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Radio-Diagnosis

CHEST RADIOGRAPHIC FINDINGS IN RT-PCR POSITIVE COVID-19 PATIENTS

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ABSTRACT

Aims and objectives : To describe the chest radiographic findings in RT-PCR positive COVID 19 patients and to evaluate the effectiveness of chest radiographs in detecting pulmonary alterations in RT-PCR positive COVID-19 patients.

Materials and methods: A retrospective cross-sectional study was carried out from May 2021 to June 2021 in a tertiary care hospital in Karnataka, India. A total of 100 covid positive patients who underwent chest X-ray were included in the study. The chest X-rays were evaluated for presence or absence and the type of pulmonary alterations, and their distribution. Chi-square test was used to compare percentages and *p*-value of less than 0.05 was considered statistically significant.

Results: In total, 100 patients consisting of 70 males and 30 females with positive RT-PCR results for COVID-19 pneumonia were included in this study, their mean age being 51.6 years. The presence of at least one chest alteration was found in 90 patients. The presence of ground-glass opacities (51%) and consolidation (41%) was the most common findings. Reticular opacities were found in 6% of the cases. Seventy percent of the radiographic findings were bilateral and involvement of both peripheral and central zones was significantly frequent.

Conclusion: Frequent findings at chest radiography in patients with COVID-19 included bilateral lower zone ground glass opacity and consolidation.

KEYWORDS : COVID-19 pneumonia, Chest X-ray, SARS-CoV-2, RT-PCR.

INTRODUCTION

The World Health Organization has declared the Corona virus disease 2019 (COVID-19) caused by severe acute respiratory syndrome corona virus 2 (SARS-CoV-2) as a global pandemic. Health signs vary from asymptomatic to a wide range of systemic and/or respiratory manifestations[1]. Symptoms of SARS-CoV-2 infection in humans vary from minor respiratory symptoms to severe acute respiratory syndrome. Laboratory findings in hospitalized COVID-19 patients include lymphopenia, high amino transaminase levels and elevated inflammatory markers[2]. Several molecular assays based on reverse transcription polymerase chain reaction (RT-PCR) for the individualization of SARSCoV-2 genes are recommended for confirmation of COVID-19[1] according to WHO.

Some initial radiological studies have highlighted the role of radiological imaging in early detection and management of COVID-19[1]. As far as imaging is concerned, computed tomography (CT) presents a sensitivity of up to 95%, far outperforming RT-PCR[3]. The CT scan should not be used for screening or as a first-line diagnostic test for COVID-19 since the use of a non-dedicated CT scanner involves time-consuming and laborious decontamination procedures to reduce the risk of cross-infection.

Chest radiography (CXR) has, on the other hand, been commonly used in these patients who typically have respiratory symptoms[4]. Portable chest radiography may be considered to minimize the risk of cross infection[5]. Normal chest radiography does not eliminate COVID-19 pneumonia. A combination of peripheral lung changes in ground glass opacity and/or consolidation, most usually bilateral, may be present[6]. However, data relevant to Chest radiographic findings in COVID-19 are still minimal. Therefore, there was a need to evaluate the role of this imaging modality in COVID-19.

MATERIALS AND METHODS

This was a retrospective study conducted at the Yenepoya Medical College, a tertiary care hospital in India. Prior approval of the Institutional ethics committee was taken from the institutional Ethical Committee (Protocol No: YEC2/849,07-07-2021) and the study was conducted in accordance with the ethical norms as laid down in the Declaration of Helsinki, 1975. The data collected was kept completely confidential. The committee granted a waiver of informed consent.

INCLUSION CRITERIA

1. Patients diagnosed with COVID-19 infection and confirmed by RT-PCR testing on nasopharyngeal swabs and throat swabs and have undergone CXR examination.

EXCLUSION CRITERIA

1. Patients whose RT-PCR result was negative or inconclusive.

All the patients have undergone a baseline postero anterior or antero posterior bedside chest X-ray using a portable radiography unit (GE 60 MA) during the period May 2021 to June 2021.

The chest X rays were categorized on the basis of features specific to COVID-19. The findings to be considered in the evaluation of CXR are the presence or absence and the type of pulmonary alterations, and their distribution.

Patients were divided and their chest X rays were studied based on the following parameters:

- The number of days between symptom onset and Chest X ray.
- Chest X ray alterations (reticular / ground glass opacity (GGO) / consolidation)
- Pattern of distribution (bilateral/ unilateral, upper/middle/lower zones, peripheral/central)
- Other features at Chest X ray

CXR alterations were defined according to the Fleischner Society's nomenclature, available in the Glossary of Terms for Thoracic Imaging[7].

