DOI: https://doi.org/10.53350/pjmhs2115102783

ORIGINAL ARTICLE

Role of HRCT Chest in Diagnosing Covid-19 Disease in Initially RT-PCR Negative Patients

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ABSTRACT

Objective: To analyze CTSS score in clinically symptomatic COVID-19 patients having initial negative RT-PCR report.

Design of the Study: It's a retrospective cross sectional descriptive study.

Study Settings: This study was carried out at Radiology Department, CMH Lahore from July to December 2021.

Material and Methods: A total of 1000 patients presented with suspected clinical symptoms of covid-19. 770 were male patients (average of 52±15yrs) and 230 were female patients (49±15 years).Out of which 235 (23.5%) patients had initial negative PCR report & 765 patients had initial PCR positive report. 235 initial PCR negative patients got positive PCR report on subsequent repeat testing. All the patients underwent HRCT chest.

Results of the Study: CTSS score of 765 PCR positive patients was determined as 545 (71.2%) having mild to moderate disease (<19.5 CTSS) and 220 (28.7%) as having severe disease (>19.5 CTSS).CTSS score of 235 PCR negative patients was determined on HRCT chest and classified as 210 (89.3%) having mild to moderate disease (<19.5 CTSS) and 25 (10.6%) as having severe disease (>19.5 CTSS). CO-RADS scoring were done and HRCT pattern analyzed in all the patients according to the standard protocol. Multivariate analysis was performed and showed significant correlation between CTSS score and initial PCR negative patients. Sensitivity and specificity of CT chest in determining covid-19 findings was 89.3% and 28.7%.PPV was 89.8% and NPV was 27.8%.

Conclusion: HRCT with CTSS scoring is an important tool for diagnosis of COVID-19 infection despite initial negative PCR, having sensitivity and specificity of 89.3% and 28.7% respectively. Timely identification and isolation of COVID-19 patients is helpful in preventing the spread of infection and also aid in prompt symptomatic management.

Keywords: COVID-19, Computed Tomography, Ground-Glass Opacity, Reverse Transcriptase Polymerase Chain Reaction.

INTRODUCTION

COVID-19 is an infectious disease caused by the SARS-CoV-2virus.[1] It started as an epidemic of pneumonia in Dec 2019 from City of China, Wuhan.[2] Uptil Oct 2021, this pandemic has affected more than 242million people worldwide causing more than 4.9 million deaths. As stated by Health Advisory Platform for Corona virus which is initiated by (MNHP) "Ministry of National Health Pakistan" till October-2021, 1.27 million peoples have been diagnosed with COVID-19 with almost 28,000 deaths. RT-PCR test demonstrating SARS-CoV-2 RNA is the gold standard method for confirming the diagnosis of infection. Although the test is said to be highly specific, its sensitivity varies between 60-89%.[3,4]

In this study, we investigated the sensitivity & specificity of HRCT chest in detecting changes of COVID-19 in clinically suspected patients.[4] The common HRCT appearance of COVID-19 comprises several opacities of ground glass peripheral rounded form distributed predominantly in subpleural areas with bronchovascular bundles accompanied by crazy paving, interlobular septal thickening and consolidation. Recent studies have shown that HRCT chest had appearance of lung infection by virus, having a sensitivity of 60% to 98%. Remarkably, changes in computed tomography (CT) might be recognized before that patients come to be symptomatic in addition to RT-PCR positive.[5]

MATERIAL AND METHODS

It was a retrospective cross sectional descriptive study that was conducted in Radiology Department, CMH Lahore from July to December 2021.We included all adult (18 years or older) patients who presented with typical symptoms of Covid-19 and were tested for presence of SARS-CoV-2 by RT-PCR test. If the first PCR was negative, a second PCR was performed within 03 days in patients who were still admitted in the hospital. All these patients were enrolled in this study and their CT scans were done. Exclusion criteria were incomplete clinical or laboratory information, and images with excessive motion artifacts. Patients having pulmonary as well as extra pulmonary malignancy as per clinical recode, Patients with chest trauma and co-morbidities, pediatric age group patients and those who had previous chest surgery were excluded from the study.

