e-ISSN: 0976-822X, p-ISSN:2861-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2023; 15(2); 109-114

Original Research Article

A Hospital-Based Study to Analyze the Patterns of Radiological Findings on Chest Radiograph (CXR) for Suspected and Confirmed COVID‑19 Patients on Initial Presentation to the Emergency Medical Services (EMS)

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Received: 06-01-2023 / Revised: 10-02-2023 / Accepted: 30-03-2023

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Conflict of interest: Nil

Abstract

Aim: The purpose of this study was to analyze the patterns of radiological findings on chest radiograph (CXR) for suspected and confirmed COVID‑19 patients on initial presentation to the emergency medical services (EMS) on admission and to assess the progression and resolution.

Methods: The present study was conducted at department of Radio-diagnosis, Indira Gandhi Institute of Medical Sciences, Patna, Bihar, India for one year and 500 cases of covid-19 were included in the study.

Results: 500 RT‑PCR confirmed COVID‑19 patients were included in our study who had initial CXR. 350 (70%) of our patients with positive initial RT‑PCR showed abnormal baseline CXR. The abnormal findings were described as haziness akin to ground glass opacities (GGO) on CT, peripheral opacities, patchy parenchymal opacities and consolidation. Peripheral opacities and lower zone distribution were the commonest pattern of CXR abnormalities with bilateral involvement. The severity of findings on serial CXR and radiographic regression was studied along with follow‑up to assess response to treatment. Forty‑six patients showed features of acute lung injury (ALI). Complications and new CXR findings were reported for patients who were given ventilator support.

Conclusion: CXR is a valuable baseline radiological investigation on hospital admission in symptomatic patients with suspected or confirmed Covid‑19 presenting to the EMS as it helps to monitor the progress and regression of the disease in conjunction with clinical findings.

Keywords: Acute lung injury; Covid‑19 pneumonia; ventilator‑associated pneumonia.

Introduction

The COVID-19 pandemic has spread worldwide, resulting in at least 639 million confirmed cases and 6.6 million global deaths as of December 1, 2022. [1] Since the prompt development and administration of COVID-19 vaccines, 71% of the world population has received at least one vaccine dose. [2] However, even for fully vaccinated individuals, vaccine breakthrough infections— defined as infections with SARS-CoV-2 at least 14 days after completion of the primary vaccination series—can occur because full vaccination is not 100% effective for preventing illness. [3] Nevertheless, even if breakthrough infections occur, fully vaccinated individuals have less severe disease courses and complications. [4,5] As a result of genetic variations of SARS-CoV-2 during viral replication [6,7] several variants of SARS-CoV-2 have been reported worldwide throughout the pandemic with increased transmissibility and evasiveness of treatments and vaccines (eg, the Delta and Omicron variants). Fortunately, the Omicron variant, the latest variant of concern, predominantly involves the proximal airway and is less virulent, resulting in lower rates of hospitalization, intensive care unit admission, and mortality. [8-10] Chest imaging plays a vital role in narrowing down the differential diagnosis, detecting complications, and potentially prognosticating patients with COVID-19. [11,12]

The chest X‑ray is usually the initial and often only investigation required in the evaluation of diseases of the chest. The world is gripped by a pandemic caused by SARS COV ‑2 virus which results in a lower respiratory tract viral pneumonia termed as Covid‑19 pneumonia. The clinical symptoms of the disease are nonspecific presenting with influenza‑like illness (ILI) with fever >38 degrees C, cough associated with malaise, generalised myalgia, headache and breathlessness. However, patients with Severe Acute Respiratory Infection (SARI) are advised hospitalisation as per WHO recommendation. Real‑time polymerase chain reaction (RT‑PCR) is the standard accepted test in the diagnosis of COVID‑19 to detect the nucleic acid of the virus.

The purpose of this study was to analyze the patterns of radiological findings on chest radiograph (CXR) for suspected and confirmed COVID‑19 patients on initial presentation to the emergency medical services (EMS) on admission and to assess the progression and resolution.

Materials and Methods

The present study was conducted at department of Radio-diagnosis, Indira Gandhi Institute of Medical Sciences, Patna, Bihar, India for one year and 500 cases of covid-19 were included in the study. Consecutive individuals who tested RTPCR positive for SARS COV2 and underwent chest X‑rays were collated during their stay in the hospital. The initial radiograph was evaluated as negative or positive, if positive the type of abnormality, its location, distribution, any other features of note such as cavitation, mediastinal adenopathy, pleural effusion. Note was also made if CT was performed at time of initial X‑ray, if so whether positive or negative.

Patients who had more than one X‑ray were followed up, a note was made of the progression, regression of abnormalities, number of days to reach progression, number of days to regression either from initial X‑ray or after peak of progression. Number which had complications such as ARDS, barotrauma, type of barotrauma, ventilator‑associated pneumonia were recorded.

