International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 10; Issue 02 (A); February 2021; Page No.23759-23768
DOI: http://dx.doi.org/10.24327/ijcar.2021.23768.4710

Research Article

DIAGNOSTIC EFFICACY OF CHEST XRAY AND HRCT IN DETECTION OF COVID-19 PNEUMONIA: A STUDY IN TERTIARY CARE COVID HOSPITAL, KOLKATA

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A R T I C L E I N F O

Article History:
Received 6th November, 2020
Received in revised form 15th December, 2020
Accepted 12th January, 2021
Published online 28th February, 2021

Key words:

COVID-19, CXR, HRCT THORAX, TOTAL SEVERITY SCORE, CORONA VIRUS, RT-PCR, SARS-CoV-2, CO-RADS, CT SEVERITY INDEX.

A B S T R A C T

Introduction: World is battling through a global pandemic of unprecedented extent which has posed perhaps the most serious threat to the mankind in modern times. The epicenter of the global catastrophe was Wuhan, China from where the new virus by the name of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) has spread over 188 countries and caused a death toll of over 2.16 million till now. Chest Radiography has very limited role in diagnosis of early and mild course of disease. However it showed significant efficacy in diagnosing intermediate to advanced stages of the disease as well as during follow-up. CT on the other hand has shown promising sensitivity values and has been the mainstay of imaging diagnosis of Covid-19 cases, even in RT-PCR negative patients.

Purpose: The purpose of our study is to correlate chest x-ray and HRCT Thorax findings with RT-PCR, describe various chest x-ray & CT findings and monitor patient's disease progression over time.

Materials and Methods: The study was done in the department of Radio diagnosis, Medical College Kolkata, a dedicated tertiary level Covid-19 hospital. We selected 50 patients from 10th April to 10th August, 2020 who had symptoms of COVID-19 (fever, cough, sore throat, dyspnoea). All patients performed RT-PCR nasopharyngeal and throat swab, CXR on admission and during follow-up and HRCT Thorax. RT-PCR results were considered the reference standard. A CXR severity scoring index and CT Severity score were determined for each lung. A total severity score was calculated by summing both lung scores.

Results: The study was composed of 50 clinically suspected patients, all of whom tested positive for COVID-19 by RT-PCR. 26 of 140 RT-PCR positive patients at initial scan and 6 patients in follow-up scan showed chest X-ray abnormalities. Most common findings of chest X-ray were consolidation (65.6%) followed by ground glass opacity (34.4%), reticulation and interstitial thickening (31.3%). Pleural effusion was found in 4 patients (12.5%). Most cases showed peripheral predominance (62.5%) with Bilateral lung involvement (74%) and lower zonal (78.1%) distribution. Total severity scores ranged from 0 to 8 and calculated at baseline, first week and second week of follow-up scan. Peak severity was reached at 12-14 days of disease onset. The typical findings on CT as studied were ground-glass opacities (96%) being the most common finding almost in every patient, followed by bronchovascular thickening (76%), air space consolidation (64%) and crazy paving appearance (50%). Patients with pre-existing comorbidities were found to be more prone to develop severe form of the disease with 5 out of 12 patients with diabetes and 3 out of 9 patients with hypertension having severe CT severity scores. By using RT-PCR results as standard, overall sensitivity of chest radiography and CT Thorax were 68% and 100% respectively in the diagnosis of COVID-19.

Conclusions: Chest radiography can be used as initial diagnostic tool for triaging of COVID-19 in symptomatic patients and useful for monitoring chest manifestations and extent of lung involvement and disease progression over time. CT has substantially improved diagnostic performance over CXR in COVID-19. CT should be strongly considered in the initial assessment for suspected COVID-19. This gives potential for increased sensitivity and considerably faster turnaround time, where capacity allows and balanced against excess radiation exposure risk.

INTRODUCTION

SARS-CoV-2 and its resulting disease, COVID-19, have propagated exponentially worldwide, with over 96 million cases in 188 countries at the time of writing. [1,2] The first case was seen in Wuhan, China, in December 2019. Thereafter a sudden global spreading noted with more than 2.1 million deaths. The outbreak was officially recognized as a pandemic by the World Health Organization (WHO) on 11 March 2020. [3,4] India reported first case of COVID-19 on 30th January in Kerala [5].

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This is the 7th known corona virus to infect man Coronaviruses are a family of enveloped, single-stranded, positive-strand RNA viruses classified within the Nidovirales order. This coronavirus family consists of pathogens of many animal species and of humans, including the recently isolated severe acute respiratory syndrome coronavirus (SARS-CoV) [6]. They are known to cause diseases including the common cold, Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) in humans [7].

The gold standard for diagnosis of the virus is the detection of viral RNA through reverse transcriptase PCR (RT-PCR) of respiratory tract samples. However, this method has several limitations including 1) low sensitivity at 59%–71%; [8,9] 2)

relatively slow turnaround times ranging from a few hours to several days; [10] 3) high expense; and 4) limited capacity for testing in many countries.

Plain film chest X-ray (CXR) is ubiquitous worldwide, with a 30–70 times lower dose of radiation [11] and is commonly performed as an initial investigation in COVID-19. Chest Radiography has very limited role in diagnosis of early and mild course of disease but it showed significant role in intermediate to advanced course of disease as well as during follow-up.

CT has been shown to be more sensitive than RT-PCR for diagnosis of COVID-19, [8,9] while being significantly faster and cheaper. This comes with a large radiation dose and capacity is still lacking in many countries. Chest CT has a potential role in the diagnosis, detection of complications, and predict disease severity. The hallmarks of COVID-19 infection on imaging were bilateral and peripheral ground-glass and consolidative pulmonary opacities, linear opacities, "crazy-paving" pattern and the "reverse halo" sign. [12]

However, due to infection control issues related to patient transport to CT suites, the inefficiencies introduced in CT room decontamination, and lack of CT availability in parts of the world, portable chest radiography (CXR) will likely be the most commonly utilized modality for identification and follow up of lung abnormalities. In fact, the American College of Radiology (ACR) notes that CT decontamination required after scanning COVID-19 patients may disrupt radiological service availability and suggests that portable chest radiography may be considered to minimize the risk of cross-infection (American College of Radiology). [13]

In the context of the global pandemic, infection may be widespread in the community, often with subclinical infection. [14,15] Imaging is a reliable and rapid method to detect infection in the general population, who may present to medical personnel with other complaints.

This study evaluated the performance of Chest XRay and HRCT Chest in diagnosing and evaluating COVID-19 in a tertiary care hospital with an aim to correlate the findings with RT-PCR.

MATERIALS AND METHODS

Study Design*:* Retrospective observational study.
Sample selection*:* We selected 50 patients from Medical College, Kolkata during a time period from 10th April to 10th August, 2020 who had symptoms of COVID-19 (fever, cough, sore throat, dyspnea).

Inclusion Criteria

1. Patients of age group between 14 yrs and 85 yrs.
2. Clinically suspected COVID-19 patients admitted in isolation ward – with symptoms of the disease like fever, shortness of breath, dry cough, anosmia or loss of taste sensations.
3. Symptomatic patients who are RTPCR/RAT positive.
4. Patients who gave consent to take part in the study

Exclusion Criteria

1. Asymptomatic patients
2. Unstable patients
3. Pregnant patients
4. Patients in whom CT was a contraindication.

Ethical consideration: The study was conducted after getting approval from Institutional Ethics Committee and other authority. Informed consent was taken from all participants.

