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DIAGNOSTIC ROLE OF CHEST CT USING CO-RADS CATEGORIZATION IN SARS-COV-2 INFECTION WITH EMPHASIS ON IMPACT OF CT IN PATIENTS WITH DELAYED OR NEGATIVE INITIAL RT-PCR TEST

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ABSTRACT

BACKGROUND AND OBJECTIVE: Role of chest CT in diagnosis of corona virus disease 2019 (COVID-19) has been controversial. The purpose of this study is to evaluate the diagnostic performance of chest CT when utilizing COVID-19 Reporting and Data System (CO-RADS).

METHODOLOGY: Retrospective study including consecutive patients with positive SARS-CoV-2 RT-PCR test (initial or repeat test) and chest CT done in our institute between June and September 2020. Spectrum of CT findings, CO-RADS score and 25 point CT severity score (CTSS) were recorded.

RESULTS: A total of 300 consecutive patients with SARS-CoV-2 infection were included in the analysis. Out of the 168 patients who underwent CT prior to positive RT-PCR result, 125 (74.4%) had CO-RADS 3, 4 or 5 score on chest CT. 32 study patients (10.6%) had initial negative RT-PCR of which 24 (75%) had CO-RADS 4 or 5 score. Of the total patients with CO-RADS 3 to 5 score (227), 20 (8.8%) had severe lung involvement (CTSS 18-25), 83 (36.6%) had moderate lung involvement (CTSS 8-17) and 124 (54.6%) had mild lung involvement (CTSS 1-7). The mean CTSS was 7.9 with mean lobar score being higher in lower lobes (RLL=1.82, LLL=1.78) compared to the upper and middle lobes (RUL=1.61, RML=1.19, LUL=1.53).

CONCLUSION: CT using CO-RADS scoring system has good diagnostic performance. In addition to assessing disease severity, it plays a vital role in triage of patients with suspected COVID-19 especially when there is limited availability of SARS-CoV-2 RT-PCR tests, delay in RT-PCR test results or in negative RT-PCR cases when there is high index of clinical suspicion.

KEYWORDS : COVID-19, CO-RADS, SARS-CoV-2, RT-PCR, chest CT

INTRODUCTION:

The 2019 novel corona virus disease (COVID-19) originated in China and spread all over the world at an alarming pace. In January 2020, the WHO announced COVID-19 to be a major global health emergency. Early diagnosis and treatment of the disease is of utmost importance to prevent morbidity and mortality associated with it. As of today, SARS-CoV-2 RT-PCR is considered as the gold standard diagnostic test. However, the test may yield false negative results in the initial phase of disease and is also dependent on the quality of nasal / throat swab sample. CT chest is emerging as an important additional diagnostic tool. CT using COVID-19 Reporting and Data System (CO-RADS) provides a standard assessment scheme with a 5-point scale to indicate the level of suspicion for pulmonary involvement of COVID-19 on chest CT. There are few studies which show very good diagnostic performance of CO-RADS scoring system. The combined and rational use of RT-PCR and CT may therefore have improved diagnostic accuracy and CT can also semi-objectively assess severity of lung involvement using CT severity score (CTSS), thereby useful in triaging patients. Through this study, we aim to evaluate the diagnostic performance of CT chest when utilizing CO-RADS score.

METHODOLOGY:

