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# Diagnostic Utility of Chest CT versus Radiography in COVID-19

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## Abstract

***Background*: Coronavirus Disease-2019 (COVID-19) is considered an acute infectious disease mainly involving the respiratory system. The diagnosis depends on a reverse transcription-polymerase chain reaction. However, these methods are time-consuming do not allow assessing the disease severity, and may give false negative results. *Aim:* The present study was conducted to identify the role of CT chest findings and chest radiography in the diagnosis, severity, and prognosis of the disease. *Patients and Methods:* This cross-sectional study included 105 patients with PCR-confirmed COVID-19 infection from Suez Canal University Hospital, Ismailia City, Egypt. All patients were subjected to history taking, chest X-ray, and CT. *Results:* A review of the chest X-ray of the study subjects revealed that 21.9% of the study patients had positive chest X-ray findings and 78.1% had negative findings. Those chest x-ray findings were unilateral in 13.0% and bilateral in 87.0% of the 23 positive patients. About 18.1% of the study patients had subtle CT findings, 15.2% had mild-moderate findings, 18.1% had extensive findings, 8.6% had very severe findings, and 40.0% had negative findings. This is compared to only 21.9% positive cases by the chest X-ray. Compared to the 63 subjects with positive findings in the CT scan (60 %), the chest X-ray imaging interpretation findings were much less (only 23 subjects comprising 21.9 % of all subjects). *Conclusion:* CT is the modality of choice while X-Ray has a very limited role in COVID Imaging. Further larger longitudinal studies are needed to confirm the results of our study.**

***Keywords:*** Chest CT, COVID19

## Introduction

Coronavirus illness-2019 (COVID-19) is a recently discovered acute viral illness that mostly affects the respiratory system in humans[1]. Patients first presented with symptoms including fever, exhaustion, dry cough, and as their condition worsened, acute dyspnea[2]. Reverse transcription-polymerase chain reaction (RT-PCR) or gene sequencing of sputum, throat samples, or lower respiratory tract secretions are required for the diagnosis. These techniques, however, take a lot of time, do not allow for the assessment of illness severity, and may provide falsely negative results[3]. The diagnostic accuracy of the chest CT for COVID-19 must be evaluated alongside the radiation dose. Arguments are made for the additional utility of chest CT scans in

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the diagnosis of COVID-19, particularly in individuals who display the usual clinical symptoms and have negative RT-PCR findings in the areas with the highest infection levels[4]. When clinical and epidemiological characteristics are taken into consideration, a CT scan exhibits strong sensitivity and a consistently better specificity for the diagnosis of COVID-19 pneumonia than what has been reported by other research[5]. During the 2002 and 2012 Middle East respiratory syndrome (MERS) outbreaks, chest radiographs (CXR) were important in predicting the progression and severity of the disease[6]. When diagnosing COVID-19 in the general community during the pandemic, CXR shows poor sensitivity and specificity. In the first evaluation of COVID-19 during the pandemic, CT scanning should be strongly evaluated because of its outstanding sensitivity[7]. In this study, we determined how chest radiography and CT results affect the diagnosis, prognosis, and severity of the disease. This study aimed to clarify the role of chest CT and chest x-ray in the diagnosis of proven cases of COVID-19.

## Patients and Methods

This cross-sectional comparative study was conducted at Suez Canal University (SCU) Hospital in Ismailia City, Egypt during the period from June 2020-to September 2020. It included 105 patients with PCR-confirmed COVID-19 infection from Suez Canal University Hospital, Ismailia city, Egypt. Adult patients (>18y) proved to have COVID-19 irrespective of the general condition and the O2 saturation level was included in the study. While pregnant women and children were excluded.

*Methods*

All patients were subjected to a) History taking about their symptoms and duration (fever, cough, dyspnea, and fatigue). b) O2 saturation by pulse oximeter. c) treatment received. D) Laboratory tests (CRP, CBC, D dimer, serum ferritin, PCR), and e) Radiological study as follows: 1- Chest x-ray (Either PA view or AP view, Erect or supine views). 2- High-resolution CT chest is used according to the site, location, and degree of infiltration.