Reticular alteration is defined as a collection of numerous small linear opacities that provide the impression of a net. Consolidation is defined as a homogeneous opacity in pulmonary parenchyma that obscures the vascular and airway walls. Ground-glass opacity (GGO) is an extensive hazy, radio opacity with indistinct pulmonary vessel margins.

Upper zone was described as above line through anterior end of 2nd rib. Mid zone was described as between upper zone and line through anterior end of 4th rib. Lower zone was described as below mid zone. Central zones were defined as the area within 2 cm from the lobar bronchial structures. Peripheral zones were defined as rest of the lung area between the central zones and the pleura.

STATISTICAL ANALYSIS

All statistical data were analyzed using the IBM SPSS software.

Categorical data was described using frequencies and percentages and continuous data was described using mean and standard deviation. Chi-square test was used to compare percentages and *p*-value of less than 0.05 was considered statistically significant.

RESULTS

Following the inclusion criteria, a total of 100 patients were considered; among them, 70 were men and 30 were women. The mean age was 51.6 years (range 19–88 years). Numerosity and demographics are summarized in Table 1.

[Table 1]: Baseline characteristics of the study population (N = 100)

Demographic characteristics
Age (years) 19-88
Males 70.0%
Females 30.0%
Time between onset of symptoms and CXR (days)
• A: 0-2 days – 18
• B: 3-5 days – 54
• C: 6-8 days - 21
• D: > 8 days - 7

The presence of at least one chest alteration was found in 90% patients. In 10% patients, it was found that CXR was normal without any finding. Alterations were bilateral in 70% and unilateral in 20% patients (12 in the right lung and 8 in the left lung).

The presence of GGO (51%) and consolidation (41%), alone or in combination with other alterations, was the most common findings. Reticular alteration was found in 6 cases [Table 2].

[Table 2]: Chest radiograph findings

FINDINGS	NUMBER	PERCENTAGE
Reticular alteration (total)	6	6
Ground-glass opacity (total)	51	51
Consolidation (total)	41	41
Reticular alteration alone	2	2
Ground-glass opacity alone	39	39
Consolidation alone	33	33
DISTRIBUTION AT CXR		
Peripheral predominant	16	16
Central predominant	18	18
Both peripheral and central	56	56
Bilateral lungs	70	70
Upper zone involvement	34	34
Middle zone involvement	57	57
Lower zone involvement	85	85
OTHER FEATURES AT CXR		
Pleural effusion	5	5

GGO and consolidation were significantly more frequent than reticular alteration ($p < 0.01$ in both the cases). A significantly higher frequency of involvement of the lower fields compared to the upper fields and middle fields was observed ($p < 0.01$ in all the cases) [Table 3]. The involvement of both peripheral and central zones was significantly frequent than the exclusive involvement of the peripheral zones and central zones ($p < 0.01$ in both the cases). The exclusive involvement of the central zones (18%) was frequent than the peripheral zones (16%).

Pleural effusion was observed in 5 patients which was bilateral in 2 cases and unilateral in 3 cases (2 on the left side and 1 on the right side).

[Table 3]: Significant differences in the frequency of the alterations and their distribution

ALTERATIONS (ALONE OR IN COMBINATION)	Chi square	P value	95% CI
GGO (51/100) (51%) > Consolidation (41/100) (41%)	32.008	0.000*	0.026 - 0.191
GGO (51/100) (51%)> Reticular alteration (6/100) (6%)	0.003	0.960	0.184 - 4.993
Consolidation (41/100) (41%) > Reticular alteration (6/100) (6%)	1.562	0.211	0.03 - 2.402
LUNG FIELD INVOLVEMENT			
Lower (85/100) (85%) > middle (57/100) (57%)	6.915	0.009*	1.378 -16.040
Lower (85/100) (85%) > upper (34/100) (34%)	9.091	0.003*	1.401 - 1.983
Middle (57/100) (57%) > upper (34/100) (34%)	99.000	0.453	7.241 - 438.890
LUNG ZONE INVOLVEMENT			
Central (18/100) (18%) > Peripheral (16/100) (16%)	4.181	0.047*	0.724 – 0.895
Both central and Peripheral (56/100) (56%) > Peripheral (16/100) (16%)	23.180	0.000*	0.257 - 0.463
Both central and Peripheral (56/100) (56%) > Central (18/100) (18%)	26.829	0.000*	0.242 - 0.448

