SCREENING HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) CHEST AMONG PATIENTS UNDERGOING CARDIAC INTERVENTIONS DURING COVID-19 PANDEMIC; RADIOLOGICAL FINDINGS AND CLINICAL ASSOCIATIONS

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ABSTRACT

Objective: To study the HRCT chest findings in patients undergoing cardiac interventions during COVID-19 era.
Study Design: Cross sectional analytical study.
Place and Duration of Study: Armed Forces Institute of Cardiology & National Institute of Heart Disease (AFIC/NIHD) Rawalpindi, from Apr 2020 to May 2020.
Methodology: All the admitted cardiac patients who were to undergo any invasive cardiac intervention underwent plain HRCT chest and polymerase chain Reaction (PCR) for SARS-CoV-2 simultaneously. One hundred and ten patients were studied. We analyzed preexisting respiratory illnesses, clinical, echocardiographic and radiological features. Data recording, storage, assessment and analysis was done by using SPSS-21.
Results: Our study included 110 patients (87 Male, 23 Female, median age 52 Years). Common reasons for admission were coronary angiography 43 (39.1%), acute Left Ventricular Failure (LVF) 30 (27.3%), Percutaneous Coronary Intervention (PCI) 13 (11.8%) and chest pain evaluation 10 (9.1%). Cardiomegaly (29.1%) followed by consolidation (9.1%) were commonest radiological finding. Two third patients had abnormal HRCT chest but only few had radiological findings either suspicious (6.4%) or indeterminate (11.8%) for COVID-19. Respiratoy symptoms, positive PCR for COVID-19 and severe Left ventricular dysfunctions were correlated with abnormal HRCT findings, correlation being statistically significant (p-value <0.05).
Conclusion: HRCT chest is a non-invasive and highly sensitive imaging modality, which can rapidly help in identifying, and isolating suspected cases of novel corona virus as well as in diagnosing unknown pre-existing lung diseases in cardiac patients.

Keywords: Computed tomography chest, Cardiac, COVID-19.

INTRODUCTION

There was a break out of pneumonia caused by the novel corona virus (SARS-CoV-2) in Wuhan, Hubei, China during December 2019[1]. Cases of COVID-19 (as this disease has been called), have been gradually increasing since then around the globe. On December 30, 2019, World Health Organization (WHO) declared COVID-19 a Public Health Emergency of International Concern (PHEIC)[2]. As of 06 June 2020,6,644,011 confirmed cases of COVID-19, including 391,839 deaths have been reported to WHO. Pakistan reported its first COVID-19 case in February 2020 and till to date more than 98 thousand cases and almost two thousand deaths have been reported[3].

SARS-CoV-2 is a beta coronavirus that belongs to the family Coronaviridae[4]. This family includes viruses that cause infections ranging from the common cold to severe acute respiratory syndrome (SARS) and the Middle East respiratory syndrome (MERS). It is transmitted from human to human mainly via respiratory droplets and contacts[5]. The incubation period is generally 3-7 days. Fever, fatigue, and dry cough are usually the main presenting symptoms. In severe cases, Acute Respiratory Distress Syndrome (ARDS), septic shock, difficult to correct metabolic acidosis and coagulation dysfunction develop rapidly[6]. The current standard diagnostic test for COVID-19 infection is nasopharyngeal and oropharyngeal swab Reverse-Transcription Polyme-

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rase Chain Reaction (RT-PCR)[7]. RT-PCR has a sensitivity of almost 70%[8], but specificity is much higher. According to current evidence, lung-imaging findings particularly on High Resolution Computed Tomography (HRCT) chest may manifest earlier than clinical symptoms, so imaging examination is vital in preclinical screening. Typical HRCT findings include bilateral pulmonary parenchymal ground-glass opacities (GGO's) and consolidative pulmonary opacities, sometimes with a rounded morphology and a peripheral lung distribution[9]. Notably, lung cavitation, discrete pulmonary nodules, pleural effusions, and lymphadenopathy were absent[10]. Combining HRCT chest with laboratory tests leads to improved sensitivity, earlier diagnosis and disease severity assessment. The rationale of this study was to determine HRCT chest findings in patients undergoing cardiac interventions and its utility as a tool to actively identifying and isolating patients at high risk of infection with COVID-19.