Results

Table 1: RT-PCR positive patients

	N	%
RTPCR positive patients with normal X‑ray	160	32
RTPCR positive patients with abnormal X‑ray	350	70%
Total HRCT done	260	52%
Abnormal HRCT	450	90%
Abnormal X‑ray abnormal HRCT	360	72%
Normal X‑ray abnormal HRCT	130	26%
X‑ray showing only peripheral opacities	175	35%
X‑ray showing both central and peripheral opacities	325	65%
X‑ray showing haziness (GGO)	150	30%
X‑ray showing consolidation	350	69%
Unilateral‑right lung involvement	110	22%
Unilateral‑left lung involvement	80	16%
Bilateral lung involvement	300	60%
Patients showing progression on serial X‑ray	130	26%
X‑rays showing upper half involvement	150	30%
X‑rays showing lower half involvement	350	70%
First normal x‑ray which showed progression in due course of time	25	5%
Abnormal first X‑ray showing progression	115	22%
Average days of progression	6.7	
Total patients showing regression	125	25%
Average days of regression	10	
Total number of patients which developed acute lung injury (ALI)	50	10%
Patients that presented with ALI	10	5%
Patients that progressed to ALI	14	7%
Patients that regressed from ALI	26	52%
Total patients developing barotrauma during hospital stay	10	2%
Total expired patients	20	4%
Total invasive ventilation patients	15	3%
Total non‑invasive ventilation patients	10	2%

500 RT‑PCR confirmed COVID‑19 patients were included in our study who had initial CXR. 350 (70%) of our patients with positive initial RT‑PCR showed abnormal baseline CXR. The abnormal findings were described as haziness akin to ground glass opacities (GGO) on CT, peripheral opacities, patchy parenchymal opacities and consolidation. Peripheral opacities and lower zone distribution were the commonest pattern of CXR abnormalities with bilateral involvement. The severity of findings on serial CXR and radiographic regression was studied along with follow‑up to assess response to treatment. Forty‑six patients showed features of acute lung injury (ALI). Complications and new CXR findings were reported for patients who were given ventilator support.

Discussion

Excessive transmission of COVID-19 has shown to have an adverse impact on the economy of developing countries with inadequate healthcare infrastructure. &e CXR may be considered as an inexpensive first-line investigative modality for detection of abnormalities in lung

parenchyma. This appears on Chest radiographs X‑rays as a diffuse haziness obscuring vascular markings, akin to the well documented ground‑glass densities seen on CT scans. [13] With further progression in alveolar cell apoptosis the exudation may result in denser opacities on the X‑ray appearing as consolidations. These consolidations do not incite sympathetic effusions or internal cavitation as may occur with bacterial pneumonias. Occasionally reticular opacities may be seen on the X‑ray as linear bands due to septal/alveolar thickening due to inflammation. The distribution of abnormalities is usually in the lung bases as well as in the periphery. [14,15]

In our study 70% of patients with positive RTPCR had abnormalities on the chest X‑ray. 32% were negative. Chest radiograph was negative in 26% of positive HRCT indicating CT is far more sensitive than chest X‑ray in detecting COVID 19 pneumonia. These findings were consistent with smaller cohorts reported earlier. [16,17] The diffuse alveolar damage evolves over 1‑3 weeks resulting in temporal changes on imaging. There are 3 stages of diffuse alveolar damage. [17] The alveolar oedema of ARDS is not accompanied by widening of the vascular pedicle, cardiomegaly, altered pulmonary blood flow distribution, pleural effusions and septal lines. In fact if the pulmonary vessels can be distinguished they are often constricted in size. The opacities tend to be in the periphery as compared to central in cariogenic oedema as well as don't change temporally as they do on cardiogenic oedema. In our study 9% of patients progressed to ARDS. [18]

When there is strong clinical suspicion of COVID-19 and a report of RT-PCR for SARS-CoV-2 is waited for diagnosis, a rapid radiological evaluation is mandatory to initiate early optimal treatment. The CXR should be recommended as the first-line imaging modality, while a computed tomography (CT) scan remains the imaging modality of choice in particular cases. [19,20] A CT scan has low specificity and very high sensitivity (approximately 97-98%) in diagnosing typical findings of SARSCoV- 2 pneumonia. [21,22] A CT scan is performed only in specific conditions whenever there is clinicoradiological mismatch such as negative CXR for symptomatic infective lung disease, patients having severe respiratory failure, and suspicion of pulmonary embolism or malignancy. [23] A portable X-ray machine is of value because of easy availability, faster results, less radiation exposure, easy disinfection procedure, and minimum risk of cross infection. Community-acquired pneumonias on CXRs are predominantly unilateral and involve only one part of the lung; there are no ground-glass or linear opacities, and they are typically associated with consolidation on CXRs.3

Conclusion

In COVID-19, chest imaging findings reflect pathologic changes beyond an anatomic resolution. Mild COVID-19 pneumonia manifests as ground-glass opacity–dominant lesions involving a relatively limited extent, which are pathologically reflected in the organizing pneumonia pattern or nonspecific bronchopneumonia. Potentially fatal COVID-19 pneumonia commonly manifests as more extensive mixed to consolidation-dominant lesions, pathologically representing diffuse alveolar damage or acute fibrinous organizing pneumonia patterns. Although chest imaging cannot directly depict the integrity of the alveolar-vascular basement membrane, imaging features can help stratify the disease course of COVID-19 to determine whether it can be reversed or will progress irreversibly. In addition to epithelial injury in COVID-19, endothelial injury is characteristically considered a major cause of acute respiratory distress

syndrome. The chest X‑ray is an important diagnostic tool in the detection and management of Covid‑19 pnuemonia. Chest X‑ray is useful tool to detect changes to suggest the diagnosis, CT chest however has a higher sensitivity. The common CT findings of bilateral involvement, peripheral distribution, and predominantly in lower zones were also appreciated on CXR which was commensurate with other studies.[14,16] Portable CXR being a bedside modality can be used to monitor the progression, regression of lung changes, complications in the form of ARDS, barotrauma, ventilator‑associated pneumonia and misplaced tubes and lines helping reduce the morbidity and mortality.

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