Procedure*:* The study was conducted in Medical college, Kolkata on Covid-19 patients admitted at isolation ward of Medical college, Kolkata which has been assigned as dedicated tertiary level COVID-19 hospital by Govt. of West Bengal. Covid-19 infection was confirmed by RT-PCR testing after taking both nasopharyngeal and throat swabs.

All patients underwent chest radiography by our FUJI computed radiography machine on admission and follow-up chest radiography done by portable Xray units. PA projection was done initially at the time of admission and AP projection was done during follow-up.

Patients underwent HRCT scans in EKO diagnostic centre at Medical college, Kolkata. All the patients were positive for the disease. Patient preparation was done followed by positioning and breath holding whenever necessary. EKO GE 16 slice CT machine was used and scanning parameters were chosen as follows: 120 kV, 100-250 mAs collimation of 1 mm pitch of 1-1.5 matrix size- 512 x 512. No contrast was administered. CT scans of NON-COVID patients were done from 9 am to 3 pm. Afterwards from 3pm till 9 pm there was provision for CT SCAN of COVID positive patients. Daily sanitisation of CT scan room was done with hypochlorite solution followed by fumigation.

The following informations were collected from each patient. Age, sex, H/O diabetes, hypertension, heart disease, smoking, COPD, Chronic kidney disease. Clinical features and examination findings were noted. Age of the patients were ranged from 14years to 85 years and categorized into 5 groups:<15 years, 15-29 years, 30-44 years, 45-59 years and >60 years.

Imaging Analysis

Chest Radiographs: All chest radiographs were reviewed by experienced radiologist. Radiographic features including consolidation, ground-glass opacities, reticulation and interstitial thickening, pulmonary nodules as well as pleural effusion were diagnosed according to the Fleischner Society glossary of terms [16]**.** Distribution of lung changes are classified into peripheral predominance, perihilar predominance or neither: Upper zonal distribution, lower zonal distribution or no zonal predominance: Unilateral (right or left) involvement or B/L involvement, presence or absence of effusion, collapse, pneumothorax. After analysis of images a radiographic scoring was proposed.

Radiographic Scoring: To assess the extent of infection a severity score was proposed by Warren *et al* [17]. Each lung was given a score of 0–4 depending on the extent of lung involvement (score 0 = no involvement; 1 ≤ 25%; 2 = 25–50%; 3 = 50–75%; 4 ≥ 75% lung affection). A total severity score was calculated by summing both lung scores (total severity scores ranged from 0 to 8).

Table 1 Radiographic Scoring based on Lung Involvement

Scoring of each Lung	Extent of lung involvement
0	No involvement
1	<=25%
2	25-50%
3	50-75%
4	>=75%

HRCT Thorax: Imaging findings were looked for presence of typical CT features like -

- Ground-glass opacities (GGO): bilateral, sub pleural, peripheral.
- Crazy paving appearance (GGOs and inter-/intra-lobular septal thickening).
- Air space consolidation.
- Bronchovascular thickening.
- Traction bronchiectasisetc.
- Subpleural bands.

CO-RADS: Cases are increasingly reported in which the RT-PCR assay yielded a positive result only after multiple negative results in patients with typical clinical and imaging signs of COVID-19. Also, RT-PCR takes hours, or even days, before the results are available. Hence we can use imaging as an initial assessment mode to categorise patients according to lung involvement as CO-RADS [Coronavirus disease 2019 (COVID-19) Reporting and Data System] provides a level of suspicion for pulmonary involvement of COVID-19 based on the features seen at unenhanced chest CT. The level of suspicion increases from very low (CO-RADS category 1) to very high (CO-RADS category 5).Two additional categories encode a technically insufficient examination (CO-RADS category 0) and RT-PCR–proven severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection at the time of examination (CO-RADS category 6). [(18)]

In our study all patients came under CORADS-6 as we have taken all the proven positive cases for our study.

Table 2 Overview of CO-RADS Categories and the corresponding level of suspicion of pulmonary involvement in Covid-19

CO-RADS Category	Level of Suspicion for Pulmonary Involvement of COVID-19	Summary
0	Not interpretable	Scan technically insufficient for assigning a score
1	Very low	Normal or noninfectious
2	Low	Typical for other infection but not COVID-19
3	Equivocal/unsure	Features compatible with COVID-19 but also other diseases
4	High	Suspicious for COVID-19
5	Very high	Typical for COVID-19
6	Proven	RT-PCR positive for SARS-CoV-2

Note.—CO-RADS = COVID-19 Reporting and Data System, COVID-19 = coronavirus disease 2019, RT-PCR = reverse transcription-polymerase chain reaction, SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.

CT Severity Scoring: For assessing the disease severity CT SEVERITY SCORING was used. In all cases, a semi-quantitative CT severity scoring proposed by Pan F *et al* [(19)] was calculated per each of the 5 lobes considering the extent of anatomic involvement, as follows:

1. no involvement.
2. < 5% involvement.
3. 5–25% involvement.
4. 26–50% involvement.
5. 51–75% involvement.
6. > 75% involvement.

The resulting global CT score was the sum of each individual lobar score (0 to 25). Then to grade the imaging analysis results according to score were obtained.

Table 3 CT Severity Scoring

GRADE	SCORE
MILD	<8
MODERATE	9-15
SEVERE	>15

RESULTS

- A total 50 COVID-19 positive patients were selected for our study. Each patient underwent RT-PCR testing and baseline chest radiography at the time of admission. There were 32 males (64%) and 18 females (36%). Age group examined was from 14 years to 85 years with median age 41 years.
- Most common comorbidity was diabetes (12, 24%) followed by hypertension (9, 18%) and coronary heart disease (3, 6%).
- Most of the patients were symptomatic at the time of admission. Common symptoms were fever (45, 90%), dyspnea (32, 64%), cough (27, 54%). Only 4% (2) patients were asymptomatic.

Table 4 Demographic Characteristics of Patients

Study Variable	No. of Patients
Gender	
Male	32
Female	18
Mean Age	46.8
Symptoms	
Fever	45
Dyspnoea	32
Cough	27
Asymptomatic	2
Comorbidities	
Diabetes	12
Hypertension	9
Coronary Heart Disease	3

Chart 1: Age distribution of patients

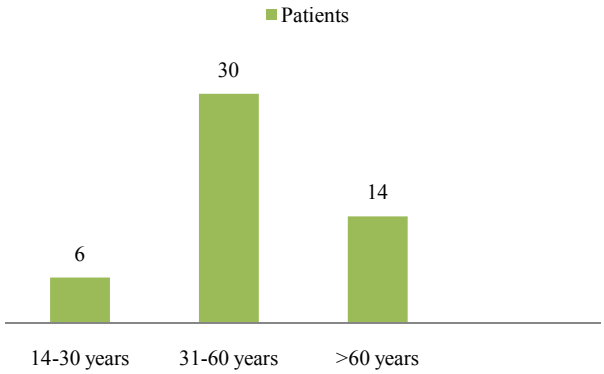
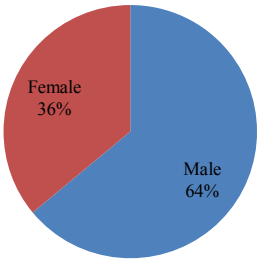