This is a retrospective study including consecutive patients with SARS-CoV-2 infection who had positive SARS-CoV-2 RT-PCR test and chest CT done within 14 day interval in our institute between June and September 2020 over a span of 100 days. Patients with initial negative RT-PCR test for whom chest CT was done and repeat RT-PCR showed positive result within the given interval were also included. Volumetric CT scan was acquired (Philips Ingenuity Core 128 slice CT scanner) with the patient in supine position in suspended deep inspiration and without using intravenous contrast. Acquired CT images were reconstructed into lung window (sharp algorithm) with section thickness < 1mm. Multiplanar reconstructions were done on the Radiologist's workstation. Epidemiological details along with dates of RT-PCR test result and spectrum of CT findings were recorded by two qualified Radiologists with 10 and 7 years of experience in reading chest CT (T.P and K.D respectively). The Dutch CO-RADS classification system[1] was used to assign a score between 1 and 5 to all patients. Semi-quantitative CT severity score (CTSS) was calculated for all CO-RADS 3 to 5 patients, based on the extent of lobar involvement (0:0%; 1:<5%; 2:5-25%; 3:26-50%; 4:51-75%; 5:>75%; range 0-5; global score 1-25). Statistical Package for the Social Sciences (SPSS, IBM Corp., Armonk, NY) software version 21 was used for statistical analysis. Clearance from Institutional Review board and ethics committee was obtained prior to the study and the need for patient informed consent was waived as this was a retrospective observational study.

RESULTS:

Study included a total of 300 patients (215 men and 85 women) between 14-92 years of age (median = 54 years; interquartile range = 38 to 64). Key imaging characteristics are summarised in Tables 1 and 2.

Table 1 summarising the spectrum and distribution of lung findings on CT

Characteristic	*Frequency (N=300)*
Ground-glass opacities (GGO)	224 (74.7%)
Consolidation	85 (28.3%)
Both GGO & consolidation	79 (26.3%)
Intralobular and/or interlobular septal thickening within the GGO ("Crazy-paving" pattern)	104 (46.4%)*
Vascular enlargement within the GGO	151 (67.4%)*
Pattern of lung involvement Bilateral multifocal Unilateral multifocal Unifocal	 201 (67%) 16 (5.3%) 12 (4%)
Predominant finding Ground-glass opacities Consolidation	 174 (58%) 27 (out of 79 patients with both)
Distribution of lung opacities Both central and peripheral lung Only peripheral lung involvement Predominantly central lung involvement	 123 (41%) 100 (33.3%) 4 (1.3%)
Lung zonal predilection (assessed on coronal CT) Upper zone Mid zone Lower zone No zonal predilection	 10 (3.3%) 7 (2.3%) 54 (18%) 155 (51.7%)
Subpleural bands	155 (51.7%)
Overt fibrosis (at least focally)	25 (8.3%)

*Denominator for % calculation is 224 (No. of patients with ground-glass opacities)

Table 2 Summarising The Diagnostic Performance Of CT Using CO-RADS Score

Characteristic	*Frequency*
Total no. of SARS-CoV-2 RT-PCR positive study patients	300
CO-RADS ≥ 3 CO-RADS 1-2 CO-RADS 3-5	 73 (24.3%) 227 (75.7%)
CO-RADS ≥ 4 CO-RADS 1-3 CO-RADS 4-5	 81 (27%) 219 (73%)
No. of patients who had CT prior to positive RT-PCR result	168 (56%)
CO-RADS ≥ 3 CO-RADS 1-2 CO-RADS 3-5	 43 (25.6%) 125 (74.4%)
CO-RADS ≥ 4 CO-RADS 1-3 CO-RADS 4-5	 49 (29.2%) 119 (70.8%)
No. of patients with initial false negative RT-PCR result	32 (10.6%)
CO-RADS 3	0
CO-RADS ≥ 4 CO-RADS 1-3 CO-RADS 4-5	 8 (25%) 24 (75%)

There was no notable difference in CT findings between subset of patients with initial false negative RT-PCR result and those with RT-PCR positive result.

CTSS was measured in 227 patients with CO-RADS 3 to 5 score and results are summarised in Table 3.