The images were interpreted using the CT machine (Toshiba) multi slice (64 slices). Spiral ct scan was performed avoiding thoracic inlet areas to region of inferior levels, angles of costo-phrenic of supine position. CT scans were done in a deep when patients inhale and hold breathe without administration in contrast (120 kV & 450 mAs.) with slice thickness of 5mm and the total scan time was 4.0 seconds. Images were transmitted to PACS workstation (picture archiving and communication system) for MPR (multi planar reconstruction) of 1mm slices and post

dispensation. The CT images were assessed, using lung window setting (width, 1200 HU; level, − 700 HU) following a standardized protocol. CT chest severity score for coronavirus was assessed using scoring system developed by Yang and his colleagues[6] which is influenced by degree of opacification of lung (range of CT-SS from 0 to 40).[6]

CO-RADS scoring was done. For coronavirus positive chest findings of HRCT were categorized as multifocal, bilateral, opacities of multilobar ground glass with sub-segmental associations or without sub-segmental associations or pattern of crazy paving in a peripheral dissemination. HRCT negative findings of chest were categorized as pleural effusion, presence of lung nodule, occurrence of isolated lobar association and lack of COVID-19 positive findings. HRCT indeterminate cases were considered as if having unilateral opacities of ground glass, association with diffuse or central dissemination lacking subpleural configuration or multilobar opacities of ground glass. For COVID-19 these cases are further divided as negative or positive on taking clinical history and if available then results of RT-PCR. These definitions are according to the guidelines of "Radiological Society of North America" for reporting CT findings of chest about COVID-19.[6]

The collected data was entered into SPSS-V20 and data analysis was done. Multivariate analysis was performed and showed significant correlation between CTSS score and initially PCR negative patients. Chi-square and one way ANOVA was applied .Sensitivity, specificity, NPV & PPV were calculated. P value was kept at <0.05 with 95% confidence interval.

STUDY RESULTS

Total 1000 patients underwent RT- PCR test and subsequent HRCT chest. Out of which 770 were male patients (average of 52±15yrs) and 230 were female patients (49±15years). 235 (23.5%) patients had initial negative PCR report & 765 (76.5%) patients had initial PCR positive report. 235 patients under went repeat RT-PCR testing and their tests came positive on subsequent testing.

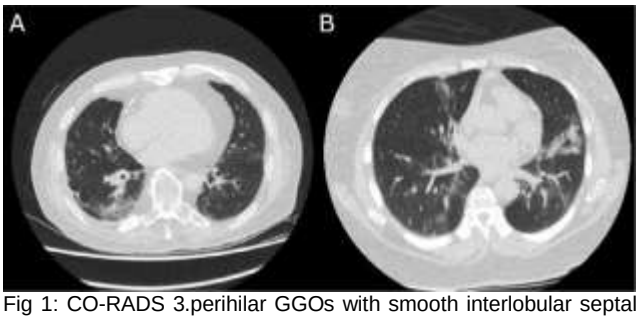

Fig 1: CO-RADS 3.perihilar GGOs with smooth interlobular septal thickening.