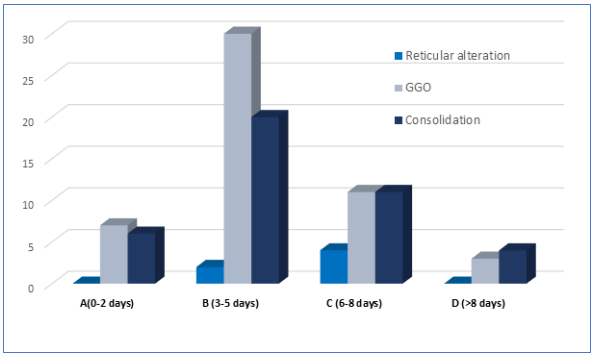
*p value< 0.05 were considered significant

DISCUSSION

Several major radiological societies have discouraged the use of CT as a screening method for COVID pneumonia. Instead, they recommend that CT use be reserved for the treatment of COVID-19 patients with deteriorating and/or severe respiratory symptoms, in particular those in hospital settings or those with special CT indications. These guidelines, along with additional issues about CT, including risks associated with patient transport and scanner decontamination, have certainly contributed to less CT tests for persons under investigation for COVID-19. In this light, chest X-rays can be considered as an alternative to CT, for effective and rapid cleaning of the equipment and for the high availability of portable units[2].

From our study at least one positive radiographic finding was found in 95% of cases and 5% of RT-PCR positive cases were reported as having normal CXR. This shows that a normal chest radiograph does not exclude COVID-19 pneumonia.

The radiological findings in COVID-19 patients vary over time with their clinical progression. A study by Pan F et al[8] have described this time course of lung changes on CT. They defined four stages namely early stage (0–4 days after initial symptoms), progressive stage, peak stage, and absorption stage (5–8 days, 9-13 days and ≥14 days after the onset of initial symptoms, respectively). One of the observations from our study is that GGO is the main finding during early stage and as pulmonary involvement worsens, consolidation becomes the predominant finding [Fig 1]. Our findings corroborate with that of Pan F et al.[8]



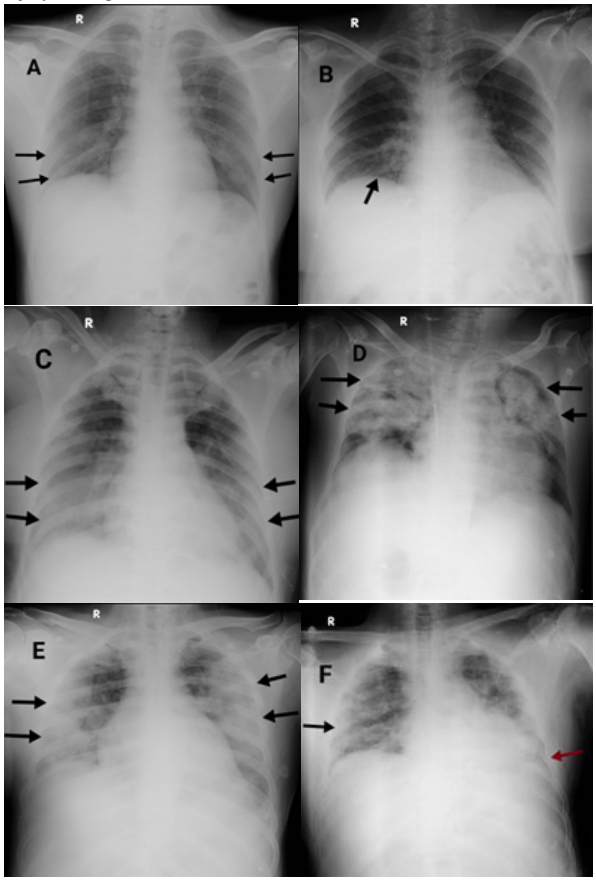
[Fig 1]: The trend of radiographic alterations in different groups

Similarly, another study by Wong et al[5] evaluated 255 CXR in 64 patients, analyzing the time course of chest X ray findings of COVID-19 pneumonia and found 31% overall prevalence of normal baseline chest radiographs. The CXR findings, peaked at 10–12 days from symptom onset.

Our study showed a maximum pool of findings in chest X rays taken within 3-5 days of onset of symptoms and those reported as normal chest radiographs with no findings were taken during the initial 1-3 days of symptoms and hence suggests that CXR acquired during early phase can be negative.