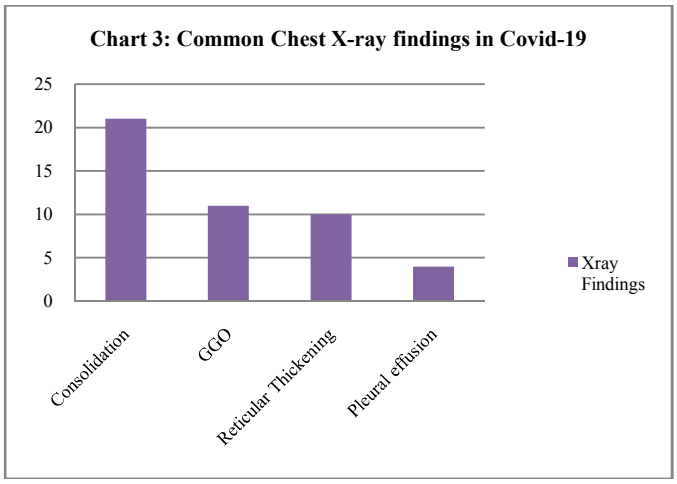
Chart 2: Sex distribution of patients



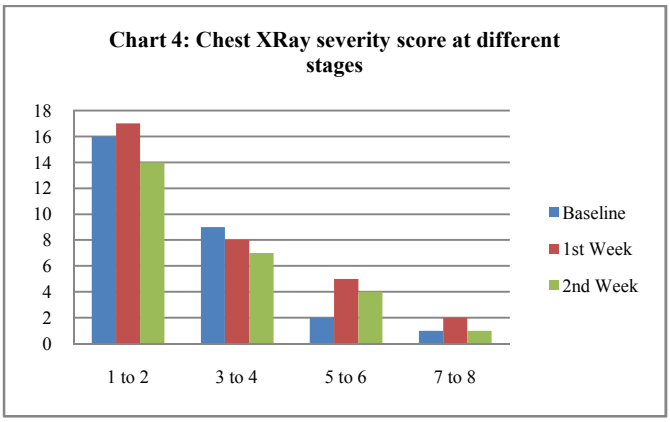
- Baseline chest Xray was performed in all patients at the time of admission. 28 patients (56%) had lung involvement on baseline scan and 22 patients (44%) had normal CXR. During follow-up scan 6 of 22 normal baseline chest X-ray showed abnormality. So,

chest Xray abnormalities were found in 34 of 50 patients at certain time of disease progression.

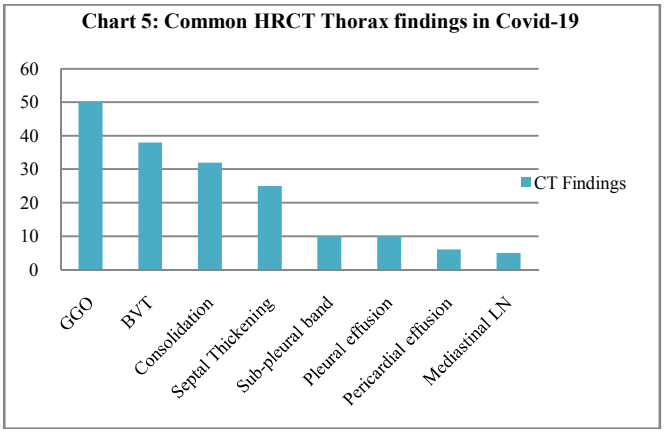
- Typical findings on Chest Xray were consolidation seen in 21 patients (65.6%) followed by ground glass opacity seen in 11 patients (34.4%), and reticular thickening seen in 10 patients (31.3%). Pleural effusion was seen in 4 patients (12.5%). Most patients showed peripheral (20,62.5%) and lower zonal distribution (25, 78.1%).



- Total severity score was calculated at baseline, first week and second week of follow-up scan. Out of 28 patients who had baseline abnormal chest X-rays, 16 patients (57.1%) had mild symptoms with TSS 1-2. Moderate to severe involvement were found in 9 (32.1%) and 2 (7.1%) patients with severity score 3-4 and 5-6 respectively. Only one patient (3.6%) had extensive lung involvement with severity score 7-8 at initial scan.
- Follow up scan was done at first and second week after the disease onset. First week follow-up scan was performed in 32 patients. Scores of 1-2, 3-4, 5-6, 7-8 were found respectively in 17(60.7%), 8(25%), 5(15.6%), 2(6.2%) patients respectively. Second week follow-up scan were done in 26 patients. Scores of 1-2, 3-4, 5-6, 7-8 were found respectively in 14(53.8%), 7(26.9%), 4(15.4%), 1(3.9%). Peak severity was reached at 12-14 days of disease onset.



- The typical findings on CT as studied were ground-glass opacities (GGO) which was present in 48 patients out of 50 (96%) being the most common finding almost in every patient, crazy paving (CP)appearance (GGOs and inter/intra lobular septal thickening), in 25 patients(50%), air space consolidation (CON) in 32 patients(64%), bronchovascular thickening (BVT) in 38 (76%) patients, sub-pleural bands in 10 (20%) patients and 1 (2%) patient had reverse halo sign(RH). Out of 50 patients 10 patients were having pleural effusion (20%), 6 patients were having pericardial effusion (12%) and 5 patients were having mediastinal lymphadenopathy (LN) (10%), however these findings were nonspecific for the disease.

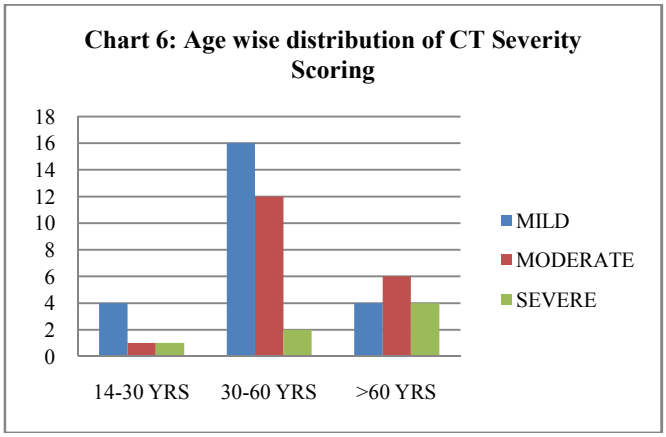


- Most cases showed peripheral predominance (32, 64%) followed by perihilar (5, 10%) involvement and neither of mentioned two (13, 26%).
- Bilateral lung involvement was found in most of the patients (37, 74%) followed by right lung (8, 16%) and left lung (5, 10%) involvement.
- Most patients showed lower zonal (35, 70%) distribution while 9 patients (18%) showed upper and 6 patients (12%) showed no zonal distribution.

Table 5 Age wise CT Severity Scoring

Age group	MILD (TOTAL=24)	MODERATE (TOTAL=19)	SEVERE (TOTAL=7)
14-30 YRS (N=6)	4	1	1
30-60 YRS (N=30)	16	12	2
>60 YRS (N=14)	4	6	4

- According to CT severity assessment in this study group there were total of 24 patients in the MILD category that is 48%; among them 17 were male (70.8%) and 7 female (29.1%). 19 patients (38%) were in MODERATE grade; among them 10 were male (52%) and 9 were female (47%). Only 7 (14%) cases were of severe disease category having 5 male (71%) and 2 female (28%) patients. Hence we can see male were more in number compared to female in each category proving males are more prone to the disease compared to females.