*Reverse transcription polymerase chain reaction*

Polymerase chain reaction (PCR) is a process that amplifies a small, well-defined segment of DNA many hundreds of thousands of times, creating enough of it for analysis. Test samples are treated with certain chemicals that allow DNA to be extracted. Reverse transcription converts RNA into DNA. Reverse transcription polymerase chain reaction (RT-PCR) first uses reverse transcription to obtain DNA, followed by PCR to amplify that DNA, creating enough to be analyzed. RT-PCR can thereby detect SARS-CoV-2, which contains only RNA. The RT-PCR process generally requires a few hours. Samples can be obtained by various methods, including a nasopharyngeal swab, sputum (coughed up material), throat swabs deep airway material collected via suction catheter] or saliva.

*CT chest*

All patients underwent scanning with the Toshiba Alexion® 16 slice CT scanner. (Toshiba Inc® Ōtawara, Tochigi, Japan). The acquisition parameters were set at 120 kVp; 100–200 mAs; pitch, 0.75–1.5; and collimation, 0.625–5 mm. All imaging data was reconstructed by use of a medium sharp reconstruction algorithm with a slice thickness of 0.625–5 mm. CT images were acquired at full inspiration with the patient in the supine position.

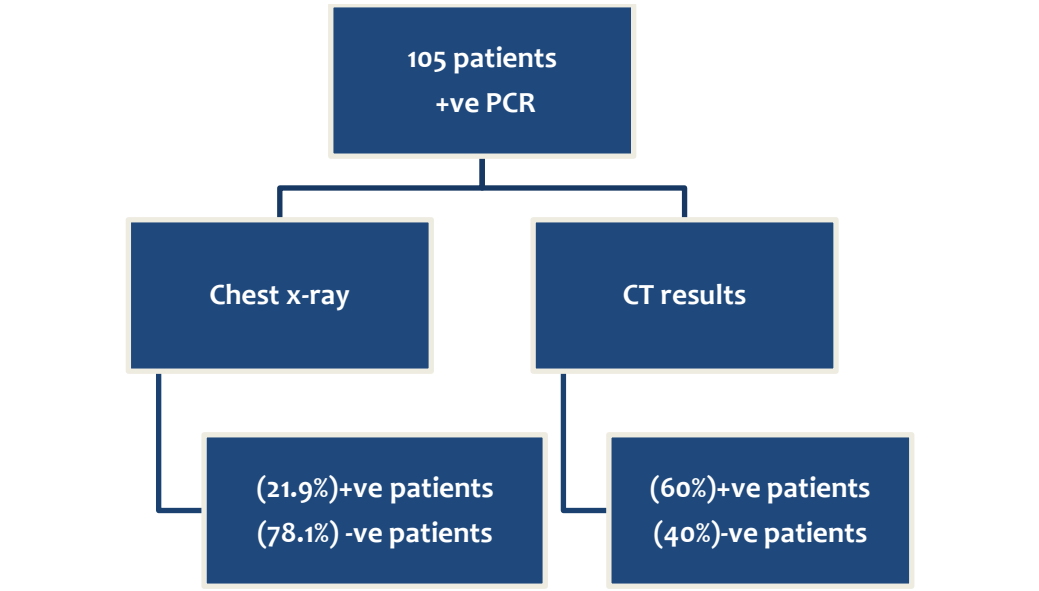
*Chest x-ray*

Chest x-Ray and CT images were assessed in two different sessions, one for each by a

single Ph.D. radiologist with experience in thoracic imaging for 6 years. Chest x-ray was interpreted for positivity versus negativity and side of affection. The most common findings are airspace opacities, which may be consolidations or, less frequently, ground-glass opacities. Chest X-ray findings in patients with suspected COVID-19 have been divided into four categories to facilitate diagnosis[8]. Normal chest X-ray. It is not uncommon for the chest X-ray to be normal early in the disease, so a normal X-ray does not rule out infection. Typical findings or findings commonly associated with COVID-19 in the scientific literature. These include a reticular pattern, ground-glass opacities and consolidations, with rounded morphology and a confluent or patchy multifocal distribution. The distribution is usually bilateral and peripheral, with a predominance in the lower fields. The differential diagnosis includes organising pneumonia, drug toxicity and other causes of acute lung damage. Between the first and third week from the onset of symptoms, typical X-ray findings may progress to diffuse disease. This is related to a severe clinical hypoxaemia situation, and the main differential diagnosis is acute respiratory distress syndrome (ARDS)[8]. The following were assessed in CT: a) Degree of infiltration by subjective assessment interpreted in two four grades: 1. Subtle (< 5%), 2. Mild (5–< 30%), 3. Moderate (30–< 60%), 4. Severe (≥ 60%). B) Presence of the following (consolidation/ GGO/ location/ crazy paving / halo sign/ pleural effusion / septal thickening). The CT images were evaluated with both lung (width,1500 HU; level, -600 HU) and mediastinal (width, 400 HU; level, 40 HU) window settings.