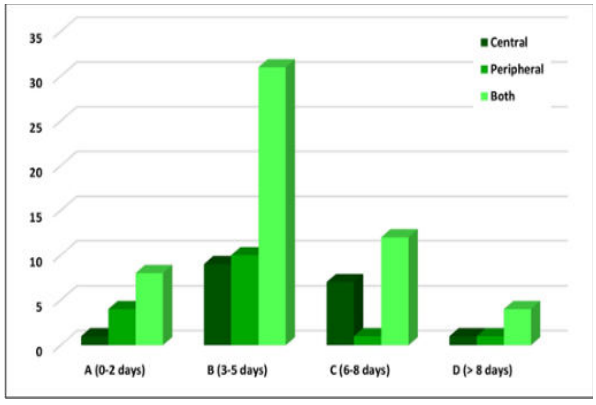
Hence, it can be compared to another study by Bernheim et al[9] in which they stated a decreasing trend in normal chest CT as time interval increases and to the study by Vancheri et al[1] which showed that 60 cases out of the 240 patients had negative chest radiography.

In our study, the majority of cases presented with ground glass opacities (51%) and consolidation (41%) while reticular changes were the predominant finding in 6% cases only. The X-ray images of patients with these pulmonary alterations are given in Fig 2. This pattern of disease described as characteristic of COVID-19 resembles the radiographic appearance in other Coronavirus-related pneumonias[10,11]. The differential diagnosis list includes chronic eosinophilic pneumonia (CEP), nonspecific interstitial pneumonia (NSIP), organizing pneumonia (OP), and acute lung injury, among others.

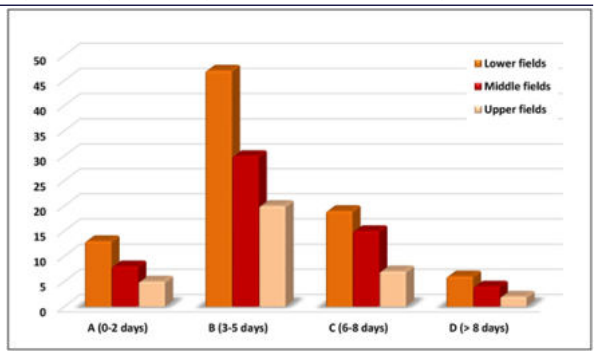


[Fig 2]: A GGO in bilateral lower zones (black arrows), **B** GGO in right lower zone (black arrow), **C-E** Consolidation in bilateral lung fields (black arrows), **F** Reticulations in right mid and lower zones (black arrow) and consolidation in left lower zone (red arrow)

Our data suggests that the presence of peripheral and central distributions together and peripheral involvement alone were significantly more frequent than central distribution alone [Fig 3]. Similar to many other studies, a significantly higher frequency of involvement of the lower fields compared to the middle fields, and of the lower and middle fields compared to the upper fields were observed [Fig 4].



[Fig 3]: The horizontal distribution of alterations in different groups



[Fig 4]: The Craniocaudal distribution of alterations in different groups

Also, we found that 5% of the patients had pleural effusion, which is low in incidence similar to other studies and case reports.

Limitation(s)

Our study had a few limitations. It was a retrospective study on a limited number of patients. We only assessed the CXR of RT-PCR positive patients and we considered only the baseline CXR taken during the admission. The serial follow-up images on subsequent days of each patient were not considered and hence our study describes the pulmonary alterations on radiographs at different time intervals since symptom onset. How the radiographic findings change over time is, therefore, not established.

Another disadvantage of this study is that AP radiographs from portable machines are of lesser quality than PA radiographs, making them more difficult to interpret. But, on the other hand, the advantage of portable bedside CXR is that, it ensures less contamination of equipment and rooms, resulting in a lesser risk of cross infection for other patients and healthcare staff.

CONCLUSION(S)

In a pandemic scenario, with a large amount of confirmed positive cases and equally large number of suspected cases, CXR must be taken into consideration as a feasible and easy-to-use approach to evaluate lung involvement. CXR could give a speedy and cost-effective diagnosis of COVID-19 in a subgroup of infected individuals, while it is not a replacement for RT-PCR or chest CT. CXR is a valuable diagnostic tool when RT-PCR is insufficient in number or quality, or when the results are inconveniently long.

Hence, based on our results, we can conclude that presence of bilateral ground glass opacity or consolidation more frequently in lower zones and central-to-peripheral distribution on a chest radiograph obtained in a patient with symptoms of COVID-19 are highly suggestive of SARS CoV-2 infection. CXR plays a valuable role as a first line imaging modality in making a diagnosis and further treatment.

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