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Original Article

Spectrum of Chest Computed Tomography Findings of Novel Coronavirus Disease 2019 in Medical City in Baghdad

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Atheer A. Fadhil * **DMRD, FIBMS**
Salam M. Joori** **DMRD, FJMC**
Zaid H. Hammoodi*** **DMRD, FIBMS**
Haider A. Ghayad** **ABHS**
Ali Ibrahim**** **ABHS**

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Abstract:

Background: Native chest Computed Tomography (CT) is a quick, non-invasive and practical investigation and plays an important role in evaluation of Coronavirus Disease 2019.

Objective: to describe the chest CT manifestations in patients with confirmed RT-PCR positive for coronavirus disease 2019 (COVID-19) in a case series from Baghdad, Iraq.

Patients and Methods: The case series consisted of 55 patients with laboratory confirmed COVID-19 for the period from 1st March through 15th April 2020. Native chest CT was performed in the Department of Radiology, Medical City Teaching Complex (MCTH). The chest CT images were reviewed and analyzed by the researchers.

Results: The most frequent CT findings were ground-glass opacities (47.3%) and mixed ground glass and consolidation (43.6%). Most lesions were multiple (67.2%), peripheral (56.3%) and bilateral (81.8%). Least common findings were pleural effusion (7.2%) and mediastinal lymphadenopathy (1.8%).

Conclusion: The commonest chest CT findings of COVID-19 in Baghdad population were multiple, bilateral, peripheral ground glass opacity and consolidation.

Keywords: COVID 19, chest CT, Baghdad.

Introduction:

During late December 2019, the World Health Organization (WHO) had announced an outbreak of unknown viral respiratory illness in Wuhan City, Hubei Province of China. In early January 2020 the outbreak was found to be caused by a 2019 novel coronavirus (2019-nCoV), and on 11 February 2020 WHO announced a name for the new coronavirus disease: COVID-19 (1). On 30 January 2020 the WHO declared the outbreak as a Public Health Event of International Concern (PHEIC) (2). WHO declared COVID-19 as a pandemic on 11 March 2020 (3) Coronaviruses include viruses that cause diseases ranging from the simple upper respiratory tract infections to severe acute respiratory syndrome (SARS), the Middle East respiratory syndrome (MERS), multiple organ failure and possibly death (4). At the time of writing this article, about 6.2 million confirmed cases of COVID 19 infection with about > 376000 deaths worldwide. COVID 19 is a member of the coronaviridae family, which is a new type of betacoronavirus with human to human transmission and possible feto-maternal vertical transmission in 9% of cases (5). The reference standard of COVID 19 infection is real-time reverse transcriptase-polymerase chain reaction (RT-PCR) with high specificity, but low sensitivity (60-95%) with significant numbers of false negative results. Together with some delay in RT-PCR results which may reach 24 hours, creates a real clinical problem. Covid-19 infection is a rapidly spreading disease, so rapid diagnosis and isolation is essential for disease control and management. Non-enhanced chest CT is a rapid, non-invasive and practical test. With COVID 19 virus predilection to invade the lungs, and the very high sensitivity of CT in diagnosing lung infection caused by this virus (6), CT is used for the diagnosis, but its role in screening is still controversial (7,8). Chest CT plays a key role as a diagnostic tool and triage for persons with suspected covid-19 disease, evaluation of disease severity, case follow-up and as a problem solving in RT-PCR negative patients. Multiple highly characteristic CT imaging features can be of great importance in the diagnosis of covid-19 infections, which can be summarized as:

A- Ground Glass Opacities (GGO): Is the most common finding in covid-19 infections, usually multifocal, bilateral and peripheral, although it may be initially unifocal in the Right Lower lobe (9)

B- Crazy paving: GGO with thickened interlobular and intralobular lines, usually seen at late stages.