## Results

This study is a cross sectional study. It included 105 patients with PCR-confirmed COVID-19 infection from Suez Canal University Hospital, Ismailia city, Egypt.




**Descriptive data of all study patients.**

Mean age of the study patients was 40.48±17.99 years. 51.4% of them were males and 48.6% were females (Table 1). The mean $O^2$ saturation of the study patients was 92.27±9.45%. 17.1% of the patients needed assisted ventilation and only

4.8% were intubated (Table 2). Review of the chest X-ray of the study subjects revealed that 21.9% of the study patients had positive chest X-ray findings and 78.1% had negative findings (Fig.1). Those chest x-ray findings were unilateral in 13.0% and bilateral in 87.0% of the 23 positive patients. Sensitivity of chest X-ray is 21.9%. On the other hand, the CT-scan imaging interpretation rendered 63 patients to have positive findings comprising 60% of the whole subjects (Table 3). Table (4) showed that compared to the only 23 subjects with positive findings in the chest X-ray (21.9), the CT-scan imaging positive findings were much higher (63 subjects comprising 60 % of all subjects).

**Table 1: Age and gender distribution of the study subjects**

| | **Group A** |
|---|---|
| **Age (Years)**<br>**Mean ± SD**<br>**Median (range)** | <br>40.48 ± 17.99<br>40 (2 – 91) |
| **Male Gender** | 51.4% |

**Table 2: severity assessment of the study subjects**

| **n=105** | **N** | **%** |
|---|---|---|
| **O2 Saturation**<br>*Mean ± S.D.*<br>*Range* | <br>92.3 ± 9.45<br>40 - ≥ 95 | |
| **Assisted ventilation** | | |
| *Yes* | 18 | 17.1 |
| *No* | 87 | 82.9 |
| **Intubation** | | |
| *Yes* | 5 | 4.8 |
| *No* | 100 | 95.2 |

Table (5) shows that 30.2% of the study patients had subtle CT findings, 25.4% had mild-moderate findings, 30.2% had extensive findings, 14.2% had very severe findings. Table (6) shows that out of the 63 CT-positive cases, posterior predominance was present in 69.8%, pleural based predominance in 92.1%, distribution was centrilobular in 7.9%, pleural based in 68.3%, no predominance in 23.8%, lower lobe predominance in 57.1%, and ground glass opacity in 95.2%. Out of the 63 CT-positive cases, consolidation was present in 41.3%, ground glass opacity in 68.3%, consolidations in 14.3%, air bronchogram in 22.2%, crazy paving in 20.6%, halo sign in 12.7%, and reversed halo sign in 4.8%. Out of the 63 CT-positive cases, pleural effusion was absent in 100.0%, septal thickening was present in 31.7%, as well as parenchymal bands in 44.4%, and significant scaring in 6.3%. Pleural sparing was none in 63.5%, some in 27.0% and all\most in 9.5%. Lymph nodes findings were absent or minimal in 100% of the CT-positive cases. Table (7) shows that 27.0% of the positive CT patients needed assisted ventilation and 73.0% did not. Sensitivity of CT findings to predict need for assisted ventilation is 94.4%.

**Table 3: CT scan findings of the study subjects (n=105)**

| | **N** | **%** |
|---|---|---|
| **Findings** | | |
| *Positive* | 63 | 60.0 |
| *Negative* | 42 | 40.0 |

## Discussion

Chest computed tomography (CT) plays a significant role in the very early stages of the infection, when the nasopharyngeal swab may still be negative, for ultimately placing the diagnosis of COVID-19 in patients who are highly suspicious (i.e., clinical features and exposure history), and for setting up a prognosis. Additionally, over the course of the disease, for evaluating changes in severity necessitating treatment adjustments, prompt radiologists to suggest the progression of the illness's CT characteristics may signal a parallel pro-

gression in the severity of the condition, which should be immediately reported to doctors (e.g., the possibility of a subsequent bacterial infection), making chest CT a crucial follow-up tool[9].

**Table 4: Findings of the CXR vs CT-scan (n=105)**

| | | |
|---|---|---|
| **Chest X-ray** | **N** | % |
| *Positive* | 23 | 21.9 |
| *Negative* | 82 | 78.1 |
| **CT** | | |
| *Positive* | 63 | 60.0 |
| *Negative* | 42 | 40.0 |

Our study's objective was to assess the diagnostic efficacy of thoracic imaging (chest X-ray, computed tomography (CT)) in the assessment of individuals suspected of having COVID-19.

