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Comparison of Rt-Pcr Test and Chest Computed Tomography in Diagnosis of Covid-19

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Abstract: Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) caused an acute lower respiratory tract infection epidemic. To detect diagnostic performance of British Society of Thoracic Imaging (BSTI) SARS-CoV-2 Disease CT classification criteria in diagnosis of the disease. Adult patients who presented our pandemic clinic with suspected SARS-CoV-2 Disease and underwent chest CT between March 14, 2020 and June 09, 2020 were included in the study. The chest CT images of the patients were evaluated according to the BSTI SARS-CoV-2 Disease CT classification criteria. The diagnostic performance of chest CT was calculated using the reverse transcription polymerase chain reaction (RT-PCR) test as the gold standard in the diagnosis of SARS-CoV-2 Disease. Of the 386 patients included in the study, 49.2% were diagnosed with SARS-CoV-2 Disease. According to the BSTI Covit-19 CT classification criteria, the number of patients in the classic SARS-CoV-2 Disease, probable Covit-19, indeterminate and non-COVID diagnosis groups were 32.6%, 14.2%, 18.9% and 34.2%, respectively. The BSTI Covit-19 CT classification criteria showed very high diagnostic performance in the diagnosis of SARS-CoV-2 Disease. The use of these criteria to differentiate SARS-CoV-2 Disease pneumonia can standardize and optimize the diagnosis of SARS-CoV-2 Disease and management of the disease. © 2022 NTMS.

Keywords: Coronavirus Disease 2019; Computed Tomography; Diagnosis; BSTI.

1. Introduction

An acute lower respiratory tract infection epidemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first reported in Wuhan, China, in the last days of 2019 (1). Later, this disease was named coronavirus disease 2019 (Covit-19) by the World Health Organization and declared a pandemic (2). Within one year after the declaration of pandemic, the number of patients that contracted SARS-CoV-2 Disease had exceeded 100 million, and nearly 2.5 million people died (3).

The gold standard diagnostic test for SARS-CoV-2 Disease is the real-time reverse transcription polymerase chain reaction (RT-PCR) assay of a nasopharyngeal swab, oropharyngeal swab, or endotracheal lavage (4). This test is highly specific but has low sensitivity, ranging from 37 to 71%, in the early

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stages of the disease or in patients with insufficient samples (5-7). Therefore, it can cause false negative results; i.e., even if the patient is infected, the RT-PCR test may be negative. In addition, existing RT-PCR tests can take up to two days to produce results, and access to such tests is limited in some regions. Chest computed tomography (CT) is not recommended as a routine screening tool, but it is used as a diagnostic tool for SARS-CoV-2 Disease pneumonia, especially in regions where access to RT-PCR tests is limited, as well as in early-stage patients with false negative RT-PCR results (8, 9). With the widespread use of chest CT in the diagnosis and management of SARS-CoV-2 Disease, many guidelines have been published for this purpose (10-12). One of them is the Covit-19 CT classification of the British Society of Thoracic Imaging (BSTI) criteria.

This study aimed to measure the diagnostic performance of the BSTI Covit-19 CT classification criteria in the diagnosis of SARS-CoV-2 Disease.

2. Material and Methods

This retrospective and single center study was carried out in a University Training and Research Hospital after receiving approval from the SARS-COV-2 Scientific Research Committee of the Republic of Turkey Ministry of Health and the Local Ethics Committee (2020/06-70). Research and Publication Ethics has been complied with at all stages, with the realization and preparation of the study. Patients aged 18 years and over who presented to our emergency department with complaints such as fever, cough, sore throat, dyspnea, and loss of taste and smell between March 14, 2020 and June 09, 2020, underwent the RT-PCR test and chest CT due to suspected SARS-CoV-2 Disease were included in the study. The exclusion criteria were as follows: pregnancy, not having an RT-PCR test, not undergoing chest CT, or chest CT images not being available. The patients' symptoms, physical examination findings, RT-PCR results, and laboratory test results (such as white blood cell count and C-reactive protein) were obtained from the hospital's electronic medical records. The patients were divided into two groups as RT-PCR (+) and RT-PCR (-). Patients that had an initial negative RT-PCR test result but underwent this test again due to clinical suspicion, this time having a positive test result, were included in the RT-PCR (+) group.

