Can chest computed tomography be useful to emergency residents in the diagnosis of COVID-19 pneumonia?

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Abstract

Aim: During the novel coronavirus disease (COVID-19) pandemic, the workload of emergency department residents (ER) has increased since emergency departments (EDs) are among the first health units to which patients apply. The aim of this study was to investigate the diagnostic value of chest computed tomography (CT) interpretations of emergency department residents in the diagnosis of COVID-19 pneumonia.

Material and methods: Patients who admitted to the tertiary ED between 30.03.2020 and 30.12.2020 with suspected COVID-19 pneumonia and underwent chest CT imaging were retrospectively analyzed. Chest CT images previously reported by the radiologist were reinterpreted by the ER and the diagnostic performance of the ER for COVID-19 pneumonia was calculated.

Results: The study included 2045 patients with suspected COVID-19 pneumonia. Chest CT images of all patients were interpreted and compared by a radiologist and the ER In this study, interpretation by a radiologist was considered as the gold standard. In all patients, the diagnostic performance capacity of ER for COVID-19 pneumonia included a low sensitivity of 66%, a high specificity of 92%, a positive predictive value (PPV) of 83% and a negative predictive value (NPV) of 82%. When patients with positive COVID-19 RT-PCR test results were analyzed, the highest sensitivity, specificity, PPV and NPV of ER were 96%, 82%, 95%, 95% and 86%, respectively.

Conclusion: ER detected COVID-19 pneumonia in COVID-19 (+) patients with high diagnostic value and excluded inconsistent findings. Chest CT interpretation in the ER has a high diagnostic value. It is as important as any other radiologist in outbreak management in the ED.

Keywords: chest computed tomography, emergency department, emergency resident interpret

Introduction

The novel coronavirus disease (COVID-19), which causes acute respiratory syndrome coronavirus-2 (SARS-CoV-2), caused an epidemic that started in Wuhan, China, and affected the whole world [1]. While the effects of the pandemic were not completely finished, emergency departments (ED) of hospitals were often the first unit where patients encountered the healthcare system during this process.

COVID-19 is an infectious disease with a high incidence and infectivity with a poor prognosis, causing 81% mild, 14% severe, and 5% critical illness, resulting in sepsis and multi-organ failure [2]. Although the epidemiology and clinical features of the disease have been widely described, there are no specific reports on the clinical course and virus spread of COVID-19 patients with mild to moderate symptoms. Therefore, early diagnosis of the disease is important to reduce the risk of community spread and ensure prompt treatment [3-7].

In the initial months of the pandemic and during the pandemic control process, the broad spectrum of new clinical symptoms, the detection of variant viruses and the need for inexpensive, rapid, highly sensitive and specific diagnostic tests have been prioritized. During this period, COVID-19 pneumonia had to be detected

quickly and the decision to hospitalize or discharge patients had to be made as quickly as possible, due to the increased volume of patients in ED. Chest Computed Tomography (CT) is typically used to detect COVID-19 pneumonia with peripherally located ground-glass pulmonary infiltrates. Rapid and accurate interpretation of chest CT is critical in helping to identify patients who will be discharged or followed up and treated as inpatients. A study about the role of chest CT in the diagnosis and management of COVID-19 showed that chest CT has a low rate (3.9%) of missed diagnoses and is a useful method for rapid diagnosis and outbreak management [8]. In light of all this information, this study aimed to investigate the diagnostic value of chest CT interpreted by the emergency department residents (ER) in the diagnosis of COVID-19 Pneumonia.