**Table 5: CT scan findings of the study subjects (n=63)**

| | N | % |
|---|---|---|
| **Positive findings** | | |
| Subtle | 19 | 30.2 |
| Mild-moderate | 16 | 25.4 |
| Extensive | 19 | 30.2 |
| Very severe | 9 | 14.2 |

In this cross-sectional investigation, 105 patients from the Suez Canal University Hospital in Ismailia, Egypt, who had COVID-19 infection that had been verified by PCR were included. The study's participants had an average age of 40.48 17.99 years. They were split between 48.6% women and 51.4% men. The research participants' average oxygen saturation was 92.279.45%. Only 4.8% of the patients required intubation whereas 17.1% required assisted breathing.

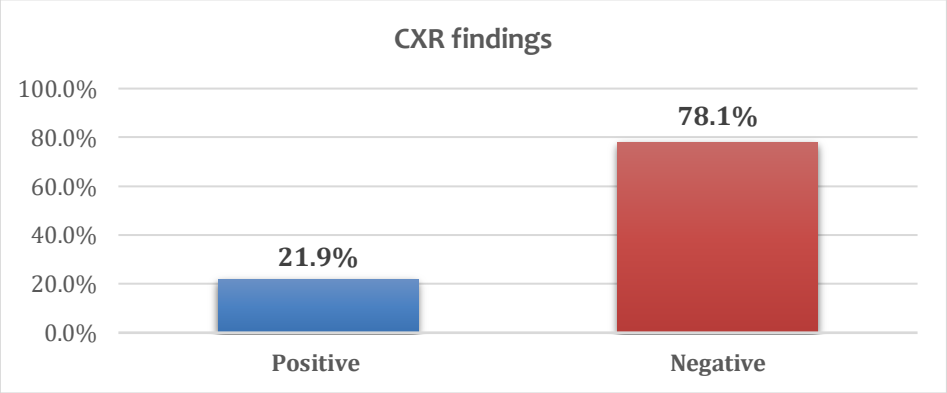



**Figure 1: Chest X-Ray findings among study subjects.**

According to our data, chest X-ray positive findings were substantially lower than CT scan positive findings (60% *vs.* 21.9%). Additionally, 94.4% of CT results were sensitive enough to indicate the requirement for assisted breathing. However, the chest X-ray had a sensitivity of 21.9% and a specificity of 34.9%. Our findings are consistent with those of Ai et al.[10], who noted that chest CT had a 97% sensitivity for predicting COVID-19 and that 59% of patients with COVID-19 had positive RT-PCR results and 88% had positive scans. Our findings are consistent with those of Chen et al.[11], who noted that 12% of patients had no abnormalities, bilateral pneumonia was the most frequent finding on the CXR (81%), and unilateral pneumonia occurred in 6% of patients who tested positive. In terms of distribution predominance, lower lobe predominance was found in 57.1% of cases, posterior predominance in 69.8%, pleural

based predominance in 68.3%, peripheral based predominance in 92.1%, centrilobular predominance in 7.9%, and centrilobular predominance in 68.3%.

**Table 6: CT findings of the study subjects (n=63)**

| | N | % |
|---|---|---|
| **Posterior predominance** | | |
| Yes | 44 | 69.8 |
| No | 19 | 30.2 |
| **Pleural based predominance** | | |
| Yes | 58 | 92.1 |
| No | 5 | 7.9 |
| **Distribution predominance** | | |
| Centrilobular | 5 | 7.9 |
| Pleural based | 43 | 68.3 |
| No predominance | 15 | 23.8 |
| **Lower lobe predominance** | | |
| Yes | 36 | 57.1 |
| No | 27 | 42.9 |
| **Ground glass opacity** | | |
| Yes | 60 | 95.2 |
| No | 3 | 4.8 |
| **Consolidation** | | |
| Yes | 26 | 41.3 |
| No | 37 | 58.7 |
| **Pattern predominance** | | |
| Ground glass opacity | 43 | 68.3 |
| Consolidations | 9 | 14.3 |
| No predominance | 11 | 17.5 |
| **Air bronchogram** | | |
| Yes | 14 | 22.2 |
| No | 49 | 77.8 |
| **Crazy paving** | | |
| Yes | 13 | 20.6 |
| No | 50 | 79.4 |
| **Halo** | | |
| Yes | 8 | 12.7 |
| No | 55 | 87.3 |
| **Reversed halo** | | |
| Yes | 3 | 4.8 |
| No | 60 | 95.2 |
| **Pleural effusion** | | |
| Yes | 0 | 0.0 |
| No | 63 | 100.0 |
| **Septal thickening** | | |
| Yes | 20 | 31.7 |
| No | 43 | 68.3 |
| **Parenchymal bands** | | |
| Yes | 28 | 44.4 |
| No | 35 | 55.6 |
| **Significant scarring** | | |
| Yes | 4 | 6.3 |
| No | 59 | 93.7 |
| **Pleural sparing** | | |
| None | 40 | 63.5 |
| Some | 17 | 27.0 |
| All\most | 6 | 9.5 |
| **Lymph nodes** | | |
| No or minimal | 63 | 100.0 |
| Extensive | 0 | 0.0 |

