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Original Article

# Detection the Severity of COVID-19: Pneumonia Infection by a Computerized Tomography Scan Assay in Kirkuk City

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## Abstract

**Background:** Novel coronavirus disease 2019 (COVID-19) is caused by the virus called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which was for the first time detected in China, Wuhan city, on December 2019. Then, a rapid spread of the virus occurred. World Health Organization declared this disease as a pandemic disease on March 2020. **Objective:** The purpose of this study was to find a relation between the severity of COVID-19 pneumonia and chest-computed tomography (CT) scan findings. **Materials and Methods:** This is an observational, cross-sectional study, conducted on 202 infected patients with COVID-19 selected from referral cases to Azadi Teaching Hospital in Kirkuk Governorate during the period from November 12, 2020 to October 2, 2021. Evaluation of basic clinical character and detailed CT-imaging features were performed and a structured questionnaire had been used to collect the data as well as to interview the patients. The data were analyzed using chi-square or Fisher's exact test. **Results:** A total of 202 patients had been included in this study. Most of our patients infected by coronavirus pneumonia had a typical chest CT finding, such as ground glass opacities (GGOs) (176 [87.1%]) or a mix of consolidation and GGO (130 [65%]), enlargement of the vessel in the lesion account (144 [72%]), and traction bronchiectasis (106 [53%]). Presence of three parameters (bronchiectasis of traction type, the architectural distortion, and score of severity in CT) is helpful in assessing the severity and extension of pneumonia. **Conclusion:** Confirmed cases of COVID-19 pneumonia possess typical chest CT-imaging findings which can help the clinician screen for infection in highly suspected patients and evaluate the extent and severity of the disease.

**Keywords:** CT-imaging findings, ground glass opacities, Kirkuk Governorate, SARS-CoV-2, score of severity in CT

## Introduction

A novel coronavirus (nCoV-2019) had been detected in China, Wuhan city, in December 2019 caused an epidemic of acute respiratory syndrome in humans, currently named as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Then, a rapid spread of the virus occurred, and World Health Organization declared this disease as a pandemic disease in March 2020. It is considered the highest pandemic illness by far.[1]

SARS-CoV-2 is related to β-coronavirus, which is RNA virus. The shape of it is round; diameter of it is about 60–140 nm when examined under the electronic microscope. This virus has a special spike on its outer surface; the size of the spike is around 9–12 nm, which is like the solar corona.[2] Human (SARS-CoV-2) has 92% similarity with the bat coronavirus sequence RaTG3; for that reason, scientists suggest that COVID-19 outbreak on February 24, 2020, is of a zoonotic origin.[3]

First case of SARS-CoV-2-infected patients had been reported in Iraq, in Najaf city on February 22, 2020; after that, the increasing number of cases and deaths started to get reported.[4] As of October 22, 2021, there were 2,042,117 confirmed cases by laboratory for COVID-19 infection with around 22,875 death cases from COVID-19 in Iraq, By October 19, 2021, the collecting confirmed cases of COVID-19 reported globally were over 240

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million and the sum death was over 4.8 million.[4,5] In addition, Iraq has been considered to be the second highest number of cumulative cases and deaths in the East Mediterranean Regions after Iran.[5] Also, Iraq has the highest rank in terms of the number of cumulative cases per 1 million population and second in terms of the number of cumulative death per 1 million population.[5,6]

Most of the presenting signs and symptoms of cases of COVID-19 infection are upper respiratory tract infection or lower or both; the severe distress in the respiratory system also may occur; the less fever constantly is the most common presenting symptom. Although the dependable test which is standard for diagnosing and confirming COVID-19 infection is real-time polymerase chain reaction (RT-PCR); the chest CT scan findings are highly sensitive than RT-PCR (around 98%) for the early detection of COVID-19-infected cases.[4,7]

The RT-PCR test is still considered the standard reference test for the confirmation of COVID-19 cases, although the RT-PCR has low sensitivity and specificity at around 30–60%.[8]Furthermore, the RT-PCR investigation cannot easily be presented within a short period of time and it is relatively a time-consuming process, while the rapid detection of COVID-19 cases is highly necessary in the treatment. This aids in reducing the number of contact cases and complications. The chest-computed tomography (CT) scan is a suitable alternative test for early diagnosis of COVID-19 because it is easily present and could be performed in a relatively short period of time.[9]

Chest CT scan has been considered to be a very helpful diagnostic machine for patients who suspect to have COVID-19 infection.[10] CT chest has an important role in diagnosing infected cases with negative RT-PCR result assay but in whom COVID-19 infection is strongly suspected.[10] However, in the early phase of the disease, CT chest can be seen normal as reported.[11,12] The peripheral ground glass opacity (GGO) and the consolidation opacity are the main two chest (CT) scan findings.[13,14] Furthermore, chest CT detects pulmonary complication and has a role in follow-up after discharge. The GGO is an increased attenuation area in the respiratory tissue in which bronchial and vascular margins are preserved. While the consolidation is an area of increase attenuating in the lung tissue in which the lung vessels and the walls of bronchiole are obscured.[15,16]

The aim of this study was to disclose the chest CT scan finding and severity score in cases confirmed with COVID-19 pneumonia and in addition help physician to evaluate and detect the severity of confirmed cases.