Materials and methods
Study design

This study was designed as a retrospective observational study. Approval for the study was obtained by the local ethics committee of our institution with decision number KAEK-149. The records of all patients who admitted to the third-level ED between March 30, 2020 and December 30, 2020 and underwent chest CT imaging were reviewed. All patients aged ≥18 years who underwent COVID-19 reverse transcriptase-polymerase chain reaction (RT-PCR) test and chest CT imaging with suspected COVID-19 pneumonia were included in the study. All patients with missing RT-PCR data and those who underwent chest CT imaging for other reasons were excluded (Figure 1).
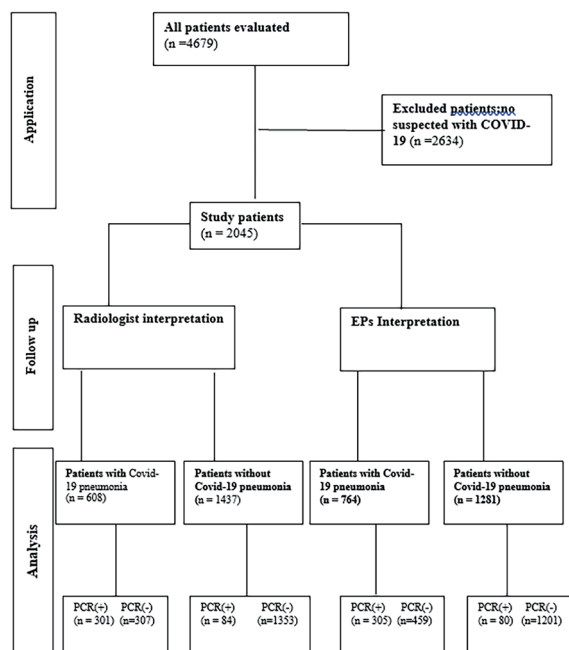

Figure 1 - Study flow chart.

All CT images were interpreted by an expert radiologist at our institution and recorded as a report in the hospital's patient record management system. Chest CT images previously reported by the radiologist specialist were considered the gold standard and compared with ER interpretation of COVID-19 pneumonia. All chest CT images, were re-interpreted by 21 postgraduate-year (PGY) 2-4 and 19 PGY 0-2, for a total of 40 ERs whose were randomized, blinded to radiology reports. Emergency medicine education is given on a regular, full-day basis every Tuesday by academic staff. The post-graduate training programs prepared annually and consisted theoretical and bedside practical training

on radiological imaging. This education was given to each ER who was included in the study at least one season a year. For radiologic evaluation, the findings in the CORADS (COVID-19 Reporting and Data System) classification, which evaluates the suspicion of pulmonary involvement of Covid-19 developed by the Dutch Society of Radiology, were used [9]. According to this, chest CT images were classified as follows: CORADS 0-1 "non-pathologic radiologic findings", CORADS 2-3 "pathologic findings incompatible with Covid-19 pneumonia" and CORADS 4-5 "pathologic findings compatible with Covid-19 pneumonia" and recorded in the study protocol form.

Data collection and measurement of variables

Vital signs, complaints and other socio-demographic data of the patients were retrospectively analyzed and recorded via the electronic patient file system at the time of admission to the ED. The results of RT-PCR tests performed on nasopharyngeal swab samples were reviewed according to the Republic of Turkey Ministry of Health SARS-CoV-2 infection COVID-19 pneumonia diagnosis and treatment guidelines. Patients with positive RT-PCR test results were diagnosed with COVID-19. Whole chest CT imaging with Toshiba ACTIVION 16 (TSX-031A, Japan) and multislice chest CT scan were performed in the emergency department.

Statistical analysis

All variables were evaluated using descriptive statistics. Statistical analyzes were performed with SPSS 25 (Statistical Package for Social Sciences) and MedCalc statistical software. Normality analysis was performed with the Kolmogorov-Smirnov test. Numbers and percentages are reported for all categorical variables, and mean, standard deviation and median values are reported for continuous variables. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive odds ratio (PLR), negative odds ratio (NLR) and Kappa (K) coefficients of ER were calculated for the diagnosis of COVID-19 pneumonia based on radiology chest CT reports. Agreement was graded according to the coefficient. (K) greater than 0.75 was considered excellent agreement. A range of 0.75 to 0.40 was considered moderate agreement, and below 0.40 was considered poor agreement [10]. Chi-Square test was used to compare categorical data. $p < 0.05$ was considered statistically significant.

Results

A total of 4679 patients who admitted to the emergency department and underwent chest CT were evaluated during the study. After excluding 2634 patients according to the exclusion criteria, 2045 patients with suspected COVID-19 were included in the study (Figure 1). 1206 (59%) patients were male. The mean age of all patients was 59.84±17.45 years. Dyspnea was the main complaint in 932 (45.5%) patients admitted to the ED. Other demographic data of the patients are shown in Table 1.