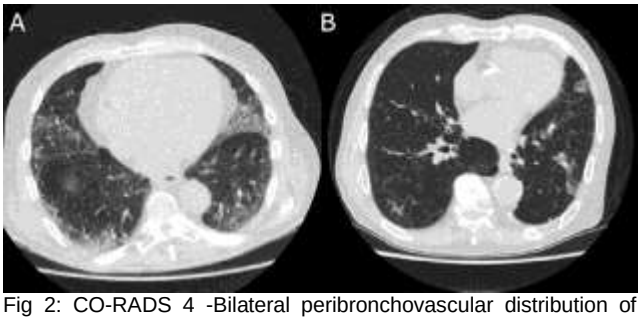

Fig 2: CO-RADS 4 -Bilateral peribronchovascular distribution of GGOs

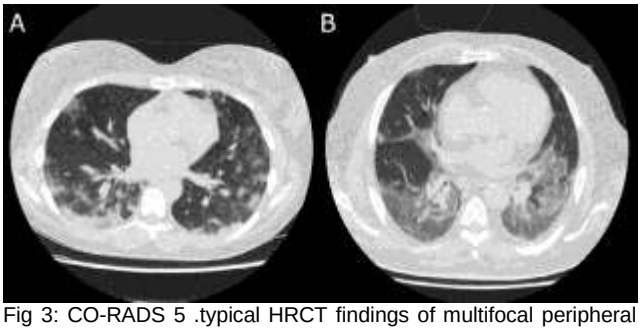

Fig 3: CO-RADS 5 .typical HRCT findings of multifocal peripheral subpleural GGOs & subpleural reticulations

Table 1: Frequency Distribution & Stratification of Data

Subgroups		N=1000	CTSS Score <19.5 (n=754)	CTSS Score >19.5 (n=246)	p-value
Age (years)	>40	420	318 (42.1%)	102(41.4%)	<0.18
	<40	580	436 (57.8%)	144 (58.5%)	
Gender	Male	770	650(86.2%)	209(85%)	<0.001
	Female	230	104(13.7%)	37(15%)	
Peripheral GGO's	Absent	116	85 (11.2%)	31(12.6%)	<0.001
	Present	883	668(88.5%)	215(87.3%)	
Cconsolidation	Absent	679	430(57%)	141(57.3%)	<0.05
	Present	321	324 (43%)	105(42.6%)	
Crazy Paving	Absent	647	584(77.4%)	63(25.6%)	<0.001
	Present	353	170(23%)	183(74.3%)	
CO-RADS-3	Absent	948	733(97.2%)	215(87.3%)	<0.05
	Present	52	21(2.8%)	31(12.6%)	
CO-RADS-4	Absent	314	169(22.4%)	145(58.9%)	<0.001
	Present	686	585(77.5%)	101(41.0%)	
CO-RADS-5	Absent	738	606(80.3%)	132(53.6%)	<0.001
	Present	262	148(19.6%)	114(46.3%)	
Unilateral Disease	Absent	583	435(57.6%)	148(60.1%)	<0.001
	Present	417	319(42.3%)	98(39.8%)	
Bilateral Disease	Absent	417	319(42.3%)	98(39.8%)	<0.001
	Present	583	435(57.6%)	148(60.1%)	

Table 2: Statically Analysis

	PCR +ve	PCR -ve	Marginal row total
CTSS >19.5	220	25	245
CTSS <19.5	545	210	755
Marginal column total	765	235	1000

The Chi-sq statistics is 31.91. p- value is <0.001 .significant at p<0.05

Table 3: Diagnostic values of different parameters

Index	value	CI (95%)
sensitivity	89.3%	84.70-93%
specificity	28.7%	25.5-32%
PPV	89.8%	85.6-92.8%
NPV	27.8%	26.5-29.1%
Accuracy	43%	39.9-46.1%

Mild to moderate disease was defined at CTSS score of <19.5 and severe disease was defined at CTSS score of >19.5 (CT-SS from 0 to 40). 6)

CTSS score of 765 PCR positive patients was determined as 545 (71.2%) having mild to moderate disease (<19.5 CTSS) and 220 (28.7%) as having severe disease (>19.5 CTSS).

CTSS score of 235 initial PCR negative patients was determined on HRCT chest and classified as 210 (89.3%) having mild to moderate disease (<19.5 CTSS) and 25 (10.6%) as having severe disease (>19.5 CTSS).