METHODOLOGY

Thisdescriptive cross sectional study was carried out at Armed Forces Institute of Cardiology & National Institute of Heart disease (AFIC/NIHD) Rawalpindi, from April 2020 to May 2020 after approval from hospital ethics committee (Letter no 15/06/R & D/2020/51). Keeping anticipated frequency of 8% and absolute precision of 5%, Open Epi calculator was used and sample size came out to be 114 which was rounded off to 110[11]. Allthe cardiac patients who were to undergo any invasive cardiac intervention (coronary angiography, percutaneous coronary intervention, coronary artery bypass grafting etc.) or were admitted in the cardiac care unit for medical stabilization were considered for the study. A non-probability consecutive sampling technique was used. Patients who were resuscitated from cardiac arrest, mechanically ventilated patients and already confirmed COVID-19 patients were excluded from the study. All the patients underwent plain HRCT chest and RT-PCR for SARS-CoV-2 simultaneously irrespective of the presence or otherwise of respiratory symptoms suggesting COVID-19 infection. Consultant radiologist reported all HRCT chest. Radiological findings were divided into three categories in context of COVID-19; classical/probable-COVID 19 (bilateral peripheral GGO's with or without consolidation or crazy paving), Indeterminate (non-peripheral GGO's with or without consolidation), and non-COVID-19 (Isolated lobar or segmental consolidation without GGO's, lung cavitation/lymphadenopathy or pleural effusions). Clinical data regarding pre-existing respiratory illness, symptoms, cardiac enzymes and transthoracic 2-D Echocardiography was also collected. Data recording, storage, assessment and analysis was done by using SPSS software version 21. Pearson's chi-square test was used for statistical analysis. The significance was set at *p*-value ≤0.05.

RESULTS

This study included 110 patients, 87 (79.1%) Male, 23 (20.9%) Female, mean age 47.25 (SD ± 15.546) with age range 19-79 years. Table-I summarizes patients clinical and laboratory characteristics. Majority 103 (93.6%) of the patients did not have known pre-existing respiratory illness. One fourth 30 (27.3%) of the total patients had respiratory symptoms (fever, cough or dyspnea). Coronary angiography was the commonest cardiac intervention required in our study population 43 (39.1%), followed by admission for the management of exacerbation of acute left ventricular failure 30 (27.3%). Cardiomegaly was commonest abnormal finding.

Baseline HRCT chest was abnormal in almost two third of the patients, but only few had radiological findings either suspicious (6.4%) or indeterminate (11.8%) for COVID-19 and >80% had negative HRCT chest for this disease. Commonest radiological abnormality was cardiomegaly/cardiogenic edema and this finding seems consistent with the study population, which consisted of patients with pre-existing cardiac illnesses. Consolidation and GGO's (Ground Glass Opacities) were other common radiological features. Peripheral and basal predominant

GGO's were the commonest radiological feature in patients with positive RT-PCR for novel coronavirus.

Presence of respiratory symptoms, positive PCR for corona virus, severe left ventricular dysfunction and raised cardiac enzymes were positively correlated with the presence of abnormal HRCT chest and this correlation was statistically significant (*p*-value<0.05). No correlation was found between pre-existing lung disease and abnormal HRCT chest, as most of our patients with abnormal radiological findings actually did not have known lung conditions. All the patients with positive PCR had abnormal HRCT chest (*p*-value <0.01) and commonest radiological finding was peripheral and basal predominant GGO's (83.33%) followed by cardiogenic edema (8.34%) and pleural effusion (8.34%). On the contrary majority of the cardiac patients with abnormal HRCT chest had either cardiomegaly with cardiogenic edema (24.5%) or consolidation (9.1%) and had negative RT-PCR results. It can be inferred that abnormal HRCT chest was a strong predictor for suspecting COVID-19 infection but presence of typical radiological features correlated well with the laboratory diagnosis of the disease.