The chest CT images of the patients were evaluated by two experienced radiologists blinded to the purpose of the study and the RT-PCR results of the patients. The radiologists evaluated the chest CT images in consensus and classified the patients into classic Covit-19, probable Covit-19, indeterminate and non-COVID groups according to the BSTI Covit-19 CT classification criteria (10).

2.1. Statistical Analyses

The statistical analysis of the data was performed using the Statistical Package for the Social Sciences version 15.0 (SPSS Inc., Chicago, IL, USA). The conformance of continuous data to normal distribution was determined with the Kolmogorov-Smirnov test. Continuous data conforming to normal distribution were expressed as mean±standard deviation (SD) while those without normal distribution were obtained as median and interquartile range (IQR) values. Categorical data were expressed as the number (n) and percentage (%) of patients. Student's t-test and the Mann-Whitney U test were used to compare continuous data between the two groups. The chi-square test was used to compare categorical data between the two groups. The RT-PCR results were used as the gold standard to evaluate the performance of chest CT in the diagnosis of SARS-CoV-2 Disease. Agreement between the chest CT diagnosis and the RT-PCR test results was determined by performing Cohen's kappa analysis. In addition, to measure the diagnostic performance of chest CT in the diagnosis of SARS-CoV-2 Disease, the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the BSTI Covit-19 CT classification were calculated. A p value of less than 0.05 was considered statistically significant.

3. Results

Throughout the study period, 386 patients were included in the study. The ages of the patients ranged from 18-95 years, with a median value of 54 (IQR:37-69) years. While 229 (59.3%) of the patients were male, 157 (40.7%) were female. According to the results of the RT-PCR test, 190 (49.2%) of the 386 patients were RT-PCR (+). There was no statistically significant difference in age and gender between the RT-PCR (+) and RT-PCR (-) groups. The C-reactive protein level was statistically significantly higher in the patients diagnosed with RT-PCR (+) group ($p<0.001$). Conversely the lymphocyte level was statistically significantly lower in the patients diagnosed with RT-PCR (+) group ($p=0.01$). The demographic characteristics and laboratory findings at the time of presentation are summarized in Table 1.

According to the BSTI Covit-19 CT classification, the CT findings were consistent with classic Covit-19 in 126 (32.6%) patients, probable Covit-19 in 55 (14.2%), indeterminate in 73 (18.9%), and non-COVID in 132 (34.2%). A SARS-COV-2 diagnosis was made based on a positive RT-PCR test in 118 of the 126 patients classified as classic Covit-19 and 12 of the 132 patients classified as non-COVID (Table 2 and Figure 1 and 2). The classic SARS-CoV-2 Disease category of the BSTI Covit-19 CT classification system had a sensitivity of 61.2%, specificity of 95.9%, PPV of 93.7%, and NPV of 72.3% in the diagnosis of the disease.

Table 1: Patients' demographic characteristics and laboratory findings at the time of presentation according to their RT-PCR test result.

	RT-PCR Test Result		
Variables	**Positive**	**Negative**	**p**
Gender, n (%)			
Male	106 (55.8%)	123 (62.8%)	0.16
Female	84 (44.2%)	73 (37.2%)	
Age, years	57 (39-68.3)	48.5 (33-70)	0.13
White blood cell count, $x10^9$/L	5.6 (4.2–7.6)	5.2 (3.9–6.8)	0.44
Neutrophil count, $x10^9$/L	4.25 (2.9–6.7)	3.7 (2.5–4.6)	0.18
Lymphocyte count, $x10^9$/L	0.7 (0.4–0.9)	1.1 (0.8–1.3)	0.01
C-reactive protein, mg/L	59.3 (42.4–94.6)	24.6 (5.1–39.8)	< 0.001
Hemoglobin, (g/dl)	13.2 ± 3.4	13.5 ± 2.5	0.67

Data are presented as n (%), mean (SD), or median (interquartile range). RT-PCR: reverse- transcriptionase polymerase chain reaction.

