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SPECTRUM OF CHEST RADIOGRAPHIC FINDINGS IN COVID-19 POSITIVE PATIENTS

Radiology

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ABSTRACT

Background: At present, the majority of radiological literature pertaining to COVID-19 is based on CT findings. Chest x-ray (CXR) can be used as a cheaper tool for screening and monitoring the progression of disease, especially in remote rural areas with non-availability of CT scan equipments.**Purpose** :To assess and describe the findings on CXR in COVID-19 patients, with observation of progression over time and correlate with reverse transcription polymerase chain reaction (RT-PCR) testing for SARS-Cov-2 nucleic acid. **Materials and Methods:** We performed a retrospective study of RT-PCR positive COVID-19 patients with CXRs, admitted at tertiary care hospital (Dr. ND Desai Faculty of Medical Science and Research, Nadiad, India), between April and May 2020. Baseline and serial CXRs (total 180 CXRs) were reviewed along with RT-PCR Correlation. Two radiologists read and reported each CXR in consensus for findings: consolidation, ground glass opacity (GGO), location and pleural fluid. **Results:** The study included 100 COVID 19 positive patients (72 men, mean age 40+/-20 years). 88 out of these 100 patients had positive initial RT-PCR (88%).71 out of these 100 patients had abnormal baseline CXR (71%).59 out of these 100 patients had positive initial RT-PCR with abnormal baseline CXR (59%).10 patients (10%) showed abnormalities on CXR before eventually testing positive on RT-PCR.Sensitivity of initial RT-PCR (88%) was higher than that of baseline CXR (71%) (p = 0.009). Radiographic (mean 6 +/- 5 days) and symptomatic recovery (mean 8 +/- 6 days) were not significantly different (p= 0.33). The following radiological findings were seen: Consolidation -most common finding (71/100, 71%), followed by GGO (57/100, 57%). CXR abnormalities showed a peripheral (58/100, 58%) and lower zone distribution (54/100, 54%) with bilateral involvement (59/100, 59%). Pleural effusion was uncommon (7/100, 7%). The severity of CXR findings was seen to peak at approximately 10-12 days from the date of onset of symptoms.**Conclusion**: Chest X-Ray in COVID-19 patients frequently showed bilateral lower zone consolidation which peaked at 10-12 days from symptom onset.

KEYWORDS

Introduction

Most of the radiological literature and studies on COVID-19 are based on primarily the CT findings[5–10], which are found to be more sensitive than chest x-ray (CXR). At our private centre in Ahmedabad(Gujarat India),we received a lot of CT scans for investigation as there was a visible shortage of RT-PCR test kits in government designated laboratories. Similarly in many other set-ups across the world, CT was often a first-line investigation for COVID-19[11,12]. On the downside, this protocol places a huge burden on radiology departments. That also increases the additional burden for infection control in the CT departments. It is very difficult and near impossible to use a dedicated specific CT scanner for evaluation of suspected COVID-19 patients only[13], due to the costs involved with installation of new CT machines.

As per the The American College of Radiology, the process for decontamination of CT scan room required after every scan of a COVID-19 patient may paralyze the routine availability and efficiency of the radiology department. To counter this, they suggest to consider the use of portable chest x-ray (CXR).

Widespread usage of portable CXR imaging instead of CT for screening and monitoring COVID-19 patients may be advantageous as it would reduce the risk of cross-infection[15]. It would also counter-act the non-availability of and time consuming reverse transcription polymerase chain reaction (RT-PCR) turnaround times[14,16]. CXR also holds an advantage over CT scans and RT-PCR testing in a country like India due to its easier availability in rural setups. The Chest screening set up for Tuberculosis already set in rural areas may be utilized for the same.

As time passes by, the prevalence of COVID-19 would increase and hence we believe that it is very important that clinicians of all specialties recognize the classic COVID-19 features on CXR so that they may also diagnose or suspect on CXRs which may have been performed for other purposes.

To further our understanding of the CXR features of COVID-19, our study aims to: (i) describe the common chest x-ray appearances of COVID-19, (ii) correlate the chest x-ray appearances with reverse transcription polymerase chain reaction (RT-PCR), (iii) describe the time course of chest x-ray appearances relative to symptom onset and (iv) describe the progress of the disease so far as choice of modality of treatment application and prognosis is concerned..

Patients

A total of 100 patients from tertiary hospital in Nadiad-India (Dr. ND Desai Faculty of Medical Science and Research) were included from 1st April 2020 to 30th May 2020. RT-PCR on nasopharyngeal swabs and throat swabs confirmed COVID-19 infection. 44 patients had serial RT-PCR test results available at the time of writing.

All of the 100 patients underwent CXR upon admission. Follow-up CXRs were available for all except five patients. In asymptomatic patients (12/100, 12%), the date of first positive RT-PCR was considered as date of symptom onset.

Image Acquisition & Analysis

All chest radiographs were acquired as digital radiographs following usual local protocols. They were acquired in the posteroanterior (PA) or anteroposterior (AP) view. All follow-up CXRs were performed on portable X-ray units in the isolation wards.

