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Original Article

Sensitivity and Specificity of High Resolution Computed Tomography Chest in Diagnosing Corona Virus Disease 2019: A Retrospective Correlation with Reverse Transcriptase Polymerase Chain Reaction

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Abstract

Background

Corona Virus Disease 2019 came into existence in December 2019, as a sudden outbreak in the city of Wuhan, China. Early identification of the patient is vital to control disease transmission. This study is aimed at estimating the sensitivity, specificity, and practicability of High resolution computed tomography chest in detecting Corona Virus Disease 2019 compared with a Reverse transcriptase-polymerase chain reaction.

Materials and Methods

This was a retrospective single-center analytical study conducted at Nobel Medical College for 5 months during the second wave of Covid 19 from Feb 2021 to June 2021 after ethical approval from the Institutional Review Committee of Nobel Medical College Teaching Hospital. All clinically suspected patients who had undergone High-resolution computed tomography chest and Reverse transcriptase-polymerase chain reaction within a 1-week time difference were included. High-resolution computed tomography chest scan was reported before Reverse transcriptase-polymerase chain reaction results became available.

Results

Among 342 consecutive patients (195 male and 147 females, mean age 64), Reverse transcriptase-polymerase chain reaction was positive in 183 (53.5%) cases. Common High-resolution computed tomography chest features significantly more common in Reverse transcriptase-polymerase chain reaction positive patients were bilateral subpleural and peripheral ground-glass opacities with septal thickening(crazy paving). In comparison with Reverse transcriptase-polymerase chain reaction, the sensitivity was 91.8% and specificity 67.2%.

Conclusion

This study revealed the high sensitivity of high-resolution computed tomography chest scans in accurately diagnosing Corona Virus Disease 2019.

Keywords: *COVID-19, Reverse Transcriptase Polymerase Chain Reaction, Sensitivity and Specificity*

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Introduction

Corona Virus Disease 2019 (COVID-19) is a novel, severely contagious viral infection occurring worldwide. It is caused by severe respiratory syndrome coronavirus (SARS-COV-2) [1]. It was first detected in the city of Wuhan, China. Typically, patients present with symptoms of fever or chills, cough, difficulty in breathing, fatigue, muscle or body aches, headache, loss of smellor taste, sore throat, congestion or runny nose, nausea, or vomiting and diarrhea.

Currently, the reference standard for diagnosing COVID-19 is Reverse-Transcriptase-Polymerase-Chain-reaction (RT-PCR) [2]. However, in the initial stages of COVID-19, because of the below detection limit of viral load or technical issues, i.e., sampling errors, RT-PCR may have suboptimal sensitivity [3]. Furthermore, in practice, it might require as long as 24 hours to get a test outcome, although same-day results are accomplished most of the time.High-resolution computed tomography (HRCT) chest assumes a significant part in the early detection of COVID-19 because of typical findings of bilateral, multifocal, peripheral, sub-pleural, ground-glass attenuation predominantly in a posterior distribution [2, 4] which may then progress to crazy paving appearance, consolidation, or ending in bilateral white-out lungs [5, 6].

The social, healthcare and economic consequences of this pandemic are immense [7]. Early identification of infected patients is vital in controlling the disease. Thus the objective of this study was to evaluate the sensitivity and specificity of Highresolution computed tomography chest scan in detecting Corona virus disease 2019 as compared with a Reverse transcriptase-polymerase chain reaction.

Materials and Methods

This retrospective single-center study was conducted at the Department of radiodiagnosis, Nobel Medical College from the period of February 2021 to June 2021. This study was approved by the Institutional Review Committee of Nobel Medical College (IRC No- 452/2021). All the patients irrespective of age and sex presented at Nobel Medical College with signs and symptoms of COVID-19 (body temperature >38°C, acute respiratory symptoms like cough or dyspnea, respiratory rate >20/min, oxygen saturation <95%) with HRCT chest and RT-PCR done within 7 days interval were included. The presence of severe motion artifacts in the CT scan, patients with pulmonary and extrapulmonary lung malignancy, chest trauma, and previous chest surgery was excluded from the study.

HRCT scan was performed using a 128-slice multidetector CT (Siemens Somatom Definition) 120kVp. Each patient was scanned in the supine position, and lung fields from apices to bases were scanned in a single breath-hold. Images were then reconstructed at axial 0.75mm sections for the lung window and axial 1mm sections forthe soft tissue mediastinal window with furtherreformations in coronal and sagittal planes. HRCT chest scan of all the enrolled patients was reported before RT-PCR results were available. Reporting was done by at least two Radiologists who were unaware of the RT-PCR status using a dedicated uniform reporting system and a consensus is reached. The common CT features were ground glass opacity (GGO), consolidation, crazy paving, reticulation, and any other findings. Each lobe of the lungs was individually assessed with the percentage involvement of the lobe noted based onvisual assessment. Score-1 (<5% of lobe involved), Score-2 (5-25% of lobe involved), Score-3 (25-50% of lobe involved), Score-4 (50-75% of lobe involved), Score-5 (>75% of lobe involved), with the total score 25. Based on the total percentage in each of the 5 lobes,CT Severity Score was allotted out of 25.

