Chest CT findings of COVID-19 Patients in Kerbala, Iraq

Dhia Mahdey Alghazali¹, Maytham A. Maamera², Thikra M. Almutairy³, Maha Sahab AlKabbi⁴, Naeem O. Talal⁵, Haider Fadel Alkazraji⁶, Raghad A. Saadi⁷

1 F.I.B.M.S-DR., Department of diagnostic radiology, Al-Imam Al-Hussein medical city, Kerbala, Iraq
2 F.I.B.M. (RESP). CABMS/ Department of Pulmonology, Respiratory care unit, Al-Imam Al-Hussein medical city, Kerbala, Iraq
3 DCH, CABP/ Department of infectious disease, Al-Imam Hussein Medical City of Kerbala, Iraq
4 Master of medical physiology, Kerbala Health Director, Al-Imam Al-Hussein medical city, Kerbala, Iraq
5 F.I.B.M. S-CM, Training and human development center, Kerbala, Iraq
6 F.I.B.M.S-DR/ Department of diagnostic radiology, Al-Imam Al-Hussein medical city, Kerbala, Iraq
7 M.B.Ch.B, Resident doctor, Al-Imam-Al-Hussein medical city, Kerbala, Iraq

*Corresponding author:
Dhia Mahdey Alghazali
dhia2603mff@yahoo.com.

Abstract
Early diagnosis of COVID-19 is the cornerstone in the management of the disease to decrease viral spread, CT scan provides a suitable diagnostic tool in this field, high-lightening the finding of chest CT in COVID-19 patients will help radiologists in early diagnosis. To describe the findings of a chest CT in a patient with COVID-19 infection, to specify these findings and to correlate its presence with the time of patient presentation for assessment of disease severity. A cross-sectional study was conducted during the period from the 1st of March to May 14, 2020, at Al-Imam Al-Hussein Medical City in Kerbala-Iraq, started with 107 COVID-19 patients referred from the respiratory care unit for CT scan; we study the findings and correlate it statistically. A total 107 COVID-19 patients with a mean ± SD of 45.27 ± 20.33 years. 77 (72%) were males, CT was done for only 99 patients. 8 patients have a contraindication for CT, 81(81.8%) of scans were positive, findings were ground-glass opacity (71.7%), consolidation (32.3%), tree in bud (7%) and others, a significant association was seen (P-value=0.002) between time of presentation and types of GGO. Conclusion: CT scan should be done for every patient with clinical suspicion of COVID-19 disease, appearance of GGO in CT scan is highly diagnostic of the disease, bilateral confluent GGO warning severe clinical condition.

Keywords: COVID-19, Chest CT, Corona COVID-19, Ground glass opacity, RT-PCR, Consolidation
Introduction

Coronavirus disease 2019 is a severely infectious disease resulting from infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the disease first diagnosed in Wuhan, China, then it starts to spread all over the world converting to pandemic disease in March 2020. COVID-19 patients complaining from upper and/or lower respiratory tract symptoms, the condition may be complicated by severe respiratory distress and respiratory failure, the reference standard for its diagnosis is the Real-time reverse transcription-polymerase chain reaction (RT-PCR). Chest computed tomography (CT) has high sensitivity reported as high as 97%, CT findings were peripheral subpleural ground-glass opacities more in posterior dependent lung fields, consolidation opacities, bronchial wall thickening and crazy paving appearance. Gradually CT became the first diagnostic tool of COVID-19. Definitions of major CT findings. GGO: areas of hazy increased opacity in the lung, with the preservation of bronchial and vascular margins definition, Consolidation appears as a homogeneous increase in pulmonary parenchymal attenuation that obscures the margins of vessels and airway walls, Crazy-paving pattern appears as thickened interlobular septa and interlobular lines superimposed on a background of GGO.

The aims of this study are: Findings of chest non-enhanced CT in a patient with COVID-19 infection, to specify the finding and to correlate its presence with the time of patient presentation to assess the severity of the disease.