Table 2: Distribution of the RT-PCR-positive and RT-PCR-negative patients according to the BSTI COVID-19 CT classification.

	RT-PCR Test Result		
BSTI COVID-19 CT Classification	**Positive**	**Negative**	**Total**
Classic COVID-19	118 (30.6%)	8 (2.1%)	126 (32.6%)
Probable COVID-19	39 (10.1%)	16 (4.1%)	55 (14.2%)
Indeterminate	21 (5.4%)	52 (13.5%)	73 (18.9%)
Non-COVID	12 (3.1%)	120 (31.1%)	132 (34.2%)
Total	190 (49.2%)	196 (50.8%)	386 (100%)

RT-PCR: Reverse transcription polymerase chain reaction; BSTI: British Society of Thoracic Imaging; CT: computed tomography

Table 3: Diagnostic performance of the BSTI COVID-19 CT classification system.

BSTI COVID-19 CT Classification	**Sensitivity**	**Specificity**	**PPV**	**NPV**	**Accuracy**
Classic COVID-19[a]	62.1% (118/190)	95.9% (188/196)	93.7% (118/126)	72.3% (188/260)	79.3% (306/386)
Classic COVID-19 or Probable COVID-19[b]	82.6% (157/190)	87.8% (172/196)	86.7% (157/181)	83.9% (172/205)	85.2% (329/386)
Classic COVID-19, Probable COVID-19, or Indeterminate[c]	93.7% (178/190)	61.2% (120/196)	70.1% (178/254)	90.9% (120/132)	77.2% (298/386)

BSTI: British Society of Thoracic Imaging; CT: computed tomography; PPV: positive predictive value; NPV: negative predictive value. [a] Kappa=0.583, p<0.001; [b] Kappa=0.704, p<0.001; [c] Kappa=0.546, p<0.001