Chest CT radiologic images of patients diagnosed with COVID-19 were interpreted by ERs and radiologists and the results were compared. In CTs evaluated by ERs, COVID-19 pneumonia findings were detected in 764 (37.4%) patients, non-COVID-19 findings in 933 (45.6%) patients and non-pathologic results in 348 patients. In chest CT images interpreted by radiologists, 608 (29.7%) patients had COVID-19 pneumonia findings, 1147 (56.1%) had non-COVID-19 findings, and 290 (14.2%) had non-pathologic results. When the interpretations of

Patient Characteristic	
Age (years) (mean±SD)	59.84±17.45
Male gender n(%)	1206 (59)
Main compliant n(%)	
Dyspnea	932 (45.5)
Fever	624 (30.5)
Cough	495 (24.2)
Sore troat	112 (5.4)
Chest pain	106 (5.1)
Diarrhea	102 (4.9)
Fatigue	93 (4.5)
Genaralizated pain	55 (2.6)
Vomiting	35 (1.7)
Loss of taste or anosmia	27 (1.3)
Vital signs at ED admission, median (min-max)	
Heart rate (beat/min)	100 (55-228)
Respiratory rate	22 (4-60)
SBP (mm/Hg)	130 (60-238)
DBP (mm/Hg)	76 (30-165)
Temperature (°C)	36.8 (34.1-41.9)
SpO2	95 (32-100)
SpO2: Oxygene saturation; **DBP,** diastolic blood pressure; **ED,** emergency department; **SBP,** systolic blood pressure.	

| Table 2 | Assessment of all patients with Chest CT by ERs and radiologist for the diagnosis of COVID-19 pneumonia |

	ERs interpretations	Radiologist interpretations	Kappa Value	p
Covid-19 pneumonia	764 (37.4)	608 (29.7)	0.610	<.001
Non Covid-19 findings	933 (45.6)	1147 (56.1)	0.470	<.001
Non-pathological results	348 (17)	290 (14.2)	0.562	<.001
Total	2045	2045		

CT: Computed Tomography; **EPs:**Emergency residents; **COVID-19:** Coronavirus disease 2019

| Table 3 | Assessment of PCR positive patients with Chest CT by ERs and radiologist for the diagnosis of COVID-19 pnemonia |

	ERs interpretations	Radiologist interpretations	Kappa Value	p
Covid-19 pneumonia	305 (95.1)	301(78.2)	0.799	<.001
Non Covid-19 findings	57 (4.6)	63 (16.4)	0.605	<.001
Non-pathological results	23 (17)	21 (5.5)	0.518	<.001
Total	385	385		

CT: Computed Tomography; **ERs:**Emergency residents; **Covıd-19:** Coronavirus disease 2019

ERs and radiologists were compared, a statistically significant difference was found between the two groups (p<.001). COVID-19 RT-PCR test results were analyzed for the definitive diagnosis of the patients. Chest CT images of patients with positive COVID-19 RT-PCR tests were interpreted and compared by radiologists and ERs. Among the patients evaluated by ERs, 305 (95.1%) had COVID-19 pneumonia findings, 57 (4.6%) had non-COVID-19 findings, and 23 (17%) had non-pathologic results. Among patients who were evaluated by radiologists, 301 (78.2%) had COVID-19 pneumonia findings, 63 (16.4%) had non-COVID-19 findings, and 21 (5.5%) had non-pathologic results. When the interpretations of ERs and radiologists were compared, a statistically significant difference was found between the two groups (p<.001).

The interpretation of radiologists was considered the gold standard. In all patients, the diagnostic performance ability of ERs for COVID-19 pneumonia was low sensitivity 66%, high specificity 92%, positive predictive value (PPV) 83% and negative predictive value (NPV) 82%. In patients with positive COVID-19 RT-PCR test results, ERs had the highest sensitivity, specificity, PPV, and NPV of 96%, 82%, 95%, and 86%, respectively (Table 4).

| Table 4 | Accuracy of the interpretation of ERs about Chest CT in the diagnosis of COVID-19 |

	Sensitivity	Specifity	PLR	NLR	PPV	NPV
All patients with Covid-19 pneumonia	66	92	8	0.3	83	82
Covid-19 PCR (+) pneumonia	96	82	5	0.04	95	86

CT: Computed Tomography; **PPV:** positive predictive value; , **NPV:** negative predictive value **PLR:** Positive Likelihood Ratio; **NLR:** Negative Likelihood Ratio; **Covıd-19:** Coronavirus disease 2019

Discussion

The results of the study were found to be significant since there is no study in the literature showing the diagnostic efficiency of the ER for COVID-19 pneumonia in chest CT. Chest CT interpreted by the ER is beneficial in the ED for the management of the COVID-19 epidemic, especially for patients with positive COVID-19 RT-PCR result in university hospitals in which crowded emergency services are present.