Table-I: Clinical and laboratory characteristics (n=110).

Demographics	**n (%)**
Median age (Range)	52 Yrs (19-79)
Men	87 (79.1%)
Women	23 (20.9%)
Known Pre-existing Respiratory Illness	
None	103 (93.6%)
COPD (Chronic Obstructive Pulmonary Disease)	3 (2.7%)
Asthma	2 (1.8%)
Interstitial Lung Disease (ILD)	2 (1.8%)
Procedure /Reason of Admission	
Chest Pain Evaluation	10 (9.1%)
Coronary Angiography	43 (39.1%)
Percutaneous Coronary Intervention (PCI)	13 (11.8%)
Coronary Artery Bypass Grafting	5 (4.5%)
Acute Left Ventricular Failure	30 (27.3%)
Misc. Causes	9 (8.2%)
Presence of Typical COVID-19 Symptoms	
No	80 (72.7%)
Present	30 (27.3%)
RT-PCR for SARS-CoV-2 Virus	
Negative	98 (89.1%)
Positive	12 (10.9%)
Left Ventricular Ejection Fraction (EF)	
<30 %	19 (17.3%)
>30% to <55%	26 (23.6%)
>55%	65 (59.1%)
Cardiac Enzymes (Troponin I)	
Normal	70 (63.6%)
Raised	40 (36.4%)

Table-II: High Resolution computed tomography (HRCT) chest findings of all the patients (n=110).

HRCT (High Resolution Computed Tomography)	**n (%)**
Normal	35 (31.8%)
Abnormal	75 (68.2%)
Radiological features of COVID-19	
Non-COVID-19	90 (81.8%)
Indeterminate	13 (11.8%)
Classical/Probable	7 (6.4%)
HRCT (High Resolution Computed Tomography) Findings	
Normal	35 (31.8%)
Cardiomegaly & Cardiogenic Edema	27 (24.5%)
Consolidation	10 (9.1%)
Ground Glass Opacities (GGO's)	14 (12.7%)
Bronchiectasis	6 (5.5%)
Chronic Obstructive Pulmonary Disease (COPD)	5 (4.5%)
Apical pleural thickening	4 (3.6%)
Atelectasis	4 (3.6%)
Pleural effusion	3 (2.7%)
Interstitial Lung Disease (ILD)	2 (1.8%)

DISCUSSION

There can be considerable overlap in symptoms of patients presenting with either cardiac or respiratory illness. With the advent of novel coronavirus, physicians in general and cardiologists in particular face augmented difficulty of suspecting and diagnosing COVID-19 in cardiac patients. Although fever (87.3%) and cough (58.1%) are the commonest manifestations of COVID-19, but a lot of patients present with

dyspnea (38.3%) and chest tightness (31.2%) according to a meta-analysis[12]. Dyspnea and chest tightness are common respiratory as well as cardiacsymptoms[13]. A timely and definitive diagnosis is mandatory for prompt initiation of the treatment as well as isolation to reduce unnecessary exposure of healthcare workers to COVID-19 patients[14]. Lung imaging findings particularly on HRCT chestmay manifest earlier than clinical symptoms and this modality is of outstanding importance in screening, diagnosing, and evaluating disease severity especially in epidemic area[15]. A study done by Tao *et al*. In China showed that HRCT chest was 97% sensitive in diagnosing COVID-19 using RT-PCR as a gold standard. In patients with negative RT-PCR results, 75% had positive chest HRCT findings. Based on serial RT-PCR test and CT scans, 90% of patients with initial positive chest CT were diagnosed with COVID-19 on either first PCR or subsequent further RT-PCR testing. In our study, 100% of the patients who were confirmed by RT-PCR had abnormal HRCT chest but 42.34% were found to have typical GGO'sand 50% did not have typical radiological features. This difference is possibly due to the study population as all our patients were suffering from cardiac illnesses and cardiogenic edema was a major HRCT finding 32 (29.1%). It can also be postulated that concomitant infection with coronavirus can occur in patients with cardiogenic edema as they are immunocompromised. Anormal HRCT chest was readily done from the ED (Emergency department) and was available much before the laboratory tests resulting in isolation and administering the appropriate treatment to the suspected cases. Although a sensitive HRCT chest may pick some "false positive" cases due to other conditions (particularly cardiogenic edema in our study group as 32 (29.1%) patients had this

Table –III: Correlation of Abnormal HRCT (High Resolution Computed Tomography) Chest with Positive RT-PCR for SARS-CoV-2.