The convenience consecutive sampling method was used. The data were then statistically analyzed using the Statistical Program for Social Science (SPSS) Version 26. Descriptive qualitative data were presented as frequency and percentage values, while descriptive quantitative data were presented as mean, standard deviations, and ranges with minimum-maximum values. Sensitivity, specificity, positive predictive value and negative predictive value, and diagnostic accuracy of the HRCT chest were calculated. For statistical analysis, the Chi-square test was used with significance at the $p<0.05$ level.

Results

Table 1: Correlation of HRCT chest with RT-PCR

		RT-PCR		
		Negative	Positive	Total
HRCT diagnosis	Normal/ Non-consistent with COVID-19	107	15	122
	Consistent with COVID-19	52	168	220
Total		159	183	342

342 patients (195 men and 147 women) were included, mean age of 45 years (Range 1-92). Of 342 patients, 183 (53.5%) had positive RT-PCR results, and 220 (64.3%) had CT findings consistent withCOVID-19 as mentioned in Table 1. Com-

pared with RT-PCR, the sensitivity and specificity of the HRCT chest scan for detecting COVID-19 were 91.8% and 67.2% (with 95% CI) respectively. Positive predictive value (PPV) was 76.3% and Negative predictive value (NPV) was 87.7%.The diagnostic accuracy of this study was 80.4%.

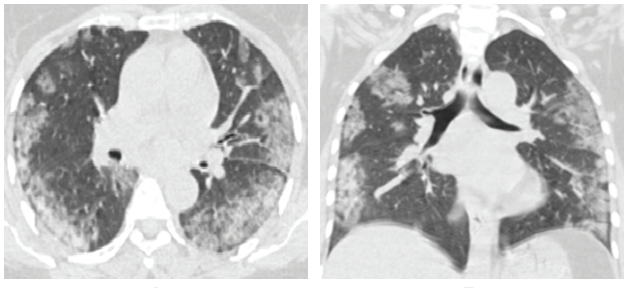
Out of 220patients with HRCT features consistent with Covid 19, 218 (99%) had bilateral involvement and 139 (63.1%) had typical CT features of peripheral, subpleural ground-glass opacities with posterior, and lower lobe predominance (Figures 1 and 2). One hundred forty-five had interstitial septal thickening, 72 subpleural bands, and 10 had traction bronchiectasis.HRCT findings are listed in table 2.As per CT severity score, 88(40%) had CT scores ranging between 5-10 as mentioned in table 3.

Table 2:Common HRCT findings

	RT PCR positive	RT PCR negative
Lung opacities present	170	77
No lung opacities	13	82
GGO		
Unilateral	0	7 (9%)
Bilateral	168 (99%)	51 (66%)
Crazy paving pattern	118(69%)	29 (38%)
Consolidation	71(42%)	27 (35%)
Subpleural bands	61(36%)	12 (16%)
Traction bronchiectasis	9(5%)	14 (18%)
Distribution		
Peripheral only	100(59%)	44 (57%)
Peripheral and central	68(40%)	14 (18%)
Distribution		
Upper lobe dominant	17 (10%)	18 (23%)
Lower lobe dominant	102 (60%)	43 (56%)
No dominance	51 (51%)	16 (21%)
Distribution		
Ventral dominant	14 (8%)	7 (9%)
Dorsal dominant	116 (68%)	48 (62%)
No dominance	41 (24%)	22 (29%)

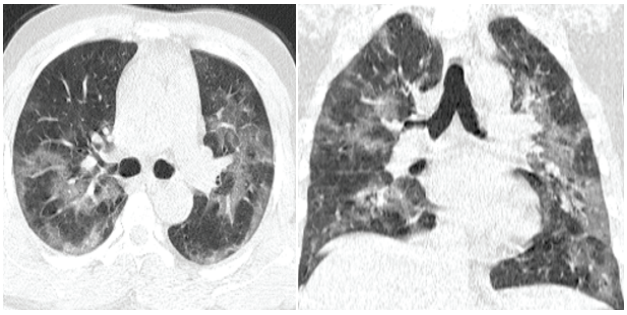
Table 3: CT severity score

CT severity	RT PCR positive	RT PCR negative
0	2 (1%)	25(33%)
<5	38 (22.4%)	15(19%)
5-10	67 (39.4%)	21(27%)
10-15	26 (15.2%)	9 (12%)
16-20	22 (13%)	5 (6%)
21-25	15 (9%)	2 (3%)



A B

Figure 1: HRCT chest axial(A) and coronal(B) images show bilateral, multifocal, peripheral ground-glass opacities with septal thickening (giving a crazy-paving pattern). Findings consistent with COVID-19 pneumonia were reported and RT-PCR came out to be positive.