Patients and methods:

This cross sectional study was conducted during the period from 1st of March to May 14, 2020, at the diagnostic radiology department in Al-Imam Al-Hussein medical city in Kerbala, Iraq, our center is the largest hospital in Kerbala governorate with more than 650 beds and represent the only referral site for other hospitals to all COVID-19 cases, the study includes 107 COVID-19 patients confirmed by RT-PCR tests, many patients were referred from different medical centers in Kerbala city to our department for CT scan, most of them presented with sign and symptoms of COVID-19 infection, others are asymptomatic but have history of contacts to COVID-19 patients or history of travel to an endemic region, our exclusion criteria were:
Those patients with known history of TB, cancer or any specific lung disease like emphysema or interstitial lung disease.

Children patients due to radiation hazard, CT was not done.

Pregnant ladies due to radiation hazard on the fetus.

Severely ARDS patients due to technical difficulties.

We include only the patients with positive RT-PCR and have no known history of chest disease, the unenhanced CT scan performed for 99 patients by using a multidetector-row scanner (SOMATOM Definition Edge Siemens medical system, Germany and Philips Brilliance 64 slice CT). The examination was carried out without patient preparation, in supine, hands up position, from the upper neck to mid abdomen depending on the scanogram, in a single breath-hold cluster, with 5-mm collimation, reconstruction at 1mm interval and energy level of 120 Kv and 200-250 mA, then the studies were assessed by two independent radiologists.

Statistical analysis
Data was entered and analyzed through the Statistical Package for the Social Sciences (SPSS version 23). Descriptive statistics presented as frequency and percentage in appropriate tables and graphs. Chi-square test or Fisher's exact test were used to find association between the categorical variables. The association was considered to be statistically significant when the P-value was found to be less than 0.05.

Results
A total 107 COVID-19 patients their age ranged from 3 to 85 years with a mean ± SD of 45.27 ± 20.33years. The male to female ratio was 2.56:1 where 77 (72%) of the patients were men. CT was done for only 99 patients, for statistical purposes, we divide time of presentation into two groups: 72(72.7%) patients presented within 1st five days and 27(27.2%) patients presented after 5th day of symptoms (or contacts), CT scans were positive in 81(81.8%). The association between time of presentation and CT results was statistically not significant (P value =0.6) as illustrated in table-1 below:

Table-1: Association of the CT results of Covid-19 patients with the time of presentation of the disease.

<table>
<thead>
<tr>
<th>Time of presentation</th>
<th>CT results</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Positive</td>
</tr>
<tr>
<td>&lt; 5 days</td>
<td>72(100)</td>
<td>58(80.6)</td>
</tr>
<tr>
<td>≥ 5 days</td>
<td>27(100)</td>
<td>23(85.2)</td>
</tr>
<tr>
<td>Total</td>
<td>99(100)</td>
<td>81(81.8)</td>
</tr>
</tbody>
</table>

*Chi-square test was used with a significant P value of less than 0.05.
The radiological findings were ground-glass opacity, consolidation, tree in bud, pleural effusion, crazy paving opacities, and other non-specific findings as bronchial wall thickening and vessels enlargement, these findings involving both lungs in 80% of cases. Ground-glass opacity seen in 71 scans (71.7%). Four configurations of GGO were identified (as shown in Figure-1 below)

![Figure-1: Types of Ground-glass opacity of the included study patients.](image)

These GGO categorized according to severity and distribution of the opacities in lung fields to:
Type 1: Unilateral single GGO in 14 (19.7%) patients, as that seen in Figure 2&3;
Type 2: Bilateral multiple discrete GGO in 19(26.8%) patients, as that seen in Figure 4; Type3: Bilateral multiple subpleural GGO in 13(18.3%) patients, as that seen in Figure 5; and Type 4: Bilateral diffuse confluent patches of GGO in 25 (35.2%) patients, Figure 6.

There was significant statistical association (P value 0.03) between the type of GGO and the time of presentation, (as clarified in table-2).