## Materials and Methods

### Design, setting, and sample collection

This is an observational, cross-sectional study, conducted on 202 infected patients with COVID-19 selected from referral cases to Azadi Teaching Hospital in Kirkuk Governorate during the period from November 12, 2020 to October 2, 2021. This department customized specially to receive patients infected with COVID-19 diseases from privet medical clinic or from other peripheral health centers in the Kirkuk Governorate with capacity of more than 20 beds; it is one of the referral sites in addition to other referral sites for COVID-19 cases.

### Working method and data collection

Data were collected from patients who had been referred to the COVID-19 department in Azady Teaching Hospital suspected to have COVID-19 disease. Patients included in this study if he or she has a positive chest CT scan findings in addition to a positive RT-PCR with symptoms and signs of respiratory tract infection (upper or lower). Verbal consents were obtained from participants after explaining to them the objectives of the study.

### The tests used and instruments

A structured questionnaire was used to collect data from patient having symptoms of respiratory tract disease who had a history of coming in contact with COVID-19 disease patient or a history of traveling to an endemic area. This questionnaire included items measuring complete blood count, c-reactive protein, and other laboratory tests, in addition to nasopharyngeal swab for RT-PCR and chest CT scan.

We studied 202 patients with a positive chest CT scan and confirmed positive RT-PCR throat swab for COVID-19 infection. We excluded five patients in this study, two of them had heart failure, other two had idiopathic pulmonary fibrosis, and one of the cases was known to have systemic lupus erytromayus syndrome.

### Classification of cases according to severity[17]

We classified our patients into four groups. According to the recommendation by Program of (Diagnosis and Treatment) of COVID-19 Pneumonia (Trial Fifth Edition)[17] which is recommended also by guideline from the Iraqi Minister of Health,[5]these four groups are first minimal disease, second common disease, third severe disease, and fourth critical disease. In minimal disease group, patients are subclinical (no obvious symptoms) and the lung is not involved by opacity in the chest CT scan. Patients with common cases have chest image that shows lung opacity with symptoms such as fever and have upper or lower respiratory tract infection. Patients with severe cases are those who have any points of the following clinical features: (1) respiratory rate 30 or more/min, (2) oxygen saturation of the blood 93% or less on rest, and (3) oxygen concentration ($FiO_2$) in the artery less than or equal to 300 mmHg, while critical patients are those who have any of the following criteria: (1) signs and symptoms of respiratory failure that need to put the patient on artificial ventilation, (2) patients with signs and

symptoms of shock, and (3) patients who need treatment and monitoring in the intensive care unit because of organ failure other than the respiratory failure.[6]

We subdivide the patients into two groups by regrouping them into group one (nonemergency) (including mild cases and common cases) and group two (emergency group) (including severe cases and critical cases). The interval time between examination of patients and chest CT scan reports was of 2 days mean (ranged between 0 and 8 days). We excluded the following patients from our study: (1) patients with malignancy, (2) pulmonary fibrosis, (3) bronchiectasis, (4) tuberculosis, and (5) interstitial lung disease.

## Imaging technique

The CT scan images were performed while the patients were in supine and at deep inspiration, with a slice thickness of 0.625–5 mm.

## Imaging interpretation and chest-computed tomography score

Three radiologists (who have experience in radiology for 5, 8, and 15 years, respectively) reported and assessed the chest CT scan clinical data. All images had been viewed with both lung and mediastina setting. We evaluated the image feature of the lesion that had been defined in a study before;[18] the features are as follows: (1) GGO, (2) consolidation, (3) mixed of GGO and the consolidation, (4) traction of bronchiectasis, (5) cavitation, (6) architecture distortions, (7) bronchial wall thickening, (8) subpleural bands, (9) reticulations, (10) interlobular sepal thickening, (11) vascular enlargement 12-11-centrilobule nodule, and (12) pleura effusions. A CT score system method (CT-ss) was used in this study to assess the extent and severity of COVID-19 pneumonia. This maneuver was mentioned by research done by Li *et al.*[19] and was published in *Radiology* journal on March 2020.