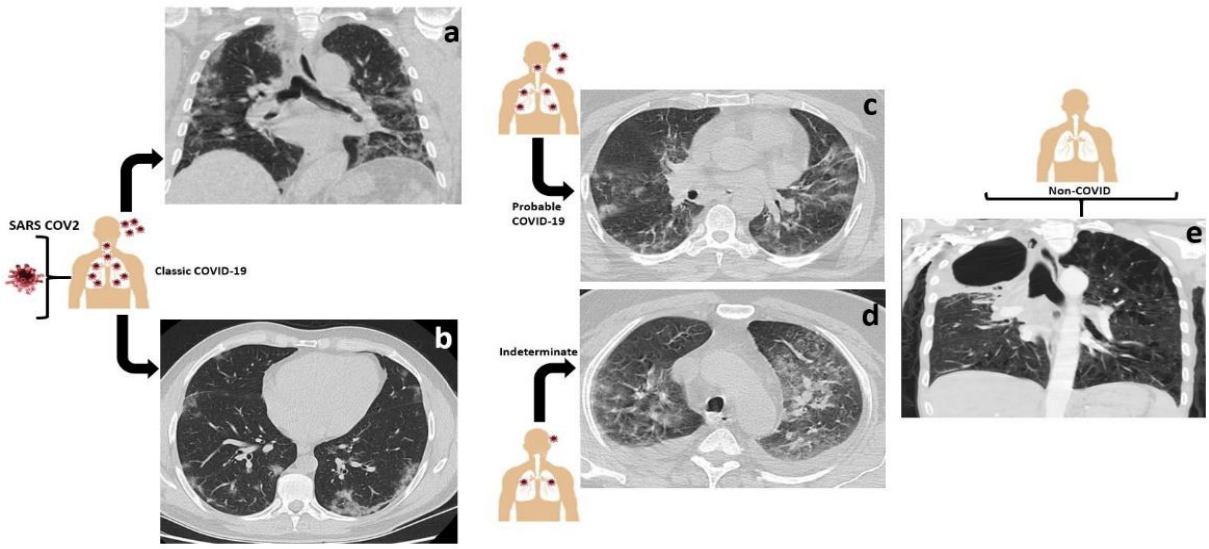

Figure 1: Experimental demonstration of SARS-CoV-2 infection according to diagnostic performance of the BSTI COVID-19 CT classification system. In the coronal and axial sections, peripheral predominantly multifocal ground-glass opacities are observed more prominent in the middle and lower lobes of bilateral lung parenchyma areas, which accompanied by diffuse interlobular septal thickening and subpleural lines. Findings were considered typical for COVID-19 pneumonia. CT findings of the patient were evaluated as Classic COVID-19 (a and b). Lower lobe dominant, bronchocentric and peripheral consolidation in both lungs; limited number of ground glass opacities are observed. CT findings of the patient were evaluated as probable Covid 19 pneumonia (c). Bilateral pleural effusion, more prominent ground-glass opacities in the central and upper zone, and accompanying nodular infiltration were present, which was evaluated clinically in accordance with the findings suggesting an alternative diagnosis (indeterminate) (d). Cavitation accompanied by volume loss in the right lung upper zone; right hilar soft tissue density, more prominent focal emphysematous aeration increases are observed on the left and apex. It was accepted as non-Covid 19 CT findings in the patient who had no sign of pneumonia (e).

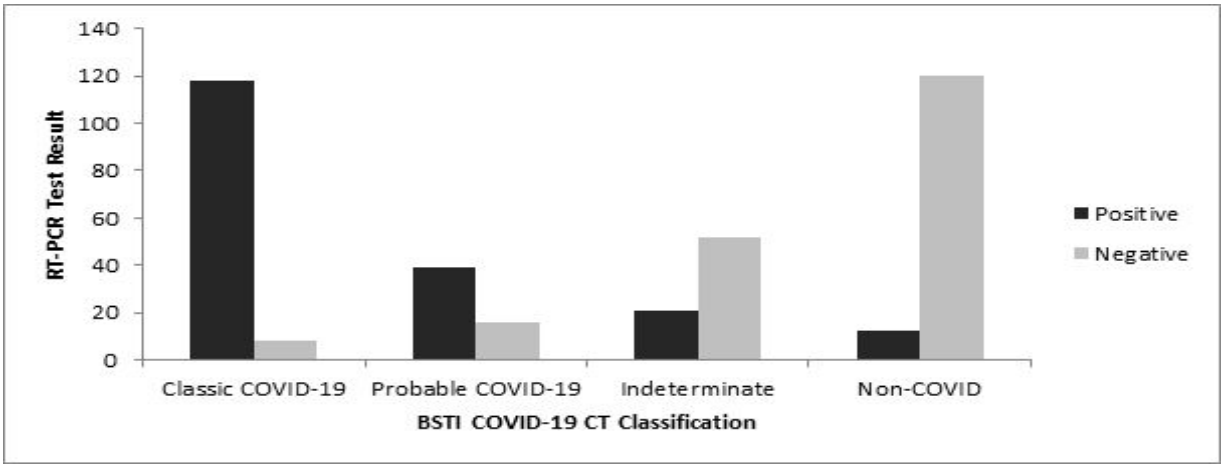

Figure 2: The ratio of CT findings according to the BSTI Covit-19 CT classification.

When the classic Covit-19 and probable Covit-19 categories were combined, the sensitivity of this classification system was determined as 82.6%, specificity 87.8%, and accuracy 85.2%. When the three groups other than the non-COVID category were combined, the sensitivity of this classification system was found to be 93.7%, specificity 61.2%, PPV 70.1%, NPV 90.9%, and accuracy 77.2% (Table 3).

4. Discussion

Since the report of the first case, SARS-CoV-2 Disease has spread all over the world in a short time, infecting millions of people from different continents. Although more than a year has passed since the onset of the pandemic, a large number of patients infected with or suspected of being infected with SARS-CoV-2 Disease still present to hospitals every day. There is not

sufficient RT-PCR test capacity worldwide to detect SARS-CoV-2 Disease, the causative agent of SARS-CoV-2 Disease, and therefore hospitals have difficulties in triage, diagnosis, management or treatment of these patients. Since SARS-CoV-2 Disease primarily involves lungs, chest CT has become the preferred auxiliary diagnostic method in the diagnosis of SARS-CoV-2 Disease (13-15).