<table>
<thead>
<tr>
<th>Time of presentation</th>
<th>Total</th>
<th>Unilateral opacity</th>
<th>Bilateral discrete</th>
<th>Bilateral Subpleural</th>
<th>Diffuse confluent</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5 days</td>
<td>49(100)</td>
<td>10 (20.4)</td>
<td>16(32.7)</td>
<td>11(22.4)</td>
<td>12(24.5)</td>
<td>0.002*</td>
</tr>
<tr>
<td>≥ 5 days</td>
<td>22(100)</td>
<td>4(18.2)</td>
<td>3(13.6)</td>
<td>2(9.1)</td>
<td>13(59.1)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>71(100)</td>
<td>14(19.7)</td>
<td>19(26.8)</td>
<td>13(18.3)</td>
<td>25(35.2)</td>
<td></td>
</tr>
</tbody>
</table>

*Fisher’s Exact Test was used with a significant P value of less than 0.05.
Consolidation was seen in 32 (32.3%) patients as that seen in Figure 7, tree in bud opacities seen in 7 (7.07%) CT scans, crazy paving appearance was seen only in 5 (5.05%) CT scans as seen in Figure 8, pleural effusion was seen only in 4 CT scans represent 4.04%, also there was no significant statistical association between presence of consolidation and the time of presentation (P. value = 0.34).

**Table-3:** Association of the Consolidation in Covid-19 patients with the time of presentation of the disease.

<table>
<thead>
<tr>
<th>Time of presentation</th>
<th>Consolidation</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Positive</td>
</tr>
<tr>
<td>&lt; 5 days</td>
<td>58(100)</td>
<td>21 (36.2)</td>
</tr>
<tr>
<td>≥ 5 days</td>
<td>23(100)</td>
<td>11(47.8)</td>
</tr>
<tr>
<td>Total</td>
<td>81(100)</td>
<td>32(39.5)</td>
</tr>
</tbody>
</table>

*Chi-square test was used with a significant P value of less than 0.05.

**Figure 2:** Axial thin-section unenhanced CT scan image of 49-year-old women who presented with fever and cough, shows left lower lobe patchy ground-glass pulmonary opacity (type 1).
**Figure 3:** images (a) of 63-year-old man and (b) of 34-year old man, both with history of contact to COVID-19 patients, presented with fever and cough. Axial thin-section unenhanced CT scan images shows left lower lobe patchy ground-glass pulmonary opacity (type 1).

**Figure 4:** images of (a) 63-year-old man and (b) of 44 year-old man presented with fever and cough. Two axial thin-section unenhanced CT scan shows bilateral discrete evenly scattered foci of GGO (Type 2).
**Figure 5:** Image in a 45-year-old man with fever, sore throat, and cough. Axial thin-section unenhanced CT scan shows bilateral subpleural patchy GGO (type 3).

**Figure 6:** Image (a& b) in a 69-year-old man who presented with fever, SOB, and cough, admitted to respiratory care unit then developed RD. These axial thin-section unenhanced CT scan images show bilateral diffuse GGO (Type 4) this appearance called white lungs.
Figure 7: Axial thin-section unenhanced CT scan image of 48-year-old man with 8 fever sore throat and cough shows right lower lobe subpleural patchy ground-glass pulmonary opacity with consolidation.

Figure 8: Axial thin-section unenhanced CT scan image of 69-year-old man with fever, SOB and cough ultimately requiring admission to respiratory care unit, shows bilateral confluent GGO, mottled by hypodense areas forming crazy-paving appearance.

Discussion
According to Kerbala health directory guidelines for management of COVID-19 disease, every suspected patient with dyspnea and cough should do chest CT scan even before RT-PCR, because in early time of spread the test was available for limited number of patients, as well as it need a relatively long time for processing, we include all the 107 positive patients in our center at time of collecting data, 99 of them had CT scans and included in this study while 8 patients have no CT because five of them were children under 13 years old we exclude them to get rid of unwanted effects of radiation, one pregnant patient in her 1st trimester, CT was unsuitable due to the effect of radiation on her fetus, and
two patients were suffering from ARDS and their clinical conditions were advanced at time of presentation.

CT sensitivity was 81.8% this relatively low rate in comparison with many published articles that states high sensitivity reaching 100% as reported by Zhiming Zhou et al. Most symptomatic patients had positive CT scans, only 18 (18.18%) patients had negative CT scans, of these 11 patients presented early within 1st days of clinical symptoms while 7 were asymptomatic contacts patients, early CT can be normal, few articles state limited number of positive RT-PCR with negative CT scans, Fang Y. et al reported 2%, Ai T. et al reported 3%, in contrast to Bernheim et al who reported 56%, on the other hand we should consider the possibility of false positive probability of RT-PCR test, unfortunately neither follow up RT-PCR nor CT was available for those patients due to over-crowded department, however, they treated as COVID-19 patients.