For scoring the severity, both lungs had been subdivided into five lobes, each of the lobes was evaluated alone, and each lobe had been given a CT score from 0 to 5 depending on the percentage of the lesion in the affected lobe: score 0 if 0% of the lobe affected by lesion; score 1 if less than 5% of the lobe is affected by the lesion; score 2 when 5–25% of the lobe is affected; score 3 when 26–49% of lobe is affected or involved by the lesion; score 4 when 50–75% involvement; and score 5 when greater than 75% of the lobe is involved.[19] The total score consists of the collecting of point from the score of each lobe; it is ranged from 0 to 25 points (maximum 25 points, score 0–5 for each lobe). To identify the severe cases of COVID-19 pneumonia, the CT score cutoff value was 7, with the sensitivity of 80% and specificity of 82.8%.[19,20]

## Ethical approval

The study was conducted in accordance with the ethical principles according to the Declaration of Helsinki, with patients' verbal and analytical approval. The protocol and the information and consent form were reviewed and approved by a local ethics committee (Kirkuk Health Directorate) according to document number 26 on 18/1/2023.

## Statistical analysis

The variable in this study was present as a median and was compared using the Mann–Whitney *U* test. The variables were presented as number and percentage, and by using chi-square or Fisher's exact test and these had been compared. By using these tests, variables had been compared between the first group the emergency group and the second group of no emergency.

By using chi-square or Fisher's exact test, the score of lung involvement had been compared between the emergency and nonemergency cases.

**Table 1: The baseline clinical features and epidemiological character**

| Clinical features | All patients *n* = 202 (%) |
|---|---|
| Sex | |
| Male | 112 (55.5) |
| Female | 90 (44.5) |
| Age (years) | |
| Mean | 44.4 |
| Range | 19–77 |
| Age group (years) | |
| ≤20 | 2 (2.0) |
| 21–40 | 88 (43.5) |
| 41–50 | 54 (26.5) |
| 51–60 | 28 (14) |
| 61–70 | 14 (28) |
| >70 | 2 (1.0) |
| Epidemiologic history | |
| Direct exposure | 168 (83.1) |
| Indirect exposure | 24 (12) |
| No exposure | 10 (5) |
| Onset of symptoms | |
| Fever | 158 (79) |
| Cough | 126 (63) |
| Fatigue or myalgia | 34 (17) |
| Throat soreness | 24 (12) |
| Diarrhea | 6 (3) |
| Shortness of breath (dyspnea) | 2 (2) |
| Nausea and vomiting | 4 (2) |
| More than one type of symptoms | 134 (67) |
| None | 4 (2) |
| Underlying disease* | |
| Cardiovascular and cerebrovascular disease | 32 (16.0) |
| Surgical history | 14 (7) |
| Gastrointestinal diseases | 12 (6) |
| Respiratory diseases | 10 (4.9) |
| Endocrine diseases | 6 (2.9) |
| None | 142 (71) |

Note: *Some patients had more than one underlying disease.

*P*-value of <0.05 was of considerable value for statistical significance. The statistical analyses were done with the software SPSS (version of 24.0, IBM Corp., Armonk, NY).

## Results

### Clinical characteristics

Among 202 included patients, 174 patients (112 men, 90 women) had criteria of nonemergency cases, while 28 patients (16 male, 12 female) had criteria of emergency group. Regarding age distribution as it has appeared in Table 1, for 71% of the cases, their ages were between 21 and 50 years. Thirty-four (17%) patients denied any history of direct exposure to patients with confirmed COVID-19, while 24 patients out of the 34 had a history of indirect exposure to patients with confirmed COVID-19, and 10 out of 34 denied any history of direct or indirect exposure to confirm COVID-19 patients. Fever was the most common symptom; it occurred in 79% (158 of 202) and cough as the onset of symptom occurred in 63% (126 of 202). Rate of onset of other symptoms like myalgia, sore throat, fatigue, diarrhea, dyspnea nausea, and vomiting also can be seen in Table 1. Four (2%) patients presented with no onset of symptoms.

### CT findings; chest CT severity score

Most of the COVID-19 patients in our study had imaging features which are typical COVID-19 disease elsewhere, such as GGO which had been found in 178 of our patients (87%). We found mixed GGO and consolidation in 130 patients (65%), while consolidation had been found in 88 patients (44%), vascular enlargement in the lesion was present in 144 patients (71.8%), and traction bronchiectasis was found in 106 patients (52.7) [Figures 1–3]. Different patterns of distribution of other lesions also can be seen in Table 2.