Table 3 summarising the categories based on severity of lung involvement on CT

Characteristic	*Frequency*
No lung involvement (CO-RADS 1)	71 (23.6%)**
CTSS 1-7 (Mild lung involvement)	124 (54.6%)*
CTSS 8-17 (Moderate lung involvement)	83 (36.6%)*
CTSS 18-25 (Severe lung involvement)	20 (8.8%)*

**Denominator for % calculation is 300 (total no. of study patients)
*Denominator for % calculation is 227 (no. of patients with CO-RADS score 3 to 5)

The mean CTSS was 7.9 with mean lobar score being higher in lower lobes (RLL=1.82, LLL=1.78) compared to the upper and middle lobes (RUL=1.61, RML=1.19, LUL=1.53). Only 9 patients had exclusive lower lobe involvement without upper lobe or right middle lobe involvement. There was only weak positive correlation (Pearson correlation coefficient 0.3) between CTSS and number of days after a positive RT-PCR test when CT was done.

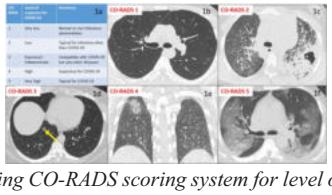

Figure 1 *showing CO-RADS scoring system for level of suspicion for pulmonary involvement in COVID-19 in upper left corner (1a). Figures 1b-1f are representative images for CO-RADS 1 (no suspicion / normal CT), CO-RADS 2 (cavity with numerous tiny nodules suggestive of probable Tuberculosis), CO-RADS 3 (unifocal GGO, yellow arrow), CO-RADS 4 (unilateral multifocal GGO; other GGOs not shown in image) and CO-RADS 5 (bilateral multifocal GGO).*

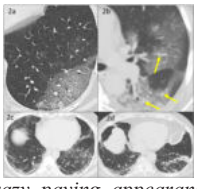

Figure 2 *showing crazy paving appearance (2a) and vascular thickening - yellow arrows (2b) in the involved lung parenchyma, subpleural curvilinear bands (2c) and areas of architectural distortion and fibrosis (2d) in patients with COVID-19 infection.*

DISCUSSION:

RT-PCR has been the reference method for diagnosis of SARS-CoV2 infection since the beginning of the pandemic. According to the Cochrane database of systematic reviews[2], SARS-CoV-2 RT-PCR has high specificity but the sensitivities ranged from 34% to 88%. In the background of the pandemic, lower sensitivity rates of RT-PCR implies that many patients with COVID-19 may not be identified and therefore not isolated from the healthy population resulting in further community spread. Chest CT findings in SARS-CoV2 infection have been well described[3–5] however, these findings were also seen in patients with negative RT-PCR result[6]. Sensitivity and specificity of CT chest will therefore depend on regional disease prevalence, presence or absence of COVID-19 symptoms and prevalence of other respiratory illnesses in the community. Pooled sensitivity and specificity of CT chest in diagnosis of COVID-19 in the wake of the pandemic was 88% an 80% respectively according to the recent Cochrane database of systematic reviews[7]. Sensitivity of CT chest in our study using CO-RADS 3 as threshold and CO-RADS 4 as threshold for diagnosis was 75.7% and 73% respectively. This value is lower than the pooled sensitivity from systematic review[7] probably owing to the mixed study population (symptomatic and asymptomatic individuals). CT diagnosis of COVID-19 (CO-RADS 4 and 5) could be made in 70.8% and 75% of patients with CT done prior to positive RT-PCR result and in patients with false negative RT-PCR respectively. Early CT diagnosis in these two subsets of patients is paramount in order to start early patient isolation and treatment while they wait for the RT-PCR result. Repeat RT-PCR for the patients with initial negative RT-PCR patients may be done depending on the clinical context for testing. There was no notable difference in CT findings between the initial RT-PCR negative subset of patients and those with RT-PCR positive result.

CONCLUSION:

CT using CO-RADS scoring system has good diagnostic performance during the pandemic but cannot replace SARS-CoV-2 RT-PCR as the primary diagnostic tool. In addition to assessing disease severity, CT plays a vital role in triage of patients with suspected COVID-19 especially when there is limited availability of SARS-CoV-2 RT-PCR tests, delay in RT-PCR test results and in subset of patients with negative RT-PCR when there is high index of clinical suspicion.

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