Two radiologists blindly reviewed all of the CXRs by consensus. Further review was undertaken by a third radiologist if there were conflicting reports. The radiologic abnormalities like consolidation and ground glass opacities (GGO) were diagnosed as per the Fleischner Society glossary of terms[18].

The distribution of the abnormalities across lung parenchyma was classified as (i) peripheral predominance, perihilar predominance (peripheral and perihilar demarcation was defined as halfway between lateral edge of the lung and hilum), or neither; (ii) right, left, or bilateral lung involvement; and (iii) upper zone, lower zone (defined as upper/

lower halves) or no zonal predominance. Presence of pleural effusion was also recorded.

Statistical Analysis

To evaluate the sensitivity of CXR, baseline positive CXRs were compared to initial RT-PCR results by McNemar Chi-squared test. Comparison of the baseline CXR between initial positive and negative RT-PCR results was done using Mann-Whitney U test. Radiologic and symptomatic recovery (defined as resolution of abnormalities on CXR and RT-PCR negative respectively) were compared using paired-sample t- test. Statistical significance was defined as $p < 0.05$.

Results

Patient Characteristics

The clinical picture of the 100 patients on presentation to the hospital is summarized in Table 1. There were 72 males (72%) and 28 females (28%), with a mean age of 40 years (range 20 to 60 years). Fever (70%) and cough (58%) were the commonest symptoms. 14 patients (14%) were asymptomatic. The most common co-morbidities were hypertension (20%) and diabetes (15%).

Chest X-ray Features

On initial baseline CXR at admission, consolidation was the most common finding (71/100, 71%), followed by GGO (57/100, 57%). Peripheral (58/100, 58%) and lower zone distribution (54/100, 54%) were the more common locations, and most had bilateral involvement (59/100, 100%). Pleural effusion was found in 7 cases (7%).

Baseline CXR findings.—All patients underwent baseline CXRs on presentation. 29 patients (29%) had normal baseline CXRs. 41 patients (41%) had mild findings. More extensive involvement was seen in 30 (30%).

Progression of Radiographic Changes with time.—The severity and extent of opacities on CXR changed over time. Peak severity was reached at 10-12 days.

Of the 29 patients who had normal baseline CXRs, 11 developed abnormalities on follow-up radiographs.

Table 1.Patient characteristics on presentation

Clinical presentation	Comorbidities
Fever (37-38C)	Diabetes
Fever (>=38C)	Hypertension
Cough	Chronic Obstructive Pulmonary Disease
Sore throat	Malignancy
Diarrhea	Chronic Liver Disease
Chest discomfort	
Dyspnea	
Asymptomatic	

Table 2.Overall radiographic findings on chest x-ray (CXR) in 71/100 patients.

Characteristic	No. of Cases
Type of parenchymal opacity at baseline CXR	
Consolidation	71
Ground glass opacities	57
Distribution at baseline CXR	
Peripheral predominant	58
Perihilar predominant	13
Right lung	8
Left lung	4
Bilateral lungs	59
Upper zone predominant	17
Lower zone predominant	54
Other features on baseline CXR	
Pleural effusion	7

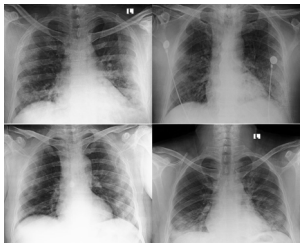
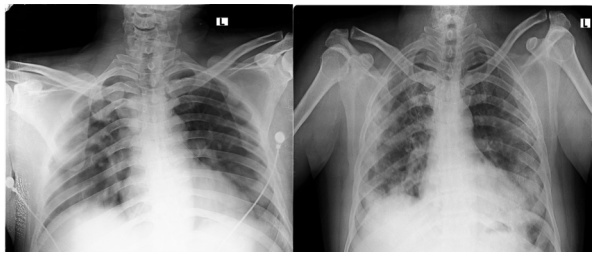
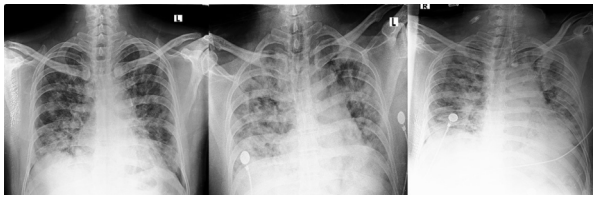


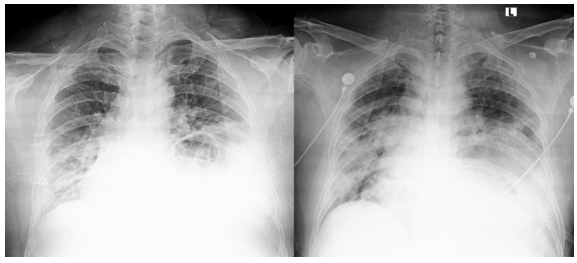
Figure. Chest x-ray findings in COVID-19: Ill-defined patchy opacities and consolidations are seen with perihilar distribution and peripheral distribution and lower zone predilection. Pleural effusion was not commonly seen.