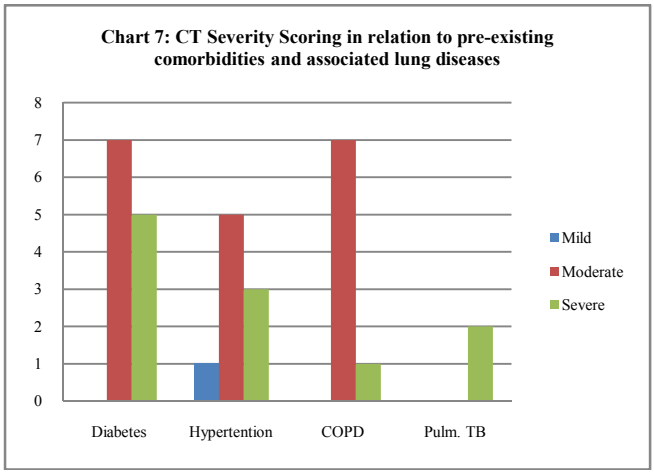


- According to age distribution we can conclude here there were more percentage of people in the severe grade i.e. 66% in the age group of 30-60 years followed by 28% in the older age groups (>60 years) and least in the 14-30 years age group i.e. 16%.Hence we can say here middle aged population are having the maximum chances of having severe disease.

Table 6 CT Severity Scoring in relation to pre-existing comorbidities and associated lung diseases

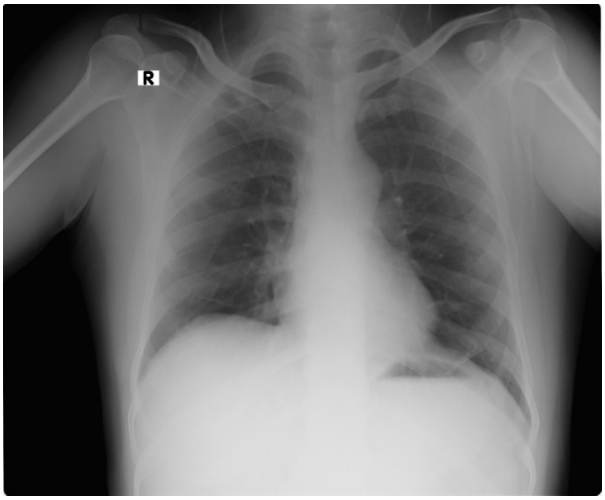
CT Severity Score	Diabetes mellitus (12)	Hypertension (9)	COPD (8)	Pulm. Tuberculosis (2)
Mild	0	1	0	0
Moderate	7	5	7	0
Severe	5	3	1	2

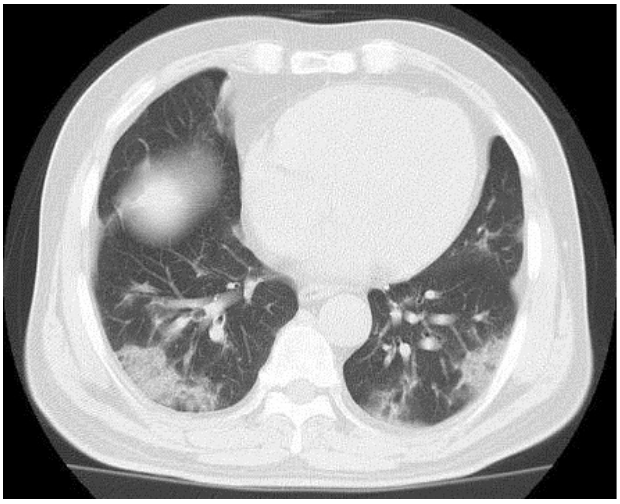
- Patients with pre-existing comorbidities were found to be more prone to develop severe form of the disease. 5 out of 12 patients with diabetes and 3 out of 9 patients with hypertension had severe CT severity score while 7 patients with diabetes and 5 patients with hypertension had moderate CT severity score.
- Patients with other lung pathologies like COPD and pulmonary tuberculosis were also shown to develop severe Covid-19 outcomes.



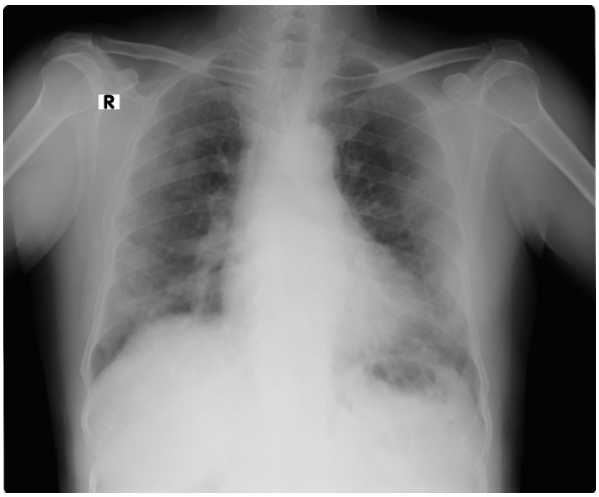
- RT-PCR and chest X-ray correlation: Out of 50 patients who were tested positive for COVID-19 on RT-PCR, 28 patients at initial scan and 6 patients in follow-up scan showed chest X-ray abnormalities.
- RT-PCR and CT Thorax correlation: All 50 patients showed at least some infective changes (mild to severe) on HRCT Thorax scans.
- By using RT-PCR results as standard, overall sensitivity of chest radiography and CT were 68% and 100% in the diagnosis of COVID-19.

Cases

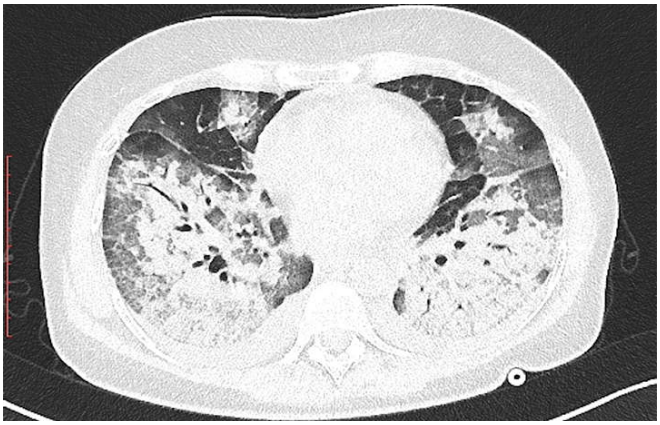




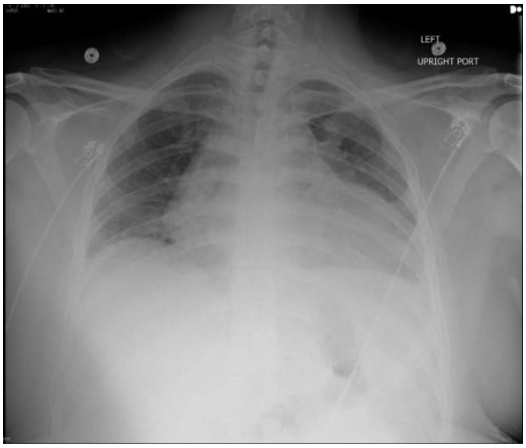
Case 1 *A 49 yrs old male presenting with shortness of breath(SOB). Chest Xray although appeared normal to the untrained eye, showed peripheral hazy opacities* bilaterally. HRCT Thorax showed bilateral, peripheral distribution, multilobar ground glass opacification (GGO) with sub-pleural banding, predominantly affecting the lower lobes. *Patient was assigned a CT Severity Score of 6.*



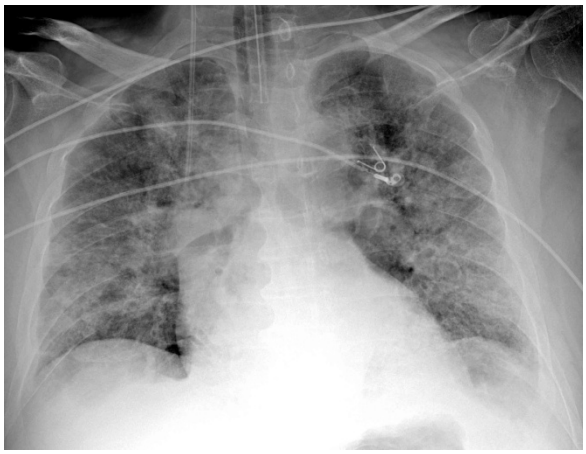
Case 2 *In a 56 yrs male patient presenting with fever, cough for 2 weeks and progressive SOB, Chest Xray showed peripheral GGO in bilateral lung fields. HRCT Thorax revealed* bilateral sub-pleural ground-glass opacities and inter-lobular septal thickening with a posterior predominance. *Patient was assigned a CT Severity Score of 10.*

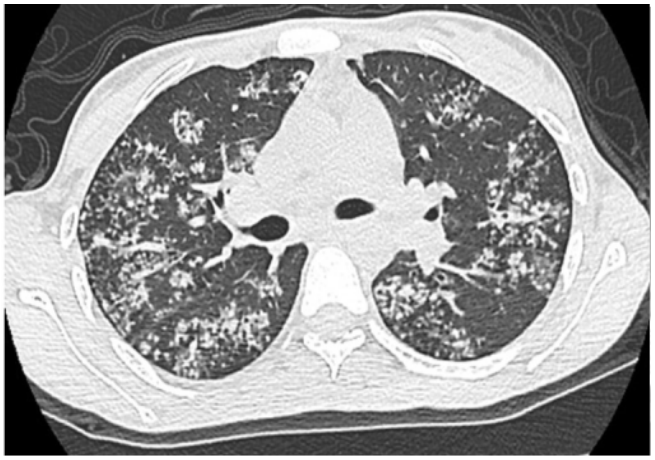


Case 3 *Chest Xray in a 68 yrs female diabetic patient presenting with history of SOB for 3 weeks & sudden loss of consciousness, showed areas of consolidation in peripheral distribution with reticular interstitial thickening and GGO. HRCT Thorax – Multi-lobar patchy areas of consolidation and GGO in bilateral lungs with septal thickening and bronchiectatic changes. Patient was assigned a CT Severity Score of 21.*



Case 4 *A 52 yrs female patient presented with sudden onset chest pain and SOB and vomiting. Chest Xray revealed increased cardio-thoracic ratio with broncho-vascular prominence in bilateral lower zones. CT Thorax done 3 days later showed Pericardial and pleural effusions with interlobular septal thickening in the background of sub-pleural GGO. Patient was assigned a CT Severity Score of 12.*





Case 5: *In a known case of pulmonary tuberculosis on ATD, sudden deterioration of SOB with spO2 < 60% Chest Xray showing GGO with patchy consolidation and fibro-cavitatory changes in bilateral lungs, along with mediastinal widening. HRCT Thorax revealed reticulo-nodular thickening in peri-lymphatic distribution with 'tree in bud' appearance. Sub-pleural patchy areas of GGO and septal thickening also noted. Patient was assigned a CT Severity Score of 18.*

DISCUSSION

COVID-19 is a highly infectious disease that has been spread widely through the world. The disease management strategies primarily depend upon the early disease diagnosis. [20, 21, 22] In radiology, much of the literature to date has focused on chest CT manifestations of COVID-19. [22] The chest computed

tomography (CT), especially high-resolution CT (HRCT) is also the main diagnostic method followed by "Pneumonia diagnosis and treatment guideline for SARS-CoV-2 infection (trial version 5) issued by National Health Commission of the People's Republic of China (http://www.nhc.gov.cn/). CT findings plays an important role in detecting lung abnormalities, facilitate the early identification of the diseases. [(23)] However, due to infection control issues related to patient transport to CT suites, the inefficiencies introduced in CT room decontamination, and lack of CT availability in parts of the world, portable chest radiography (CXR) will likely be the most commonly utilized modality for identification and follow up of lung abnormalities. [(24)] Although chest X-ray (CXR) is considered less sensitive for the detection of pulmonary involvement in early-stage disease, it is useful for monitoring the rapid progression of lung abnormalities in COVID-19, especially in critical patients admitted to intensive care units. [25]

In our study total severity score (TSS) of lung was calculated based on extent of lung involvement. Each lung was given a score of 0-4 (score 0- no involvement, score 1- <25%, score 2- 25-50%, score 3-50-75%, Score 4->75%). Total severity score calculated adding scores of both lung (total severity scores-0 to 8).

The above scoring system of lung involvement was first described by Yasin R, Gouda W. Total severity score, time to reach maximum total severity score, severity score at different stages of illness was estimates using the score. [(26)]

Borghesi *et al*. [(25)] made another CXR scoring system for COVID-19 pneumonia (Brixia score) by dividing the lungs to six zones on frontal projection (upper, middle, and lower zones); then, a score (from 0 to 3) is assigned to each zone based on the lung abnormalities detected on frontal chest projection as follows: score 0, no lung abnormalities; score 1, interstitial infiltrates; score 2, interstitial and alveolar infiltrates (interstitial predominance); and score 3, interstitial and alveolar infiltrates (alveolar predominance). The scores of the six lung zones are then added to obtain an overall "CXR SCORE" ranging from 0 to 18. Hence the above studies correlated with our study findings.

In our study there were 64% male and 36% female indicating male are more susceptible than female for developing the disease and also severity was more in male than female. Also older age group patients and those with pre-existing comorbidities were associated with higher severity and mortality in patients with both COVID-19 and SARS.

In a study by Jin JM *et al* [(27)] age was comparable between men and women in all data sets. In the case series, however, men's cases tended to be more serious than women's. In the public data set, the number of men who died from COVID-19 is 2.4 times that of women. In SARS patients, the gender role in mortality was also observed. The percentage of males were higher in the deceased group than in the survived group.

According to a study by Yanez ND *et al* [(28)] over a six-week period of data, there were 178,568 COVID-19 deaths from a total population of approximately 2.4 billion people. Age and sex were associated with COVID-19 mortality. Compared with individuals ages 54 years or younger, indicating that the mortality rate of COVID-19 was 8.1 times higher (95%CI = 7.7, 8.5) among those 55 to 64 years, and more than 62 times higher (IRR = 62.1; 95%CI = 59.7, 64.7) among those ages 65 or older. Mortality rates from COVID-19 were 77% higher in men than in women (IRR = 1.77, 95%CI = 1.74, 1.79). This agrees with our present study that is least percentage of patients in the study belonging to older age group had mild disease while more had moderate to severe disease, concluding that older age group patients were having highest burden for developing moderate and severe disease and hence mortality compared to younger patients. Hence our findings corroborated with the above studies.

In our study most common chest Xray finding was consolidation seen in 21 patients (65.6%) followed by ground glass opacity in 34.4% and reticular thickening in 31.3% cases. Pleural effusion was seen in 4 patients (12.5%). Most patients showed peripheral (62.5%) and lower zonal distribution (78.1%). The disease affection was mostly seen to be involving B/L lungs(74%).

Wong HYF *et al*. [(29)] reported that at baseline chest radiography, consolidation was the most common finding (47%), followed by ground-glass opacities (33%). Peripheral distribution (41%) and lower zone distribution (50%) were the more common locations, and most had bilateral involvement (50%). Pleural effusion was found in two patients (3%).

Rousan LA *et al*. [(30)] found that peripheral ground glass opacities (GGO) were the most common findings affecting the lower lobes. In the course of illness, the GGO progressed into consolidations (GGO 70%, consolidations 30%). The consolidations regressed into GGO towards the later phase of the illness (GGO 80%, consolidations 10%).

Lomoro P *et al*. [(31)] who did a study on 32 COVID-19 patients, found that five patients exhibited normal CXR despite chest CT scan showed bilateral ground-glass opacities (GGO). In the remaining twenty-seven cases, consolidation was most common findings seen in fifteen patients (46.9%) with bilateral (78.1%) and lower zone involvement (52%) and hazy increased opacity in twelve patients (37.5%), no pleural effusion was identified.

Therefore the findings of our study are in corroboration with all the above studies.

In our study, 24 patients (48%) had shown mild severity with Total Severity Score 1-2. Moderate Severity score ranging between 3-4 was found in 19 patients (38%) and TSS 5-6 score (severe) seen in 7(14%) patients. Peak severity was reached at 13-14 days of disease onset.

Wong HYF *et al* [(29)] found that baseline chest radiography was normal in 20 patients (31%). Twenty-six patients (41%) had mild findings with total severity score of 1–2. More extensive involvement was observed in 13 (20%) and five (8%) patients, who had severity scores of 3–4 and 5–6, respectively. There was no patient severity score greater than 6 at baseline chest radiography with the severity of CXR findings peaked at 10–15 days from the date of symptom onset. Thus our study variables correlated with the above-mentioned study.

GGO (96%), bronchovascular thickening (76%), Consolidation (64%) and crazy paving appearance (50%) etc were the typical CT features studied in most patients in our study.

In the study done by Bao C *et al* [(32)] a total of 13 studies met the inclusion criteria. The pooled positive rate of the CT

imaging was 89.76% and 90.35% when only including thin-section chest CT. Typical CT signs were ground glass opacities (83.31%), ground glass opacities with mixed consolidation (58.42%), adjacent pleura thickening (52.46%), interlobular septal thickening (48.46%), and air bronchograms (46.46%). Other CT signs included crazy paving pattern (14.81%), pleural effusion (5.88%), bronchiectasis (5.42%), pericardial effusion (4.55%), and lymphadenopathy (3.38%). The most anatomic distributions were bilateral lung infection (78.2%) and peripheral distribution (76.95%). The incidences were highest in the right lower lobe (87.21%), left lower lobe (81.41%), and bilateral lower lobes (65.22%). The right upper lobe (65.22%), middle lobe (54.95%), and left upper lobe (69.43%) were also commonly involved. The incidence of bilateral upper lobes was 60.87%. It corroborated perfectly with the findings of our study. Thus, the above study correlates with our findings.

The present study results showed that sensitivity of chest radiography and CT Thorax for detecting COVID-19 infection were 68% and 100% respectively by using RT-PCR as standard.

Tsakok M *et al*. [33] also found similar senisitivity of 61% and specificity of 76% in the diagnosis of COVID-19 by Chest Xray compared to PCR as reference test.

CT has been reported in previous studies by Ai T *et al* [8] and Fang Y *et al* [9] as being up to 98% sensitive for the diagnosis of COVID-19 in confirmed patients, when RT-PCR is used as the reference standard in confirmed patients.

Hence our study results correlated with the findings of previous studies.

CONCLUSION

Chest radiography can be used as diagnostic tool with a sensitivity of 68% for initial triaging of COVID-19 in symptomatic patients. CXR is useful for monitoring COVID-19 chest manifestations and its scoring system provides an accurate method to understand extent of lung involvement and disease progression over time.

A complete disease assessment of COVID-19 can be done using CT which excels in evaluation of disease, assessment of extent, severity and progression of the disease and hence help in better management of risks or morbidity associated with it. So every patient having positive test must undergo a CT scan for accurate assessment of the disease severity and progression. Even though test is negative but patient is having typical clinical symptoms CT scan is must to rule out the disease.

Though x ray is used as a primary screening modality in every covid patient as it is widely available, cheaper and faster, CT is always the gold standard due to higher sensitivity and specificity.

Limitations

- All the patients could not be followed till the final outcome as the course of the disease was truncated in these patients. In such an emergency, the completeness of data recorded was less than optimal.
- AP images from portable machines, performed in intensive care unit produced poorer quality images.
- Lack of correlation between the patients' total severity score to the final disease outcome.
- CT evaluation couldn't be done in pregnant patients who were COVID positive and others in whom CT was a contraindication.
- Inadequacy of CR cassettes, unavailability of DR Xray system and lack of in-house CT setup posed a hurdle in proper and prompt utilization of these imaging modalities.
- There was difficulty in doing CT in Unstable patients with oxygen support.
- Further research with larger number of patient is needed for correlation of CT findings and disease manifestation.

Scope for further Research

- Although this study used RT-PCR of nasopharyngeal swabs as a reference standard, newer methods exist for diagnosis of the disease. Serological assays for antibodies against SARS-CoV-2 are increasingly available and may represent a better gold standard in diagnosis for future research. [34] RT-PCR is limited by swabbing technique for nasopharyngeal samples and the fact that the virus is more avid in the lower respiratory tract. [35]
- Point-of-care lung ultrasound is a new technique for diagnosis of COVID-19 which may mitigate many of the issues noted with the modalities discussed so far. It has no radiation, is fast, cheap and may be able to detect lower respiratory tract disease unlike nasopharyngeal swab.
- Finally, much research has been conducted in the use of artificial intelligence techniques to correctly diagnose COVID-19 based on imaging. [36, 37] These techniques would obviate capacity limitations in reporting imaging as well as eliminate inter-reporter variability.

References

1. Sheraton M, Deo N, Dutt T, Surani S, Hall-Flavin D, Kashyap R. Psychological effects of the COVID 19 pandemic on healthcare workers globally: A systematic review. Psychiatry Res. 2020 Oct;292:113360. doi: 10.1016/j.psychres.2020.113360. Epub 2020 Aug 3. PMID: 32771837.
2. Dong E, Du H, Gardner L. An interactive web-based dashboard to track COVID-19 in real time. Lancet Infect Dis. 2020 May;20(5):533-534. doi: 10.1016/S1473-3099(20)30120-1. Epub 2020 Feb 19. Erratum in: Lancet Infect Dis. 2020 Sep;20(9):e215. PMID: 32087114.
3. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Huang B, Shi W, Lu R, Niu P, Zhan F, Ma X, Wang D, Xu W, Wu G, Gao GF, Tan W; China Novel Coronavirus Investigating and Research Team. A Novel Coronavirus from Patients with Pneumonia in China, 2019. N Engl J Med. 2020 Feb 20;382(8):727-733. doi: 10.1056/NEJMoa2001017. Epub 2020 Jan 24. PMID: 31978945.
4. World Health Organization website. Pneumonia of unknown cause: China. www.who.int/csr/don/05-january-2020-pneumonia-of-unkown-cause-china/en/. Accessed 13 Feb 2020.

5. Andrews MA, Areekal B, Rajesh KR, Krishnan J, Suryakala R, Krishnan B, Muraly CP, Santhosh PV. First confirmed case of COVID-19 infection in India: A case report. *Indian J Med Res*. 2020 May;151(5):490-492. doi: 10.4103/ijmr.IJMR_2131_20. PMID: 32611918.
6. Weiss SR, Navas-Martin S. Coronavirus pathogenesis and the emerging pathogen severe acute respiratory syndrome coronavirus. Microbiol Mol Biol Rev. 2005 Dec;69(4):635-64. doi: 10.1128/MMBR.69.4.635-664.2005. PMID: 16339739
7. Hui DS, Azhar EI, Memish ZA, Zumla A. Human Coronavirus Infections—Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS), and SARS-CoV-2. Reference Module in Biomedical Sciences. 2020:B978-0-12-801238-3.11634-4. doi: 10.1016/B978-0-12-801238-3.11634-4. Epub 2020 May 20. PMCID: PMC7241405..
8. Ai T, Yang Z, Hou H, Zhan C, Chen C, Lv W, Tao Q, Sun Z, Xia L. Correlation of Chest CT and RT-PCR Testing for Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases. Radiology. 2020 Aug;296(2):E32-E40. doi: 10.1148/radiol.2020200642. Epub 2020 Feb 26. PMID: 32101510.
9. Fang Y, Zhang H, Xie J, Lin M, Ying L, Pang P, Ji W. Sensitivity of Chest CT for COVID-19: Comparison to RT-PCR. Radiology. 2020 Aug;296(2):E115-E117. doi: 10.1148/radiol.2020200432. Epub 2020 Feb 19. PMID: 32073353.
10. Konrad R, Eberle U, Dangel A, Treis B, Berger A, Bengs K, Fingerle V, Liebl B, Ackermann N, Sing A. Rapid establishment of laboratory diagnostics for the novel coronavirus SARS-CoV-2 in Bavaria, Germany, February 2020. Euro Surveill. 2020 Mar;25(9):2000173. doi: 10.2807/1560-7917.ES.2020.25.9.2000173. PMID: 32156330.
11. Lin EC. Radiation risk from medical imaging. Mayo Clin Proc. 2010 Dec;85(12):1142-6; quiz 1146. doi: 10.4065/mcp.2010.0260. PMID: 21123642; PMCID: PMC2996147.
12. Bernheim A, Mei X, Huang M, Yang Y, Fayad ZA, Zhang N, Diao K, Lin B, Zhu X, Li K, Li S, Shan H, Jacobi A, Chung M. Chest CT Findings in Coronavirus Disease-19 (COVID-19): Relationship to Duration of Infection. Radiology. 2020 Jun;295(3):200463. doi: 10.1148/radiol.2020200463. Epub 2020 Feb 20. PMID: 32077789; PMCID: PMC7233369.
13. Jacobi A, Chung M, Bernheim A, Eber C. Portable chest X-ray in coronavirus disease-19 (COVID-19): A pictorial review. Clin Imaging. 2020 Aug;64:35-42. doi: 10.1016/j.clinimag.2020.04.001. Epub 2020 Apr 8. PMID: 32302927; PMCID: PMC7141645.
14. Mizumoto K, Kagaya K, Zarebski A, Chowell G. Estimating the asymptomatic proportion of coronavirus disease 2019 (COVID-19) cases on board the Diamond Princess cruise ship, Yokohama, Japan, 2020. Euro Surveill. 2020 Mar;25(10):2000180. doi: 10.2807/1560-7917.ES.2020.25.10.2000180. Erratum in: Euro Surveill. 2020 Jun;25(22): PMID: 32183930; PMCID: PMC7078829.
15. Arons MM, Hatfield KM, Reddy SC, Kimball A, James A, Jacobs JR, Taylor J, Spicer K, Bardossy AC, Oakley LP, Tanwar S, Dyal JW, Harney J, Chisty Z, Bell JM, Methner M, Paul P, Carlson CM, McLaughlin HP, Thornburg N, Tong S, Tamin A, Tao Y, Uehara A, Harcourt J, Clark S, Brostrom-Smith C, Page LC, Kay M, Lewis J, Montgomery P, Stone ND, Clark TA, Honein MA, Duchin JS, Jernigan JA; Public Health–Seattle and King County and CDC COVID-19 Investigation Team. Presymptomatic SARS-CoV-2 Infections and Transmission in a Skilled Nursing Facility. N Engl J Med. 2020 May 28;382(22):2081-2090. doi: 10.1056/NEJMoa2008457. Epub 2020 Apr 24. PMID: 32329971; PMCID: PMC7200056.
16. Hansell DM, Bankier AA, MacMahon H, McLoud TC, Müller NL, Remy J. Fleischner Society: glossary of terms for thoracic imaging. Radiology. 2008 Mar;246(3):697-722. doi: 10.1148/radiol.2462070712. Epub 2008 Jan 14. PMID: 18195376.
17. Warren MA, Zhao Z, Koyama T, Bastarache JA, Shaver CM, Semler MW, Rice TW, Matthay MA, Calfee CS, Ware LB. Severity scoring of lung oedema on the chest radiograph is associated with clinical outcomes in ARDS. Thorax. 2018 Sep;73(9):840-846. doi: 10.1136/thoraxjnl-2017-211280. Epub 2018 Jun 14. PMID: 29903755; PMCID: PMC6410734.
18. Prokop M, van Everdingen W, van Rees Vellinga T, Quarles van Ufford H, Stöger L, Beenen L, Geurts B, Gietema H, Krdzalic J, Schaefer-Prokop C, van Ginneken B, Brink M; COVID-19 Standardized Reporting Working Group of the Dutch Radiological Society. CO-RADS: A Categorical CT Assessment Scheme for Patients Suspected of Having COVID-19-Definition and Evaluation. Radiology. 2020 Aug;296(2):E97-E104. doi: 10.1148/radiol.2020201473. Epub 2020 Apr 27. PMID: 32339082; PMCID: PMC7233402.
19. Pan F, Ye T, Sun P, Gui S, Liang B, Li L, Zheng D, Wang J, Hesketh RL, Yang L, Zheng C. Time Course of Lung Changes at Chest CT during Recovery from Coronavirus Disease 2019 (COVID-19). Radiology. 2020 Jun;295(3):715-721. doi: 10.1148/radiol.2020200370. Epub 2020 Feb 13. PMID: 32053470; PMCID: PMC7233367.
20. World Health Organization (2020) WHO Director-General's remarks at the media briefing on 2019-nCoV. https://www.who.int/dg/speeches/detail/who-director-generals remarks at the-media-briefing-on–2019-ncov-on–11-february–2020.
21. Toussie D, Voutsinas N, Finkelstein M, Cedillo MA, Manna S, Maron SZ, Jacobi A, Chung M, Bernheim A, Eber C, Concepcion J, Fayad ZA, Gupta YS. Clinical and Chest Radiography Features Determine Patient Outcomes in Young and Middle-aged Adults with COVID-19. Radiology. 2020 Oct;297(1):E197-E206. doi: 10.1148/radiol.2020201754. Epub 2020 May 14. PMID: 32407255; PMCID: PMC7507999.
22. Chung M, Bernheim A, Mei X, Zhang N, Huang M, Zeng X, Cui J, Xu W, Yang Y, Fayad ZA, Jacobi A, Li K, Li S, Shan H. CT Imaging Features of 2019 Novel Coronavirus (2019-nCoV). Radiology. 2020 Apr;295(1):202-207. doi: 10.1148/radiol.2020200230. Epub 2020 Feb 4. PMID: 32017661; PMCID: PMC7194022.
23. Meng H, Xiong R, He R, Lin W, Hao B, Zhang L, Lu Z, Shen X, Fan T, Jiang W, Yang W, Li T, Chen J, Geng

Q. CT imaging and clinical course of asymptomatic cases with COVID-19 pneumonia at admission in Wuhan, China. J Infect. 2020 Jul;81(1):e33-e39. doi: 10.1016/j.jinf.2020.04.004. Epub 2020 Apr 12. PMID: 32294504; PMCID: PMC7152865.