Peripheral pattern of distribution of lesions was the most common pattern which was detected on chest CT scan of our case with COVID-19 chest infection (176 of 202 [87.1%]), and most of the lesions (166 [82.2%]) affect both lungs (bilateral), and more lesions were affected, predominantly the lower lobes (110 of 202 [54.8%]); the lesions in our patients mostly were scattered multifocal distribution (110 of 202 [54.8%]). Other evaluated features of the image in our patients are shown in Table 2.

Score 8.7 was a mean score of the involved lung in our study; significant differences were found between the score of lung involvement in nonemergency and emergency subgroup, *P* <0.05 [Table 3].

Total chest CT score severity (CT-ss) was 12.4 (15.3 mean) in the nonemergency group, and total CT-SS was 18 (22.2 mean) in the emergency group [Table 3, Figures 3 and 4].

Pleural effusions were found in 10 cases out of 28 (35.6%) and lymphadenopathy in 2 cases out of 28 (7.1%) in the emergency group, whereas pleural effusion found in 18 out of 174 (10.3%) in nonemergency group and enlarged

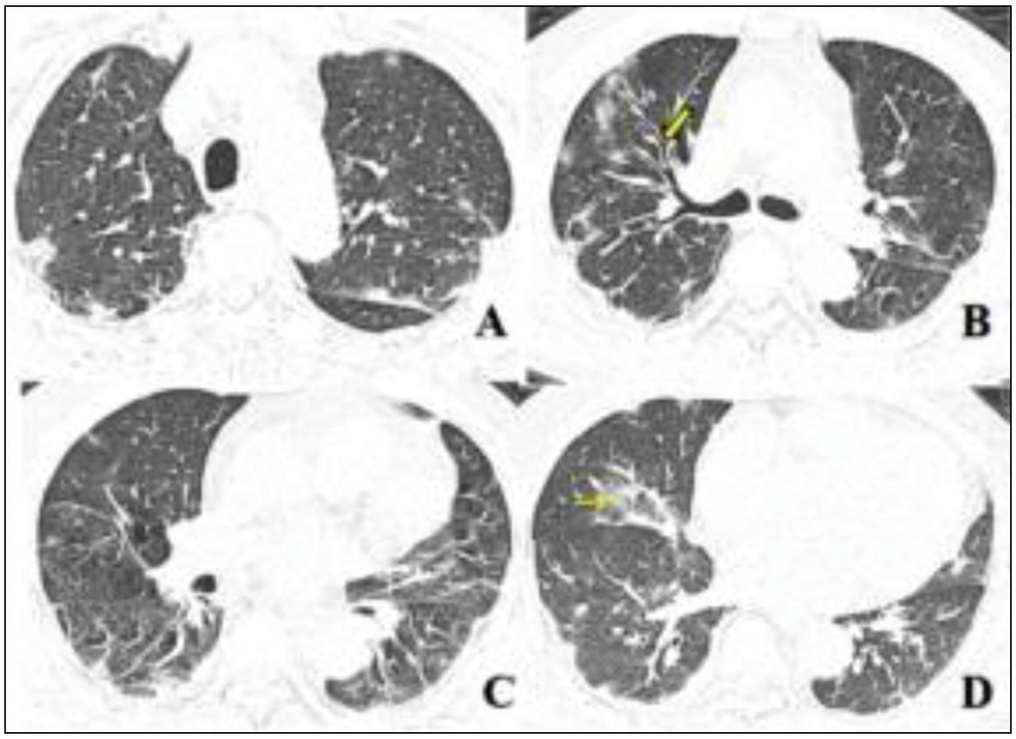


**Figure 1:** Chest CT showed lesions of GGOs of multifocal and bilaterally distributed, and a mixture of GGO with consolidation. Also, the traction bronchiectasis with enlarged vasculature appeared (arrow)

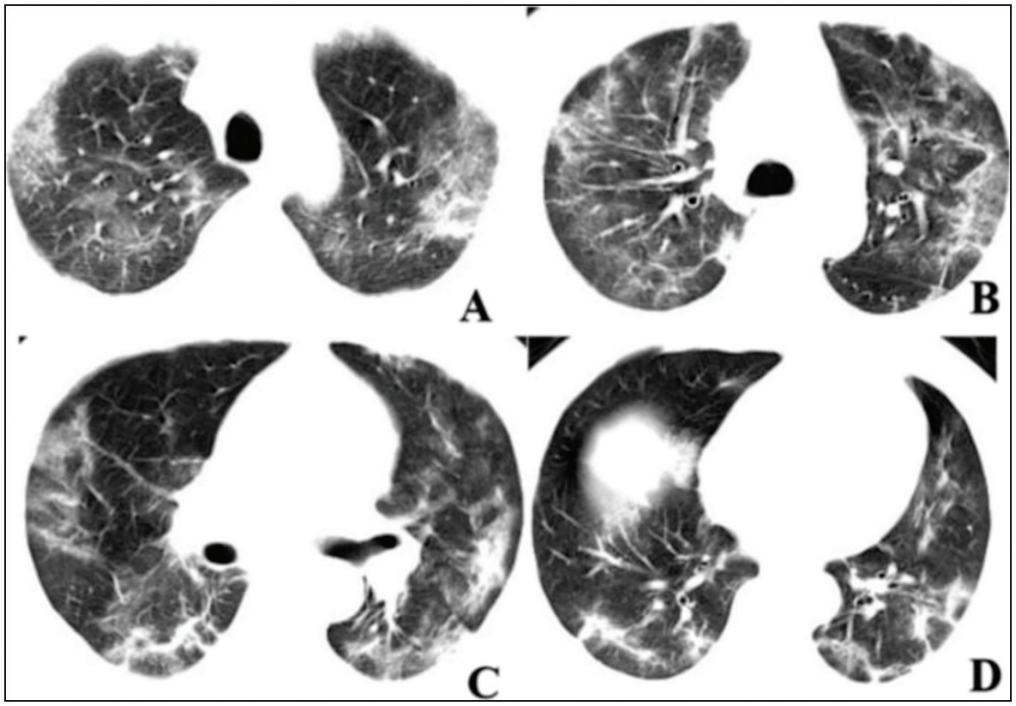


**Figure 2:** CT scan of chest found a GGO of multifocal mixed with consolidation seen mostly at periphery bilaterally

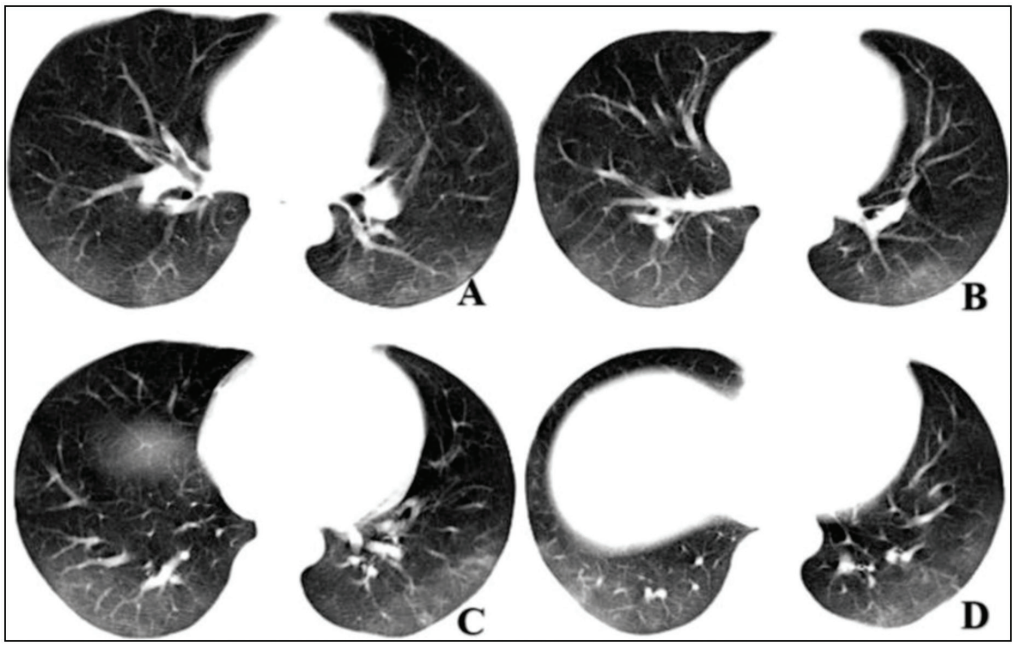


**Figure 3:** Chest CT scan showed a GGO which was bilateral band-like subpleural

lymphedema was not detected in nonemergency patients' subgroup [Table 2].

### Comparison of basic clinical features and chest CT findings between emergency and nonemergency groups

Regarding the age of the patients, emergency subgroup patients were older in age than patients in nonemergency subgroup, where 20 (71.3%) COVID-19 patients of emergency subgroup had been in the age group of more than 50 years. Four of the most characteristic imaging features of COVID-19 detected in emergency subgroup are as follows: first is traction bronchiectasis, second is mediastinal lymphadenopathy, third is architectural distortion, and fourth is pleural effusions ($P < 0.05$) [Table 2].

**Table 2: Baseline characteristics of the imaging findings**

| Characteristic features | Total patients = 202 (%) | Nonemergency group *n* = 174 (%) | Emergency group *n* = 28 (%) | *P*-value |
|---|---|---|---|---|
| Age (years) | | | | |
| Mean (SD) | 44.4(12.4) | 43(11.6) | 53.8(12.6) | 0.003 |
| Gender (sex) | | | | 0.900 |
| Male | 112(56) | 96(55) | 16(57) | |
| Female | 90(45) | 78(45) | 12(43) | |
| Underlying illness | 60(30) | 46(27) | 14(50.0) | 0.0800 |
| Imaging features | | | | |
| Ground-glass opacities(GGO) | 176(87) | 146(84) | 28(100) | 0.107 |
| Consolidation | 88(44) | 72(41) | 16(57) | 0.28 |
| Mixed GGO and consolidation | 130(65) | 112(65) | 9(65) | 1.001 |
| Centrilobular nodule | 46(23) | 40(23) | 6(22) | 0.900 |
| Architectural distortion | 44(22) | 32(18.5) | 12(43) | 0.041 |
| Bronchial wall thickening | 58(29) | 44(25.4) | 12(43)) | 0.172 |
| Reticulation | 98(49) | 78(44.8) | 18(64.2) | 0.177 |
| Subpleural bands | 56(28) | 46(26.5) | 8(29) | 0.877 |
| Traction bronchiectasis | 106(52.7) | 82(47.1) | 25(89)) | 0.005 |
| Vascular enlargement | 144(71.8) | 116(66.7) | 27(96.5) | 0.099 |
| Pleural effusion | 28(14) | 18(10.3) | 10(35.6) | 0.010 |
| Lymph node enlargement | 2(4%) | 0(0) | 2(7.1) | 0.006 |
| Crainiocaudal distributions | | | | 0.250 |
| Predominantly upper lung | 12(6) | 12(6.9) | 0(0) | |
| Predominantly lower lung | 110(54.8) | 96(55.2) | 6(21.4) | |
| No crainiocaudal distribution | 64(32.1) | 50(28.2) | 8(28.5) | |
| Transverse distribution | | | | 0.501 |
| Central | 3(1.4) | 1(1.0) | 0(0) | |
| Peripheral | 176(87.1) | 148(84) | 28(100) | |
| No transverse distribution | 8(4) | 8(4.6) | 0(0)) | |
| Regional distribution | | | | 0.180 |
| Unilateral | 20(20) | 20(11.5) | 0(0) | |
| Bilateral | 166(82.2) | 138(79.3) | 28(100) | |
| Scattered distribution | | | | 0.001 |
| Focal | 12(6) | 12(7) | 0(0) | |
| Multifocal | 110(54.8) | 104.(59.9) | 6(21.3) | |
| Diffuse | 64(32) | 42(24.2) | 23(80) | |

**Table 3: Comparison of the score of lung involvement in nonemergency and emergency group**

| Variable | *P* value | Emergency patients = 28 | Nonemergency patients = 174 | Total patients = 202 |
|---|---|---|---|---|
| Extent of lesion (total score) | 8.7 (0–25)# | 12.4 (15.3)* | 18 (22.2)* | <0.001 |

*Mean (SD)

#Mean (range)

The result proved that the CT severity scores were high in emergency subgroup, more than in nonemergency subgroup ($P < 0.001$).

## Discussion

In this study, we assessed and analyzed 207 confirmed COVID-19 pneumonia patients by clinical evaluation and characteristics chest CT scan finding who visited an Azady Teaching Hospital or seen in private clinic in Kirkuk city, Iraq. The epidemiological and clinical baseline features had been reported. Typical chest CT scan features' finding can be beneficial in helping for early screen testing patients who suspected to have COVID-19 disease and efficiently assess and evaluate the severity and extent of SARS-CoV-2-causing pneumonia.[6]

The strategy of management of the COVID-19 disease mostly depends on the diagnosis of the disease; however, the screening tests of COVID-19 had been challenged by more factors such as limited laboratory facility and poor and unavailability of nucleic acid kits in the health centers.[21] Chest CT scan is more sensitivity than chest X-ray in the early stages of disease, where the CT