This study exhibiting higher male to female ratio (2.5:1) this could be explained by the social customs in Kerbala where men spend more time outside doors, unlike women, similar finding seen by Chen et al, although the susceptibility to infection should be similar for both genders, but men are more risky for worse outcomes and death, as seen by Jian-Min et al.

Regarding time of presentation, most of our patient (73.8%) examined by CT during the first five days of the clinical presentation, this possibly due to the efforts of the primary health care workers in follow up of traveler citizens that returns to Kerbala from countries affected by COVID-19 like china and Iran. CT finding involve both lungs in 80% of patients, this finding was seen in previous radiological studies of patients with H7N9 influenza as reported by Wang Q et al.

GGO is a descriptive name referring to an area of high attenuation in chest CT with preservation of bronchial and vascular markings, it was the commonest CT findings (71.7%) in COVID-19 patients are reported by many articles. It is a non-specific sign with a wide etiology including infection, interstitial lung disease and acute alveolar disease as pulmonary edema, in COVID-19 era any such GGO without evidence of previous lung disease should carry the possibility of COVID-19 disease.

Four configurations of GGO were identified and categorized according to severity and distribution of the opacities in lung fields this also described by C. Hani, most cases of GGO (49/71) presented in the early period of the disease (<5days), while the more sever (type IV) GGO was evenly distributed in early and late periods, 6 patients of these developed ARDS, so we consider the bilateral confluent type of GGO with or without consolidation alarming to sever disease, those patient usually deteriorated rapidly and need special treatment in the intensive care unit, M. Yuan et al report similar finding and called this "white lung".
Consolidation refers to filling of the alveoli and respiratory bronchioles with fluid causing hyperattenuation of lung fields, it is a descriptive term, seen in pulmonary edema, hemorrhage cancer and infections, it might refer to further infiltration of lung parenchyma, however there was no association between time of patient presentation with appearance of consolidation, this was against Pan et al and Yuhui et al\(^{18,19}\) who studied the time course of lung changes on chest CT and found that most severe changes seen in the second week, this difference may due to patients variation in calculating their symptomatic periods in this study.

Multiple another findings were seen astree in bud opacities (7%), crazy-paving pattern (5%), pleural effusion (4%) and bronchial wall thickening, we consider none of these CT features (including GGO and consolidation) are specific or diagnostic to COVID19 pneumonia, these finding also seen in other non-infectious conditions like eosinophilic pneumonia, non-specific interstitial pneumonia and bronchiolitis obliterans with organizing pneumonia this also reported by Ujita M et al and Travis WD et al\(^{20,21}\), but we also consider appearance of such findings in COVID-19 era carry very high probability of infection. Lymphadenopathy and cavitation were not reported in this study, this also described by Heshui Shi et al\(^{22}\). Of 107 patients, 7 developed respiratory distress syndrome, 6 of them exhibiting GGO Type-4 while one patient as Type-2 GGO, while consolidation occurred in 6 patients. Unfortunately, all these 7 patients have been died, here we accept white lung (type 4 GGO) as a risk factor for RDS.

Limitations:
This study faced few limitations: First, availability of RT-PCR tests, the number was inadequate at the early time of data collection. Second, we do not account the individual variations in calculation the exact time intervals from the onset of symptoms to the date of CT acquisition, few patients were asymptomatic at time of examination, third, no follow-up CT scans were available. Although this study has high lightened the main radiological findings seen on CT imaging in COVID-19 patients, a follow up CT scans are mandatory to study the outcome of these changes in lung. Finally, no correlation between the radiological and histopathological findings was available.

Conclusion:
CT scan should be done for every patient with clinical suspicion to have COVID-19 disease, appearance of GGO in such patient's CT scan is highly diagnostic of the disease, bilateral confluent GGO warning sever clinical condition.

Reference:


