID-19 intensive care patients. From two different radiological scorings; CO-RADS can be used to predict mortality and CTSS to predict clinical severity.

Declaration of conflict of interest

The authors received no financial support for the research and/or authorship of this article. There is no conflict of interest

References:

1. WHO. WHO Timeline – COVID-19 [online]. 2021. https://www.who.int/news-room/detail/08-04-2020-who-timeline--covid-19;accessed 11 March 2020
2. Prokop M, van Everdingen W, van Rees Vellinga T et al. CO-RADS: a categorical ct assessment scheme for patients suspected of having COVID19-definition and evaluation. Radiology 2020; 296: 97-104.
3. Herpe G, Lederlin M, Naudin M et al. Efficacy of Chest CT for COVID-19 Pneumonia Diagnosis in France. Radiology 2021; 298: 81-7.
4. Machnicki S, Patel D, Singh A et al. The Usefulness of Chest CT Imaging in Patients With Suspected or Diagnosed COVID-19. Chest 2021; 160: 652-70.
5. Use of chest imaging in COVID-19. https://www.who.int/publications/i/item/use-of-chest-imaging-in-covid-19. WHO/2019-nCoV/Clinical/Radiology_imaging/2020.1
6. Lieveld A.W.E, Azijli K, Teunissen B.P et al. Chest CT in COVID-19 at the ED: Validation of the COVID-19 Reporting and Data System (CO-RADS) and CT Severity Score: A Prospective, Multicenter, Observational Study. Chest 2021; 159: 1126-35.
7. Ai T, Yang Z, Hou H et al. Correlation of Chest CT and RT-PCR Testing in Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases. Radiology 2020; 26: 200642.

8. Zayed N.E, Bessar M.A, Lutfy S. CO-RADS versus CT-SS scores in predicting severe COVID-19 patients: retrospective comparative study. The Egyptian Journal of Bronchology 2021; 15: 13.
9. Mruk B, Plucińska D, Walecki J, Półtorak-Szymczak G, Sklinda K. Chest Computed Tomography (CT) Severity Scales in COVID-19 Disease: A Validation Study. Med Sci Monit 2021; 27: 931283.
10. Yang R, Li X, Liu H et al. Chest CT Severity Score: An Imaging Tool for Assessing Severe COVID-19. Radiol Cardiothorac Imaging 2020; 2: 200047.
11. Bellos I, Tavernaraki K, Stefanidis K et al. Chest CT severity score and radiological patterns as predictors of disease severity, ICU admission, and viral positivity in COVID-19 patients. Respir Investig 2021; 59: 436-45.
12. Abbasi B, Akhavan R, Khameneh A et al. Evaluation of the relationship between inpatient COVID-19 mortality and chest CT severity score. Am J Emerg Med 2021; 45: 458-63.
13. Kurri N, Tyagi B, Singhal E et al. Assessing the Impact of Inflammatory Markers and CT Severity Score on Disease Severity of COVID-19 Patients Admitted to ICU at a Tertiary Hospital. Journal of The Association of Physicians of India 2021; 69: 41-9.
14. Xie L, Hou K, Xu H et al. Chest CT features and progression of patients with coronavirus disease 2019. Br J Radiol 2020; 93: 20200219.
15. Atta H, Hasan H.A, Elmorshedy R, Gabr A, Abbas W.A, El-Barody M.M. Validation of imaging reporting and data system of coronavirus disease 2019 lexicons CO-RADS and COVID-RADS with radiologists' preference: a multicentric study. Egyptian Journal of Radiology and Nuclear Medicine 2021; 52: 109.
16. Nguyen N.T, Chinn J, Ferrante M.D, Kirby K.A, Hohmann S.F, Amin A. Male gender is a predictor of higher mortality in hospitalized adults with COVID-19. PLoS One 2021; 16: 254066.
17. Risk for COVID-19 Infection, Hospitalization, and Death By Age Group. CDC COVID-19.https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-age.html