HRCT (High Resolution Computed Tomography) Finding		PCR for SARS-Cov2		Total	*p*-value
		Negative	Positive		
	Normal	35 (31.8%)	-	35 (31.8%)	
	Abnormal	63 (57.3%)	12 (10.9%)	75 (68.2%)	0.01
Total		98 (89.1%)	12 (10.9%)	110	

Table-IV: Radiological features of COVID-19 patients in our study group.

Radiological Feature	Number of Patients
Peripheral & basal predominance Ground Glass Opacities (GGO's)	10 (83.33%)
Cardiomegaly and Cardiogenic edema	1 (8.34%)
Pleural Effusion	1 (8.34%)

Table-V: Breakdown of radiological findings with reverse transcriptase-polymerase chain reaction (RT-PCR) result.

Radiological Findings	Polymerase Chain Reaction (PCR) for SARS-Cov2		*p*-value
	Negative	Positive	
Normal	35	0	<0.05
Cardiomegaly and Cardiogenic Edema	26	1	
Consolidation	10	0	
Bronchiectasis	6	0	
Chronic Obstructive Pulmonary Disease (COPD)	5	0	
Ground Glass Opacities (GGO's)	4	10	
Apical pleural thickening	4	0	
Atelectasis	4	0	
Pleural Effusion	2	1	
Interstitial Lung Disease (ILD)	2	0	

finding on HRCT), but cases with typical COVID-19 radiological features may actually be 'true positive" as a number of many factors may affect RT-PCR testing results including sampling technique, specimens source (upper or lower respiratory tract), sampling timing (different period of the disease development)and performance of detection kits[16].

Another study by Yicheng *et al*. showed the sensitivity of chest CT was greater than that of RT-PCR (98% vs 71%, respectively, $p<0.001$) and almost 30% of patients in their study group had abnormal initial HRCT with negative RT-PCR eventually became PCR positive[17].

This study has also shown the added advantage of screening HRCT chest during COVID-19 pandemic has helped in diagnosing unknown pre-existing respiratory illnesses. Bronchiectasis 6 (5.5%), COPD 5 (4.5%), atelectasis 4 (3.6%) and ILD 2 (1.8%) were some of the conditions diagnosed on HRCT that mandate appropriate management. Surveys in some countries have shown that respiratory illness such as COPD are under diagnosed as much as 81% in various countries[18]. The prevalence of undiagnosed lung condition may more in known cardiac patients due to overlap in symptomatology and HRCT chest may aid in definite diagnosis.

LIMITATION OF STUDY

Our study has some limitations. We did not review chest radiographs as this modality may have some utility, with the potential to serve as a screening tool on the front lines in medical settings with high disease prevalence but limited resources and unavailability of HRCT chest. As our study population included only cardiac patient so cardiogenic edema was a major radiological finding which neither represented typical COVID-19 feature nor pre-existing lung condition.

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CONCLUSION

Early diagnosis of COVID-19 is crucial for disease treatment and control particularly during a pandemic. Compared to RT-PCR, chest HRCT imaging may be a more reliable, practical, and rapid method to suspect and diagnose this disease. It also helps in rapidly isolating patients with abnormal radiological findings till the PCR results are available, keeping a low index of suspicion for the disease in patients with abnormal HRCT chest and initial negative PCR, determining cardiac cause of respiratory symptoms (e.g. Cardiomegaly and cardiogenic edema) and finally diagnosing unknown pre-existing respiratory illnesses in cardiac patients with overlapping symptomatology.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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