A B

Figure 2: HRCT chest axial(A) and coronal(B) images show bilateral, multifocal, ground-glass opacities with septal thickening (giving a crazy-paving pattern). Findings consistent with COVID-19 pneumonia were reported however, RT-PCR came out to be negative.

Discussion

Our study meticulously reviewed the available works of literature about the efficacy of chest CT in detecting this disease.The consequences of this examination showed the high efficacy of HRCT in detecting COVID-19 when contrasted with RT-PCR.HRCT has a limited ability to differentiate COVID-19 from other types of viral pneumonia, exhibiting a low specificity[4]. This leads to more patients being labeled as suspected of COVID-19, overburdening the hospitals, healthcare providers, and healthcare facilities. But early isolation of these patients reduced the risk of COVID-19 being missed diagnosed.

Various studies especially those from the radiology community on the efficacy of chest CT as compared to RT-PCR in COVID-19 diagnosis-support the vital role of HRCT chest in detecting COVID-19. A large study from China including 1014 patients conducted by Ai T et al. had 97% sensitivity and specificity of 25% of HRCT chest scans compared to RT-PCR results [8]. Their study stated that HRCT chest detected nearly all cases who had positive RT-PCR, and 75% of the cases that were primarily missed by a serological test.Kim et al. [9] in their meta-analysis reported HRCT chest having 94% sensitivity in diagnosing COVID-19 [95 % CI 91–96]. In comparison, our sensitivity (91.8%) is slightly lower but still within the 95 % CI. Wen et al. in their study reported 93% sensitivity and 53%specificity of CT chest [10]. Caruso et al. also showed high sensitivity and relatively low specificity of CT of 97% and 56% in their study conducted in Rome, Italy, similar to our present study[11].

In a study done by Song et al. most common HRCT imaging findings were bilateral lung involvement (86%) with ground glass opacities (77%) in subpleural posterior distribution mainly in lower lungs [12]. Our study concluded that on HRCT chest consistent with COVID-19, >99% of patients had bilateral lung involvement with 63.1% having peripheral, subpleural ground-glass opacities.

Some patients have typical HRCT chest findings, symptoms, and examination results consistent with COVID-19 but initial RT-PCR results were negative in agreement with previous research reports [4, 8, 13]. Fang et al. in their study stated 15 patients out of 51 had typical CT scan findings although they had an initial negative RT-PCR [8, 13]. According to Xu et al study, 31.8% of highly suspected RT-PCR-negative cases had positive results on HRCT-distinct COVID-19 scans [14]. Shi and colleagues in their study of patients with SARS-CoV-2 infection reported abnormal chest CT findings even in asymptomatic patients [15]. In our study 52 out of 220 (23.63%) had HRCT features consistent with Covid-19, however, their initial RT-PCR test was negative. Another piece of literature from Wuhan, China, concludes that HRCT chest can be used as a standard method for disease screening and diagnosis [16].

Bernheim et al. stated that 56% of patients who had done HRCT chests within 2 days of onset of symptoms, had unremarkable HRCT findings as compared to 9% of intermediate patients (3-5) days and 4% of late patients [17]. Chung et al. reported negative imaging in known infected patients with COVID-19 at initial presentation [18]. Many cases with initial false-negative RT-PCR have been reported to have typical COVID-19 HRCT findings [19]. The majority of false negative findings likely result from imaging taken during early viral infection when infectious changes are not yet visible in lung parenchyma and a considerable number of patients with symptomatic respiratory tract infections do not develop pneumonia [20, 21]. So it is imperative to correlate HRCT chest scans, epidemiologic features, and clinical symptoms for early detection of COVID-19.

The major limitation of this study was that this was a retrospective study with a limited number of patients meeting the inclusion criteria. A prospective study with large sampling is required for a better correlation between HRCT chest and RT-PCR.

Conclusion

This study has shown that HRCT chest scan shows high sensitivity and good specificity for diagnosing COVID-19 pneumonia, especially when other parameters like clinical and epidemiological features are taken into account. The use of a uniform reporting system of HRCT chest scans based on the imaging findings helps in the triage of emergency patients and thus further management.

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Conflict of interest: None

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