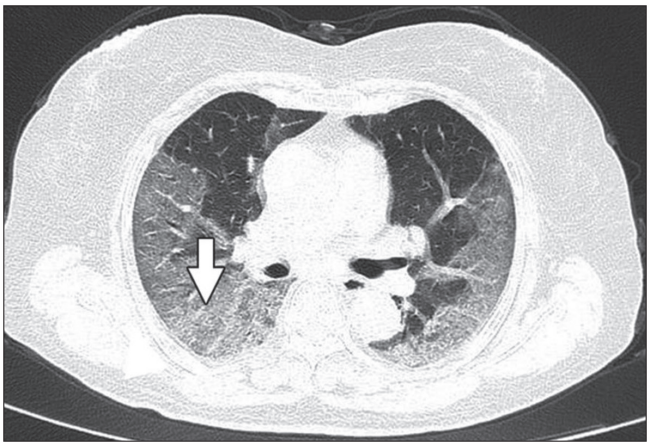

**Figure 4:** CT scan of chest showing diffused GGO with reticulation

detects abnormal clinical feature in the parenchyma of lung, especially in patients with an initial negative PCR screening result.[18] Suspected cases of COVID-19 may promote virus transmission and cross-infection to other persons; also, false-negative result of RT-PCR is a well-known problem to the clinician during laboratory testing for COVID-19.[22] Because of these reasons, CT scan of the chest is considered a precedence method for diagnosing COVID-19 infection during the time of the outbreak.[23]

In our cohort study, 24 (12%) patients denied any history of direct exposure to confirmed COVID-19 cases. Ten patients (4.9%) denied history of any indirect or direct exposure to confirmed cases. These findings make the importance of early detection of COVID-19 cases and separating them from those nondiseased or from those suspected to have a disease to decrease person-to-person transmission of the virus.

Three typical radiological features which are present in this study are first GGO (87%), second mixed GGO and consolidation (65%), and third reticulation (49%). These radiological features are similar to the results of the chest CT findings of other viruses infecting the respiratory tract, like SARS virus and MERS virus.[24,25] Surprisingly, in our study, vascular enlargement of the lesion was found in most of the patients (71.8%).

Regarding the distribution of the lesions in patients with SARS-CoV-2 in our study, most of the patients 176 (87.1%) have lesions which are peripheral in distribution, bilateral involvement was present in 82.2%, lower lung predominance found in 54.8%, and multifocal distribution detected in 54.8%; these results were consistent with the findings of Huang *et al.*[26]

We analyzed the differences in clinical and imaging features' baselines between the two groups (the emergency and nonemergency group), regarding the age of the patients: ages of emergency group patients were older than ages of patients in nonemergency subgroup. While, regarding underlying diseases' rate, there were no significant differences in between the two groups, this indicated that there were other factors (like load of the virus) that may play a major role in severity and extent of infection with SARS-CoV-2 pneumonia.

We found that four radiological features, which are tractions bronchiectasis, intrathoracic enlargement of the lymph node, distortion of architectural, and pleural effusions, had significant statistical difference between our two subgroups (emergency and nonemergency); this finding may help clinician to define the emergency group of the disease. Moreover, we found that the diffused lesions' incident was greater in the emergency group patients than in the nonemergency group (80% vs. 24.2%), which is consistent with the results of other studies.[20,24,27]

It is not surprising that the CT severity scores were high in the emergency subgroup than the scores in the nonemergency ($P < 0.001$). Most important finding is that a CT-severity score threshold of 18 can identify severe cases of COVID-19 and could provide an objective means to identify patients with severe disease which are consistent with the results of other studies.[19]

This study had some limitations. First, the number of confirmed COVID-19 cases included in the study was only 202 patients which is relatively small; infected patients with RT-PCR-negative results were not included in the database and analyses. Second, we chose first CT scan findings of chest to be evaluated which is obtained on patient admission, but follow-up chest CT examination findings were not considered in our study; so, the study had not been controlled by number of days from the beginning of signs and symptoms that may have greater effects in interpretation of chest CT severity score.

## Conclusion

Confirmed cases of COVID-19 pneumonia possess typical chest CT imaging findings which can help the clinician for early screening of infection in highly suspected patients and evaluate the extent and severity of the disease. A CT severity score of less than 18 could be considered to rule out a critical or severe type of disease.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

## References

1. Pareek S, Kaur H. Impact of COVID-19 on maternal and child health services. Med J Babylon 2022;19:507-10.
2. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, *et al*. A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med 2020;382:727-33.