Sensitivity and specificity of CT chest in determining covid-19 findings was 89.3% and 28.7%.PPV was 89.8% and NPV was 27.8%. C0-RADS scoring were done and HRCT pattern of peripheral GGO's, sub-segmental consolidations & crazy paving was determined and analyzed. Significant percentage of patients (88.5% in mild to moderate disease and 87.3% in severe disease) had peripheral GGO's. Sub-segmental consolidation was found in around 43% of both mild to moderate & severe disease. Crazy paving was found more in severe disease 74.3% (CTSS>19.5)as compared to mild to moderate disease 23% (CTSS<19.5). CO-RADS 4 (fig 2.) was seen more(77%) in mild moderate disease and CO-RADS- 5 (fig 3) was seen more in severe disease (46.3%) as compared to mild to moderate disease. Bilateral disease was seen more than unilateral disease in both mild to moderate and severe cases (57.6% & 60% respectively).CTSS score was not found to be dependent on any specific age group however 60% of the patients were found to be in the age group of 40-50yrs.

DISCUSSION

Globally for screening of COVID-19 currently RT-PCR test is very efficient and convenient. For screening of COVID-19 indicated sensitivity of RT-PCR is 50% to 62% which is suitable but still there are some cases which has missed diagnosis.[8] Ct of chest show an main role in timely detection then evaluation and monitoring response of treatment of coronavirus infection. However, chest CT manifestation of COVID-19 pneumonia overlaps with other types of viral pneumonia, bringing potential impact on its specificity.[8]

In screening of COVID-19 observed sensitivity of Ct is much high to be 98%.[9] A study which is conducted on large sample of Wuhan observed the sensitivity of chest Ct to be 97% patients displaying typical manifestations of Ct before positive result of RT-PCR test.[10] We observed the sensitivity of chest Ct to be 89.3% in our study which is very related to results of study by Guan et al.[14]

(86.2%, 840/975 CT scans). However it was less than 97% which was reported by Ai et al.[10] Specificity in our study was 28.7% which was lower than 53% reported by Wen Z et al.[17]. Song et al.[11] reported GGOs in 77% and consolidation in 23% of patients younger than 50 yrs. Our study was close to this with reported GGOs in 75% and consolidation 35.6% of patients younger than 40 yrs. Our study matches the Huang et al.[12] and Xie et al.[13] study who reported cases with initially negative RT-PCR results having typical CT findings of covid pneumonia with results becoming positive on subsequent PCR testing. The findings of our study are related to the systematic review conducted by Salehi et al.[15]

Many other studies have similar results showing larger percentage of peripheral GGOs than consolidation or crazy paving pattern.[14,17,18,19] However some difference was seen from Caruso D et al.[16] which revealed a higher frequency of both pulmonary associations (72% vs. 35%) and GGOs together (100% vs 87.5%), respectively. The proportion of mild to moderate disease pattern was high in our study as shown by Fang Y et al.[20]. In this context, Bai et al.[7] and his colleagues have concluded that these particular findings were found to be more prevalent in viral pneumonia other than COVID-19. We had 23.5% of the cases with initial RT-PCR negative report and positive covid CT findings .This is a significant percentage however it is quite less as compared to the study conducted by Nadia et al.[22] in Pakistan that showed a much higher percentage of patients (59.6%) with negative 1st RT-PCR results.

Our study had limitations. Identifying a small number of patients in a single academic institution, potentially limits the generalization of results with other populations. Secondly cases with co-morbidities were not included. Thirdly CT cases with severe motion artifacts could not be included in the study, despite having RT-PCR positive results.

CONCLUSION

HRCT chest shows a high sensitivity for sensing coronavirus (89.3%) disease in initially negative RT-PCR patients. However it cannot be used for screening of coronavirus patients due to low specificity (28.7%) & NPV (27.8%). Pakistan has lower testing capabilities and resource constrained environment than the developed world. Improvement in availability of RT-PCR testing kits, timely testing & patient isolation is required in preventing the spread of infection and also aid in prompt symptomatic management.

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