Previous studies have shown that chest CT performs well in the diagnosis of COVID-19 pneumonia, according to the review of the literature [11, 12]. It was reported in a prospective study conducted with 319 suspected COVID-19 patients in the ED that chest CT had a sensitivity, specificity, PPV and NPV of 90.2%, 88.2%, 84.5% and 92.7%, respectively, based on initial RT-PCR results [13]. Similar to our study with 135 COVID-19 RT-PCR

positive patients, another study investigating the diagnostic performance of chest CT by radiology residents found a high diagnostic accuracy, specificity, PPV and NPV of 97.22%, 88.89%, 90.91% and 96.55%, respectively [14]. A rapid diagnosis is essential while waiting for RT-PCR results in crowded EDs facing the COVID-19 pandemic. In a study that was conducted in an ED, the diagnostic performance of chest CT in triage of symptomatic patients with suspected COVID-19 was shown to have a high sensitivity of 99%, specificity of 76%, PPV of 90% and NPV of 97%, similar to our study [15]. In another study with 287 definite positive patients among 694 patients in multicenter EDs during the COVID-19 pandemic, chest CT was shown to have high diagnostic performance with 90.2% sensitivity, 88% specificity, 84.1% PPV and 92.7% NPV [16]. Although chest CT has high sensitivity in patients with suspected COVID-19

pneumonia, it may cause specificity problems when overlaps with the findings of other viral pneumonia agents [17]. In this study, we also examined the diagnostic performance of chest CT in RT-PCR-confirmed COVID-19 patients and showed that it has higher specificity. Indeed, from previous studies, Bai et al., reported in a retrospective study with 213 positive COVID-19 patients, that chest CT differentiated COVID-19 pneumonia from viral pneumonia with high specificity and moderate sensitivity. In a study of W. Guan et al., pathological findings were found in 2.9% of chest CT imaging of RT-PCR-positive COVID-19 patients with severe disease [7]. The differences in elapsed time may be due to the presence of similar CT findings with other viral agents. Therefore, the American College of Radiology and SIRM (Società Italiana di Radiologia Medica e Interventistica) recommended that chest CT should not be used as a primary diagnostic screening tool in the radiological management of COVID-19, but can be used in suspected symptomatic patients with clinical indications or positive COVID-19 patients [19]. In the related literature, there are some studies evaluating the effectiveness of chest CT as a COVID-19 diagnostic screening tool. When the full texts of 28 studies were reviewed and 4486 patients were evaluated, it was shown in one review that a total of 3164 patients had positive chest CTs and 3014 had positive PCR results. Results from this review suggest that chest CT should not be used as a screening tool but can be used in inpatients and symptomatic patients [20]. Therefore, the recommendations in the guideline for radiological management have been confirmed by the conducted studies.

In light of all this, this study showed that ER has low sensitivity for diagnosing COVID-19 pneumonia on chest CT in all patients with suspected COVID-19, but high specificity for excluding the diagnosis of COVID-19. In COVID-19 patients who were RT-PCR positive, ER was found to have high sensitivity and specificity on chest CT and diagnostic value for COVID-19 pneumonia.

Limitations

This study has some limitations. First, this study was retrospectively designed and the number of RT-PCR positive patients was relatively small. The second important limitation was that only the registered data of patients with RT-PCR test results from the hospital electronic file system were included in the study. Therefore, the radiologic findings on chest CT at admission of patients with missing RT-PCR results are unknown. In addition, since the clinical duration of pneumonia was not known, only chest CT scans at admission were interpreted and some patients may not have had radiologic pneumonia findings.

Conclusion

In conclusion, this study showed that ER has sufficient diagnostic value and knowledge to diagnose COVID-19 pneumonia using chest CT in patients with suspected COVID-19 for epidemic management.

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