3. Zhou P, Yang XL, Wang XG, Hu B, Zhang L, Zhang W, *et al*. Discovery of a novel coronavirus associated with the recent pneumonia outbreak in humans and its potential bat origin. BioRxiv 2020. Doi: 10.1101/2020.01.22.914952.
4. Baiee HA, Hussein KH, Ismail IS, *et al*. Epidemiological and clinical features of COVID-19 confirmed cases in Babel Governorate, Iraq. Med J Babylon 2021;18:304-11.
5. Iraqi Ministry of Health, Daily Online Update Reports on COVID19 Infection. Available from: http://www.who.int [Last accessed on June 12, 2020].
6. Albarwari N, Ahmed MH, Maerozy KA, Mohammad JB. Effect of coronavirus disease 2019 (COVID-19) pandemic on catheterization laboratory activity in Azadi Heart Center, Duhok, Iraq. Med J Babylon 2022;19:21-5.
7. Jin YH, Cai L, Cheng ZS, Cheng H, Deng T, Fan YP, *et al*. A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version). Military Med Res 2020;7:1-23.
8. Kim JY, Choe PG, Oh Y, Oh KJ, Kim J, Park SJ, *et al*. The first case of 2019 novel coronavirus pneumonia imported into Korea from Wuhan, China: Implication for infection prevention and control measures. J Korean Med Sci 2020;35:e61.
9. Pan Y, Guan H, Zhou S, Wang Y, Li Q, Zhu T, *et al*. Initial CT findings and temporal changes in patients with the novel coronavirus pneumonia (2019-nCoV). Eur Radiol 2020;30:3306-09.
10. Dalloo FL, Shukur MS, Taha AO. The severity of clinical symptoms and paranasal sinuses CT-scan finding in COVID-19 patients in Kirkuk Province. Med J Babylon 2022;19:459-62.
11. Chung M, Bernheim A, Mei X, Zhang N, Huang M, Zeng X, *et al*. CT imaging features of 2019 novel coronavirus (2019-nCoV). Radiology 2020;295:202-7.
12. Ksiazek TG, Erdman D, Goldsmith CS, *et al*. A novel coronavirus associated with severe acute respiratory syndrome. N Engl J Med 2003;348:1953-66.
13. Drosten C, Günther S, Preiser W, van der Werf S, Brodt HR, Becker S, *et al*. Identification of a novel coronavirus in patients with severe acute respiratory syndrome. N Engl J Med 2003;348:1967-76.
14. Zaki AM, van Boheemen S, Bestebroer TM, Osterhaus ADME, Fouchier RAM. Isolation of a novel coronavirus from a man with pneumonia in Saudi Arabia. N Engl J Med 2012;367:1814-20.
15. Huang P, Liu T, Huang L, Liu H, Lei M, Xu W, *et al*. Use of chest CT in combination with negative RT-PCR assay for the 2019 novel coronavirus but high clinical suspicion. Radiology 2020;295:22-23.
16. Chan JF, Yuan S, Kok KH, To KKW, Chu H, Yang J, *et al*. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: A study of a family cluster. Lancet 2020;395:514-23.
17. Pan F, Ye T, Sun P, Gui S, Liang B, Li L, *et al*. Time course of lung changes on chest CT during recovery from 2019 novel t67 coronavirus (COVID-19) pneumonia. Radiology 2020;296:198-207.
18. Xie X, Zhong Z, Zhao W, Zheng C, Wang F, Liu J, *et al*. Chest CT for typical 2019-nCoV pneumonia: Relationship to negative RT-PCR testing. Radiology 2020;296:E41-E45.
19. Li K, Wu J, Wu F, Guo D, Chen L, Fang Z, *et al*. The clinical and chest CT features associated with severe and critical COVID-19 pneumonia. Invest Radiol 2020;55:327-31.
20. Li K, Fang Y, Li W, Pan C, Qin P, Zhong Y, *et al*. CT image visual quantitative evaluation and clinical classification of coronavirus disease (COVID-19). Eur Radiol 2020;30:4407-16.
21. Xiao SY, Wu Y, Liu H. Evolving status of the 2019 novel coronavirus infection: Proposal of conventional serologic assays for disease diagnosis and infection monitoring. J Med Virol 2020;92: 464-7.
22. Ng MY, Lee EYP, Yang J, Yang F, Li X, Wang H, *et al*. Imaging profile of the COVID-19 infection: Radiologic findings and literature review. Radiol Cardiothorac Imaging 2020;2: e200034.
23. Fang Y, Zhang H, Xie J, Lin M, Ying L, Pang P, *et al*. Sensitivity of chest CT for COVID-19: Comparison to RT-PCR. Radiographics 2020;61:722-9.
24. Wong KT, Antonio GE, Hui DS, Lee N, Yuen EHY, Wu A, *et al*. Thin-section CT of severe acute respiratory syndrome: Evaluation of 73 patients exposed to or with the disease. Radiology 2003;228:395-400.
25. Gao F, Li M, Ge X, Zheng X, Ren Q, Chen Y, *et al*. Multi-detector spiral CT study of the relationships between pulmonary ground-glass nodules and blood vessels. Eur Radiol 2013;23: 3271-7.
26. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, *et al*. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020;395:497-506.
27. Hammoodi Z, Al-Khafaji H, Al-Murib Z, Al-Esawy HK, Baiee AS, Al-Shimmary AAA. Accuracy of noncontrast chest computed tomography in COVID-19 infection: An observational and retrospective study. Med J Babylon 2020;17:282-7.