Our findings are very comparable to those of Zhao et al. [12], who noted a preference for the lower lobes in 55 (54.5%), 88 (87.1%), 1, (0.1%), central, 83 (82.2%), and 10 (9.9%) of instances, respectively (Zhao et al., 2020). Regarding the specific signs of CT findings, interstitial thickening was evident in 31.7% of cases, parenchymal bands in 44.4%, and severe scarring in 6.3%. Air bronchogram was detected in 22.2% of cases, halo sign in 12.7%, and inverted halo sign in 4.8%. Additionally, 100% of patients lacked extrapulmonary symptoms including pleural effusion. However, in 100% of the instances where the CT was positive, there were no or few lymph node abnormalities. Yu stressed that these results may be related to the capillary wall swelling and damage brought on by pro-inflammatory substances[13]. Our findings are consistent with those of Xu et al.[14], who said that interstitial thickening or reticulation was evident in 33 (37%), air broncograms were detected in 7 (8%), fibrotic streaks or linear opacities were observed in 55 (61%), and lymphadenopathy was present in 1 (%) cases. Pleural retraction sign/thickening was evident in 50 (56%) of the patients, whereas pleural effusion was present in 4 (4% of the cases). According to our findings, 14.2% of the research participants had extremely severe findings, 30.2% had extensive findings,

25.4% had mild-moderate findings, and 30.2% had faint CT abnormalities. In the early stages of the illness, our findings on the CT scans showed pure ground-glass opacity, which was followed by the emergence of crazy paving and, subsequently, increased consolidation. These results reduce anchoring heuristics that can be prevalent among practitioners in high-volume situations and enable the identification of patients at high risk. Similar to this, Liu et al.[15], identified the initial and follow-up CT features in COVID-19 patients by categorizing them according to severity, in patients with moderate, common, severe, and critical type. Atelectasis and pleural effusion findings were rarely observed and were found only in critically ill patients, suggesting a worse prognosis when these signs occurred; in the follow-up, CT scans, mostly in patients who had recovered from the disease, GGO, and consolidation were resolved, while the interlobular septum and bronchial wall thickening, band opacities and scattered patchy consolidation were still visible in a minority of patients[15]. CT may show a crazy-paving pattern. According to Wang et al. 70% of patients with this abnormality will be classified as severely or critically ill. It is caused by an alveolar pattern plus an interstitial pattern. It reflects an increase in alveolar exudate and dilation with increased permeability of the capillaries of the interlobular septa, leading to interlobular interstitial oedema[16]. There are disagreements and debates regarding the use of CT as a diagnostic modality since, despite its high sensitivity, it has low specificity (25%), given that COVID-19 findings overlap with findings in other viral infections such as H1N1 influenza, severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS). For this reason, most associations, such as the ACR, consider CT a second-line technique. Other associations with PCR testing limitations, such as the Chinese association, use CT as the initial diagnostic modality. They justify it by its higher sensitivity compared to chest X-ray and its lower likelihood of false negatives, especially in early-stage disease[8]. The choice of CT or X-ray in the initial diagnosis of the patient must be made taking into account the attributes of each technique and the resources available at each hospital[17]. Because COVID-19 can affect anybody, including neonates and babies, the radiation dose of CT may be a potential drawback; nonetheless, preliminary data on low-dose CT procedures revealed good outcomes.

## Conclusion

CT is the modality of choice while X-Ray has a very limited role in COVID Imaging. Further larger longitudinal studies are needed to confirm the results of our study.

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