The results of our study showed that the classic SARS-CoV-2 Disease category of the BSTI Covit-19 CT classification system was highly specific and moderately sensitive in the diagnosis of the disease. The lower sensitivity compared to specificity may be due to the RT-PCR test being performed in the early period of the infection. Previous studies have shown that in patients with CT findings of SARS-CoV-2 Disease, early RT-PCR tests can produce false negative results, and serial RT-PCR tests should be performed for the diagnosis of SARS-CoV-2 Disease in these patients (16, 17).

In a study by Inui et al., it was reported that the sensitivity of BSTI classic Covit-19 category was 64.5% and its specificity was 92% (8). In the same study, it was shown that when the BSTI classic Covit-19 and probable Covit-19 categories were combined, the sensitivity increased to 71% and the specificity decreased to 87% (8). Our results support these findings. We determined that when combined, the classic Covit-19 and probable Covit-19 categories had increased sensitivity and reduced specificity in diagnosing the disease. Another important result of our study is that although 3% of the patients were in the non-COVID category according to the BSTI Covit-19 CT classification criteria, the RT-PCR tests of these patients were positive. This confirms the BSTI non-COVID categorization emphasizing SARS-CoV-2 Disease cannot be definitively ruled out in these cases and the RT-PCR test may be required.

Structured chest CT reporting is recommended for the diagnosis of SARS-CoV-2 Disease since it facilitates radiological diagnosis, reduces variability in interpretation of chest CT reports by clinicians, and standardizes the reporting language. To date, in addition to BSTI, several other structured reporting systems, such as the SARS-COV-2 Reporting and Data System (CO-RADS), SARS-COV-2 imaging reporting and data system (COVID-RADS), and the Radiological Society of North America Expert Consensus statement have been defined (11, 12, 18). These systems are reported to have similar diagnostic performance in SARS-CoV-2 Disease (8). If the patient has underlying interstitial lung disease, emphysema, non-specific interstitial pneumonia, chronic obstructive pulmonary disease, or interstitial pneumonitis, the performance of all chest CT reporting systems decreases in the diagnosis of SARS-CoV-2 Disease. This is due to chest CT findings of Covit-19 pneumonia being similar to those seen in above-mentioned diseases and other viral pneumonias (19). In the BTSI Covit-19 CT classification system, if there is an underlying disease such as interstitial lung disease and emphysema, it becomes difficult to make a diagnosis, and thus the patient is classified into the indeterminate category (10), which reduces the diagnostic performance of the BSTI classification system. The results of our study are in agreement with this information. In our study, of the patients in the BTSI indeterminate category, 29% had a positive RT-PCR test result while 71% had a negative RT-PCR test result.

5. Conclusions

The BSTI Covit-19 CT classification criteria showed reasonable diagnostic performance for SARS-CoV-2 Disease. In particular, the classic Covit-19 category was highly specific and moderately sensitive for the diagnosis of the disease. Further studies are needed to validate the BSTI Covit-19 CT classification system in larger and more diverse populations.

Limitations of the Study

This study has certain limitations. First, due to the retrospective nature of the study, there may have been selection bias. Second, the study being conducted in a single center may have affected the generalizability of the results. Another limitation is that SARS-CoV-2 Disease can be asymptomatic. The inclusion of only symptomatic patients in the sample may have affected the calculated diagnostic performance value of chest CT findings.

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Conflict of Interests

The authors declare that there is no conflict of interest.

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Author Contributions

KY, KK, DO, EA, ETS, HM, AS: Manuscript writing, coordination of the study, database management and analysis, KY, KK, DO, EA, ETS, HM, AS: Data collection, statistical analysis, KY, KK, DO, EA, ETS, HM, AS: contribution to the concept, design and critical revision of article.

Ethical Approval

The study was approved by the SARS-COV-2 Scientific Research Committee of the Republic of Turkey Ministry of Health and the Local Ethics Committee (2020/06-70).

Data sharing statement: The data sets generated and analyzed during the present study are included in this published article. Further details are available for noncommercial purposes from the corresponding author on reasonable request.

Informed Statement

Individuals who consented to participate were included in the study.

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