

MANIFESTATIONS OF PCR POSITIVE COVID-19 PNEUMONIA ON CT CHEST: OUR INITIAL EXPERIENCE AT SHIFA INTERNATIONAL HOSPITAL, ISLAMABAD

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ABSTRACT

PURPOSE: COVID pneumonia, emerged as a pandemic, is a highly communicable viral infection, pathogen being novel corona virus. Though the definitive diagnosis is established by a positive RT-PCR throat swab; radiological imaging may also provide an important adjunct towards the diagnosis of novel corona virus infection. The first line imaging modalities being radiograph and computed tomography (CT) chest. Purpose of the study was to document the common imaging appearances of emerging novel corona virus disease on CT scan. **MATERIALS AND METHODS:** All the consecutive patients presenting to Shifa International hospital (SIH), Islamabad from February 2020, to May 2020, having RT-PCR positive COVID-19 infection were enrolled retrospectively with CT chest performed at admission. These imaging scans were evaluated by two independent Consultant Radiologists. Data was analyzed on SPSS v21 and displayed as frequency percentages. **RESULTS:** 150 patients (115 (76.7%) men, 35 (23.3%) women; mean age 57.39 ±13.5 standard deviation) were included in the study. The characteristic CT features of COVID-19 pneumonia included ground-glass opacities (GGOs) in 138 patients (92%) which were bilateral, multifocal and multilobar. Among these 138 patients with bilateral and multifocal ground-glass opacities (GGOs) with concomitant consolidations were present in 41 (29.7%) and crazy paving was seen in 105/138 scans (76%). 5 out of 150 patients lacked these GGOs and showed consolidations without GGOs. Other imaging features included subpleural lines in 10 patients (6%), vascular dilatation in 22 patients (14.6%) and air bronchograms in 30 patients (20%). Pleural effusion in 3 scans (2%). None of the initial cases showed enlarged lymph nodes. 7 out of 150 scans (4.6%) had no positive findings. Predominantly peripheral and bilateral distribution in 146 of 150 scans (97.3%). **CONCLUSION:** According to our initial experience, the imaging appearances of COVID-19 infection on CT chest comprises of predominantly bilateral, multilobar and multifocal GGOs. Crazy paving and concomitant consolidations may or may not be seen. Other commonly reported features were subpleural lines, vascular dilatation and air bronchograms with pleural effusions being the least common.

Keywords: Corona virus, Computed tomography (CT), PCR, ground glass opacities, consolidations, air bronchograms, pleural effusion.

Introduction

COVID pneumonia, emerged as a pandemic, is a highly communicable viral infection, pathogen being (SARS-CoV-2) novel corona virus. The clinical pre-

sentation in patients infected with corona virus varies from no obvious symptoms at all to development of mild or severe respiratory complications including

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respiratory distress syndrome (RDS).² Though the definitive diagnosis is established by a positive Real-time reverse transcription polymerase chain reaction (RT-PCR) throat or nasal swab; radiological imaging may also provide an important adjunct towards the diagnosis of novel corona virus infection. The initial radiological imaging modalities being radiographs as well as High resolution CT chest (HRCT).¹⁻³

The gold standard for diagnosis of COVID-19 infection remains Real-time reverse transcription polymerase chain reaction (RT-PCR); however, recent studies have emphasized upon the significance of CT chest in diagnosing the disease especially in cases where PCR results turn out to be false negative.^{4,5} The reported CT chest sensitivity in diagnosis of COVID 19 pneumonia is documented up to 98%.⁶ Also, the importance of CT scan is limited not only to diagnosis of COVID 19 infection but it also aids in surveillance of progression of disease and to monitor the response to treatment.^{1,7}

Common imaging manifestations of this highly contagious viral infection are described in literature particularly on CT imaging. Initially these findings included bilateral peripheral ground-glass opacities (GGOs) may or may not be accompanied by consolidations.^{8,9} With further advancement in disease pattern and ongoing research studies, a variety of imaging appearances were described on CT. These include combination of aforementioned GGOs and consolidations with or without crazy paving pattern, air bronchograms, subpleural bands, vascular dilatation and pleural effusions etc.¹⁰⁻¹²

Every country and its population harbors unique set of immune system influenced by genetic, environmental and epidemiological factors, so it is important to study spectrum of disease on imaging in our own population. In the current study, we described the manifestations of CT findings of this pneumonia in our local population who had laboratory-confirmed COVID-19 pneumonia.