The first CXR (to the left) was taken on admission and showed opacities in right mid zone and both lower zones. Follow-up CXR taken after 5 days showed increase in extent of the opacities on either side.



The first CXR (to the left) was taken on admission and showed faint opacities in upper, mid and lower zones on either side. Follow-up CXR (in centre) taken after 4 days showed increase in extent of the opacities on either side. Further follow-up CXR was taken after 3 more days which showed slight reduction in the extent of opacities with linear reticulations suspicious for early fibrosis.



The first CXR (to the left) was taken on admission and showed opacities in both mid and lower zones. Follow-up CXR taken after 4 days showed increase in extent of the opacities on either side.

CXR Correlation with RT-PCR

All of the patients underwent a median of 2 RT-PCR tests. On presentation, 91 out of 100 patients had both baseline CXRs and initial RT-PCR testing performed within the first 24 hours, while 9 out of 100 patients had CXR and RT-PCR performed within 48 hours. The severity of the abnormalities on baseline CXR showed no significant difference between patients with positive or negative PCR at initial testing.

Of the 88 patients who tested positive on initial RT-PCR, 59 had abnormalities on baseline CXR. 12 patients were negative on initial RT-PCR, but demonstrated abnormalities on baseline CXR. Of these 12 patients, 10 subsequently tested positive after 24 hours, and 2 tested positive after 48 hours.

The sensitivity of baseline RT-PCR was 88%, which was higher than baseline CXR 71% (p=0.009).

We had follow-up for 54 patients for symptomatic recovery; and follow-up for 38 patients for chest x- ray recovery. The mean time from initial positive RT-PCR to negative RT-PCR was 8+/-7 days. The mean time from initial positive CXR to negative CXR was 6+/-5 days. Five patients never exhibited radiographic follow up x rays. There was no statistically significant difference in the recovery time for RT-PCR and CXR recovery groups (p=0.33).

Discussion and Suggestions.

The main abnormality on CXR in COVID-19 patients was of consolidation, which is consistent with previously published case

series[9,21]. Consolidation was the most common finding, followed by ground glass opacities. These had a peripheral and lower zone distribution with bilateral involvement. Pleural effusion was not common. The severity of CXR findings peaked at 10-12 days from the date of symptom onset.

Our study suggested that CXR was able to appreciate the commonly seen findings on CT. Peak CXR severity score at 10-12 days after symptom onset is also in agreement with previously documented peak severity for CT, which was reported at 6-11 days[8,23]. Furthermore, CXR abnormalities were detectable in 12 patients whose initial RT-PCR was negative. Baseline CXR sensitivity was 71% which was lower than the reported 97-98% sensitivity of CT[6,24].

However the rest of the findings of our study suggest that CXR can be used with certain confidence in the initial screening of COVID-19 and for monitoring the progression of disease.

CXR can be especially of help in rural set-ups where there is a shortage of essential medical facilities like CT scan equipment and shortage of RT-PCR test kits. We can utilize the screening chest set up already available forTuberculosis programme for screening COVID patients.

With CXR we can also run the programme with lack of technical personnel as compared to technical staff required to perform CT scans.

There have been a few reports of some COVID-19 patients testing positive on RT-PCR again after discharge[25,26].With this in mind, we opine that imaging should be used as an adjunct to clinical parameters in monitoring the disease course, until further evidence is available.

CXR is also helpful to assess the severity and progress of the disease with time and thereby helpful to decide the line of treatment, whether OPD treatment or Indoor treatment is essential for particular patient.

Our study has limitations. We were not able to follow all patients to their final outcome. The interval between serial CXRs and RT-PCR testing was decided by clinical scenario and varied and thus potentially affects the analysis. Some of the radiologic features were subtle, which may not be appreciated in suboptimal viewing conditions or by non-specialist readers in rural set ups and requires training of medical and para medical personnel at rural set ups..

In summary, we described the findings of COVID-19 on CXR and advise to use it as a tool to screen and monitor the progress of the disease, to detect early cases where RT-PCR and CT facilities are not available or time consuming, as it can save much needed time to patients who do not have access to CT scans and immediate RT-PCR testing despite of having lesser sensitivity than CT. CXR is fast, easily available and relatively inexpensive screening procedure which is easily available in many resource constrained health care settings.

The authority may establish the protocol for mass screening of clinically suspected COVID patients at Rural Set ups with available mass screening chest facilities to decide the use of further testing by RT-PCR, to decide the line of treatment whether requires OPD line or Indoor line of treatment and to assess the progress of the disease in positive or negative direction. It will also save much burden of RT PCR testing and much burden on District and Urban hospitals.

We hope that further research with more number of patients and long period of follow up is done and other studies are published so that we have a better understanding of this disease.

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