24. Jacobi A, Chung M, Bernheim A, Eber C. Portable chest X-ray in coronavirus disease-19 (COVID-19): A pictorial review. Clin Imaging. 2020 Aug;64:35-42. doi: 10.1016/j.clinimag.2020.04.001. Epub 2020 Apr 8. PMID: 32302927; PMCID: PMC7141645.
25. Borghesi A, Maroldi R. COVID-19 outbreak in Italy: experimental chest X-ray scoring system for quantifying and monitoring disease progression. Radiol Med. 2020 May;125(5):509-513. doi: 10.1007/s11547-020-01200-3. Epub 2020 May 1. PMID: 32358689; PMCID: PMC7194501.
26. Yasin R, Gouda W. Chest X-ray findings monitoring COVID-19 disease course and severity. Egypt J Radiol Nucl Med. 2020;51(1):193. doi: 10.1186/s43055-020-00296-x. Epub 2020 Sep 22. PMCID: PMC7506170.
27. Jin JM, Bai P, He W, Wu F, Liu XF, Han DM, Liu S, Yang JK. Gender Differences in Patients With COVID-19: Focus on Severity and Mortality. Front Public Health. 2020 Apr 29;8:152. doi: 10.3389/fpubh.2020.00152. PMID: 32411652; PMCID: PMC7201103.
28. Yanez ND, Weiss NS, Romand JA, Treggiari MM. COVID-19 mortality risk for older men and women. BMC Public Health. 2020 Nov 19;20(1):1742. doi: 10.1186/s12889-020-09826-8. PMID: 33213391; PMCID: PMC7675386.
29. Wong HYF, Lam HYS, Fong AH, Leung ST, Chin TW, Lo CSY, Lui MM, Lee JCY, Chiu KW, Chung TW, Lee EYP, Wan EYF, Hung IFN, Lam TPW, Kuo MD, Ng MY. Frequency and Distribution of Chest Radiographic Findings in Patients Positive for COVID-19. Radiology. 2020 Aug;296(2):E72-E78. doi: 10.1148/radiol.2020201160. Epub 2020 Mar 27. PMID: 32216717; PMCID: PMC7233401.
30. Rousan LA, Elobeid E, Karrar M, Khader Y. Chest x-ray findings and temporal lung changes in patients with COVID-19 pneumonia. BMC Pulmonary Medicine. 2020 Dec;20(1):1-9.
31. Lomoro P, Verde F, Zerboni F, Simonetti I, Borghi C, Fachinetti C, Natalizi A, Martegani A. COVID-19 pneumonia manifestations at the admission on chest ultrasound, radiographs, and CT: single-center study and comprehensive radiologic literature review. Eur J Radiol Open. 2020;7:100231. doi: 10.1016/j.ejro.2020.100231. Epub 2020 Apr 4. PMID: 32289051; PMCID: PMC7129441.
32. Bao C, Liu X, Zhang H, Li Y, Liu J. Coronavirus Disease 2019 (COVID-19) CT Findings: A Systematic Review and Meta-analysis. J Am Coll Radiol. 2020 Jun;17(6):701-709. doi: 10.1016/j.jacr.2020.03.006. Epub 2020 Mar 25. PMID: 32283052; PMCID: PMC7151282.
33. Tsakok M, Shaw R, Murchison A, Ather S, Xie C, Watson R, Brent A, Andersson M, Benamore R, MacLeod F, Gleeson F. Diagnostic accuracy of initial chest radiograph compared to SARS-CoV-2 PCR in patients with suspected COVID-19. BJR Open. 2020 Aug 5;2(1):20200034. doi: 10.1259/bjro.20200034. PMID: 33178988; PMCID: PMC7594890.
34. Long QX, Liu BZ, Deng HJ, Wu GC, Deng K, Chen YK, Liao P, Qiu JF, Lin Y, Cai XF, Wang DQ, Hu Y, Ren JH, Tang N, Xu YY, Yu LH, Mo Z, Gong F, Zhang XL, Tian WG, Hu L, Zhang XX, Xiang JL, Du HX, Liu HW, Lang CH, Luo XH, Wu SB, Cui XP, Zhou Z, Zhu MM, Wang J, Xue CJ, Li XF, Wang L, Li ZJ, Wang K, Niu CC, Yang QJ, Tang XJ, Zhang Y, Liu XM, Li JJ, Zhang DC, Zhang F, Liu P, Yuan J, Li Q, Hu JL, Chen J, Huang AL. Antibody responses to SARS-CoV-2 in patients with COVID-19. Nat Med. 2020 Jun;26(6):845-848. doi: 10.1038/s41591-020-0897-1. Epub 2020 Apr 29. PMID: 32350462.
35. Wang W, Xu Y, Gao R, Lu R, Han K, Wu G, Tan W. Detection of SARS-CoV-2 in Different Types of Clinical Specimens. JAMA. 2020 May 12;323(18):1843-1844. doi: 10.1001/jama.2020.3786. PMID: 32159775; PMCID: PMC7066521.
36. Shi F, Wang J, Shi J, Wu Z, Wang Q, Tang Z, He K, Shi Y, Shen D. Review of Artificial Intelligence Techniques in Imaging Data Acquisition, Segmentation, and Diagnosis for COVID-19. IEEE Rev Biomed Eng. 2021;14:4-15. doi: 10.1109/RBME.2020.2987975. Epub 2021 Jan 22. PMID: 32305937.
37. Li L, Qin L, Xu Z, Yin Y, Wang X, Kong B, Bai J, Lu Y, Fang Z, Song Q, Cao K, Liu D, Wang G, Xu Q, Fang X, Zhang S, Xia J, Xia J. Using Artificial Intelligence to Detect COVID-19 and Community-acquired Pneumonia Based on Pulmonary CT: Evaluation of the Diagnostic Accuracy. Radiology. 2020 Aug;296(2):E65-E71. doi: 10.1148/radiol.2020200905. Epub 2020 Mar 19. PMID: 32191588; PMCID: PMC7233473.

How to cite this article:

Ruchi Bansal *et al* (2021) 'Diagnostic Efficacy of Chest XRAY And HRCT In Detection of Covid-19 Pneumonia: A Study In Tertiary Care COVID Hospital, Kolkata', *International Journal of Current Advanced Research,* 10(02), pp. 23759-23768. DOI: http://dx.doi.org/10.24327/ijcar.2021.23768.4710

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