Material and Methods

The study was approved by our institutional review board and ethics committee (IRB and EC). All the patients who presented to emergency department of Shifa International hospital with symptoms of corona

virus disease and having PCR positive for COVID 19 pneumonia were enrolled in our study from February 2020 to May 2020. The total number of these PCR positive cases at the time of admission was 150. These 150 patients also underwent a CT chest as initial radiological investigation.

CT IMAGE ACQUISITION:

Non contrast high resolution CT chest images were acquired on a 128 slice CT scanner (Somatom Definition Edge Siemens, Germany) and 320 slice CT scanner Toshiba Aquilion one. Following were the imaging / CT acquisition parameters: tube current and voltage= 20 mAs and 100 kVp respectively; slice thickness and reconstruction interval each of 1 mm and scan time, 3.32 seconds. The CT scan was performed in all patient's position being supine and in full inspiration. No contrast medium was used in acquisition of CT images. Kernel Bf37 for mediastinum and kernel BI57 for lungs were used with SAFIRE strength 2 for both.

CT REVIEW:

Two independent consultant radiologists (having 05 years and 07 years of radiology experience) evaluated the acquired CT chest study in consensus. For lung window, the window width of 1200 Hounsfield units (HU) and -600 HU level was utilized. While for reviewing mediastinum, 350 HU window width and 50 HU level was used. CT chest was then reviewed for the following imaging parameters: predominant pattern of lung involvement (both lungs or single lung) and in case of unilateral lung the lobe was identified. Distribution of abnormalities on the basis of location (peripheral location, centrally located or both). Imaging features (ground-glass opacities, consolidations, or combination of consolidation with ground-glass opacities), presence of any additional finding (crazy-paving, subpleural lines, air bronchograms, nodules and vascular thickening). The presence of any extrapulmonary finding (pleural effusion or lymphadenopathy particularly in mediastinum) was also documented.

DATA ANALYSIS AND STATISTICS:

The analysis of data was carried out utilizing SPSS version 21.0. The results were displayed as counts and frequency percentages for categorical variables and mean with standard deviation for continuous variables.

Results

Among these 150 patients, 115 (76.7%) were males and 35 were (23.3%) females; mean age was 57.39 \pm 13.5 standard deviation).

On the basis of analysis; the characteristic CT features for COVID 19 pneumonia included ground-glass opacities (GGOs) which were bilateral, multifocal and multilobar in 138/150 patients (92%). Among these 138 patients with bilateral multifocal GGOs; concomitant consolidations were present in 41 (29.7%) and crazy paving was seen in 105/138 scans (76%). 5/150 patients (3.3 %) lacked ground glass opacities and showed consolidations without GGOs. 7 out of 150 scans (4.6%) had no positive findings and were normal studies.

Other imaging features included subpleural lines in 10 patients (6%), vascular dilatation in 22 patients (14.6%) and air bronchograms in 30 patients (20%). Pleural effusion was documented in 3 cases (2%). None of the initial cases showed enlarged lymph nodes. Predominantly peripheral and bilateral distribution in 146 of 150 cases (97.3%) and rest of the 4 cases showed unilateral lung involvement.

Discussion

COVID pneumonia, is a highly communicable viral infection, pathogen being (SARS-CoV-2) novel corona virus. Since the emergence of this pandemic, radiological imaging is thought to play a crucial role in prompt diagnosis and triage. CT Chest being the most convenient and non invasive modality owing to its great sensitivity for prompt diagnosis of COVID 19 pneumonia particularly in the areas with high incidence of infection.^{3,13} We enrolled 150 patients in our study having PCR positive COVID 19 pneumonia. Majority of the patients infected were males 115 (76.7%), concordant with previously published data. While analyzing and reviewing the CT manifestations of COVID-19 infection in our enrolled patients, we concluded that most of the cases on CT chest had predominantly bilateral and multifocal lung involvement as seen in 146 of 150 scans (97.3%); however, 4 of 150 scans (2.6%) showed involvement of a single lung either left or right, and among these

cases, 3 patients showed involvement of upper and lower lobe of right lung and 2 patients had left upper lobe involved.

In our experience, COVID 19 pneumonia showed a diversified spectrum of CT appearances, showing mixed pattern with involvement of lung parenchyma, interstitium and combination of both.¹⁴ These imaging features comprising of multilobar ground-glass opacities (GGOs) in 138 patients (92%). Only 5 patients (3.3%) were exceptional as they lacked ground glass opacities and showed bibasal consolidations without groundglass opacities. Among these 138 patients with bilateral and multilobar ground-glass opacities (GGO) concomitant consolidations were present in 41 (29.7%) and crazy paving was seen in 105/138 scans (76%). Other imaging features included subpleural lines in 10 patients (6%), vascular dilatation in 22 patients (14.6%) and air bronchograms in 30 patients (20%). Pleural effusion was documented in 3 cases (2%). None of the initial cases showed enlarged lymph nodes. 7 out of 150 scans (4.6%) had no positive findings and were normal studies.

The mechanism for these imaging appearances is described in literature manifested as acute lung injury; pathogen being the virus. The predominant pattern of pulmonary damage is alveolar damage with accumulation of exudative fluid in the alveolar sac along with congestion of alveolar capillaries forming GGOs on CT examination. Another pattern of micro or macro coagulopathy is also described in literature leading to pulmonary thromboembolism. Further the pulmonary interstitium invasion by the virus is represented by edema and thickening of interlobular septa, subpleural, interlobular central and peribronchovascular interstitium. When the lung parenchyma gets further infiltrated, this manifests as consolidation. Air within the bronchus in consolidations forms air bronchograms on CT. A combination of GGOs and reticular pattern evolve in to subpleural line and represents interlobular septal thickening.¹⁵ The vascular dilation sign occurs as the blood supply to inflammatory area is increased. A combination of interlobular septal thickening and intralobular lines superimposed on a background of GGOs results in Crazy paving pattern, mimicking irregular paving stones. The involvement of pulmonary interstitium is observed during healing or resorptive phase of disease. The fibrotic bands are seen in chronic fibrotic phase of alveolar damage

and can be seen in follow up studies only, thus none of our patients had fibrotic phase as study was carried out in initial phases of pandemic.^{7,13,16}

The rare imaging manifestations described in literature include Halo sign, the exact pathogenesis of this however at present remains unknown. None of our patients manifested this sign. In limited recent data on COVID 19 pneumonia, the only reported case having halo sign in a young 27 year old COVID 19 positive female patient is by Li et al.¹⁷ Previously, halo sign however has been reported with angio-invasive fungal infections particularly seen with perilesional hemorrhage or metastases of hypervascular nature.¹⁸ It also has been reported in organizing pneumonias and variety of viral pneumonias / infections.¹⁹ Pleural findings manifesting predominantly as pleural effusion have been reported upto 5% cases in literature.²⁰ About 4-8% of COVID-19 patients manifested lymphadenopathy.^{20,21} None of our patients manifested lymphadenopathy; while pleural effusions were seen in 2% of our cases.

The diversified appearances of corona virus disease on chest CT may overlap with imaging spectrum of other viral infections and pneumonia especially within the alike genre of Coronaviridae due to diffuse interstitial and alveolar damage attributed to similar pathogenesis.¹⁴ Current researches including our study however reinforces bilateral and multilobar lung involvement in COVID-19 infection. This differs from lung disease in subjects with previously seen viral infections including SARS and MERS that appeared as unifocal rather than being multifocal as in COVID 19 patients.²² Moreover, the described bilateral peripheral GGO of COVID-19 disease can mimic other diseases such as pneumonia caused by Influenza or organizing pneumonia which may be idiopathic or may be secondarily due to underlying disorders related to connective tissues and drug toxicity.²³

Our study had certain limitations; including the retrospective study design, we only included CT chest studies carried out upon admission and changes in the imaging pattern along with temporal phases of the disease were not assessed due to unavailability of follow up studies and early phases of epidemic in Pakistan. This study is based on initial CT scans and we used non contrast HRCT chest, we were not able to access well recognized thromboembolic complications (pulmonary thromboembolism) associated

with COVID 19 disease. Sample size was small due to initial phases of pandemic in our population. The study is unicentric and focused on results from our hospital, input from other centers offering radiological facilities / CT chest for COVID 19 disease patients would also be helpful in validating our results. Also, in our analysis, we documented the spectrum of CT appearances manifested upon admission to the hospital to provide a broad perspective and informative impression for early diagnosis of this ongoing pandemic, thus helping radiologists and clinicians.

In conclusion, COVID-19 pneumonia involves both lung parenchyma and interstitium resulting in a diverse spectrum of imaging findings on CT chest. Typical findings include presence of multifocal bilateral GGOs, concomitant consolidations may or may not be present. The typical crazy-paving pattern formed due to combination of interlobular septal thickening and GGOs having peripheral predominant distribution on CT chest. Our findings of diversified spectrum of CT appearance of COVID 19 disease were concordant with data published previously. Regarding distribution pattern, multifocal and predominantly bilateral peripheral involvement of lungs was confirmed, consistent with the studies performed worldwide.

Conflict of Interest: Declared none by authors.

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