* *Baghdad Teaching Hospital, Correspondence email: atheeradnan@gmail.com.*
***X-ray Institue, salamjoori@yahoo.com.uk. dr_haiderameer@yahoo.com.*
****Ghazi Alhariri hospital for specialised surgeries zaid.hammoodi@meciq.edu.iq.*
**** *Iraqi center for heart diseases ali77ibrahim@yahoo.com*

C- Vascular dilatation sign: Typically seen as dilated vessels within GGO.
D- Traction bronchiectasis: A dilated bronchiole within GGO, filled with air or mucus.
E- Subpleural bands and architectural distortion.
F- Nodules less than 3 cm sometimes seen in 3-12% of cases with halo signs or reverse halo signs.
H- Pleural effusion, pleural thickening and mediastinal lymphadenopathy, pericardial effusion, cavitation and pneumothorax are rare but also may occur in late and advanced cases of covid-19 infection (10). Chest CT can give rapid and objective evaluation about the severity of lung involvement in covid-19 with good clinical correlation to the patient's status (11). Temporal chest CT changes over time are important to be recognized especially as part of monitory follow up and sometimes to confirm the diagnosis in RT-PCR negative patients. Four stages on CT have been described:
1- Early/initial stage (0-4 days): Either normal CT or minimal GGO or crazy paving only. Up to 50% of covid-19 patients may have normal CT scans within 2-4 days of onset of symptoms.
2- Progressive stage (5-8 days): Increased GGO and increased crazy paving patters.
3- Peak stage (9-13 days): segmental or subsegmental consolidation.
4- Absorption stage (>14 days): Gradual improvement of findings, fibrous stripes appear, and the abnormalities resolve at one month and beyond (12, 13).
The Iraqi Ministry of Health approved the use of chest CT in classifying positive COVID-19 cases into mild (with no pneumonia in chest CT scan) or moderate and severe (with pneumonia on chest CT scan) (14).
In the Medical City Teaching Complex, Al-Shafa Center for corona crisis (200 beds and an intensive care unit of 50 beds) is reserved for treating confirmed COVID-19 patients. This center is equipped with two CT machines (one is 4 multislice CT and the other is 40 multislice CT; both were installed during the COVID-19 crisis as part of the crisis management). The purpose of the study was to describe the chest CT scan findings in patients with RT-PCR positive for coronavirus disease 2019 (COVID-19) in a case series from Baghdad, Iraq.

Patients and Methods:

Study design and sample

This is a descriptive case series study approved by the supreme scientific committee for corona crisis management in the Medical City Teaching Complex. The committee waived the need for individual consent due to the retrospective nature of the study.
The study is conducted by reviewing and analyzing chest CT findings of (55) patients with confirmed COVID-19 disease for the period from 1st March through 15th April 2020. The age of the cases ranged from (15-80) years. Only RT-PCR positive patients for COVID-19 were included in the study as diagnosed by nose-throat swab specimens that were obtained from patients clinically suspected to have COVID-19. The specimens were maintained in a viral transport medium and sent for RT-PCR test at the Central Public Health Laboratory in Baghdad.

CT data acquisition

CT scan was done using 64 multi-detector CT scanners (SOMATOM Definition AS, Siemens healthineers) in the Department of Radiology, Baghdad Teaching Hospital or 64 MDCT (Toshiba Aquilion 64) in the Radiology Institute in the Medical City Complex in Baghdad. The imaging acquisition data in this study were set as follows: Tube voltage, 120 kVp, tube current (with automatic current modulation) ranging from 100-660 mA. Rotation time 0.6-0.75 second, nominal single collimation width 0.6 mm and pitch factor 1.2. All patients were examined in supine position and were instructed to hold breathing at end inspiration. No intravenous contrast was used. The images were taken at 5 mm with reconstruction at 0.6 mm and 1.5 mm and viewed at workstation and in lung and mediastinal windows. All CT examinations were performed under strict precautions with full protection of the staff (all staff were instructed to wear a disposable isolation gown with fluid-resistant properties, gloves, goggles or face shields, and a "filtering face piece" FFP3 mask) and adequate disinfection of the scanners after examining every patient by washing their surfaces with disinfectant.

Imaging interpretation

Non-contrast chest CT features were interpreted by three specialist and consultant radiologists. Differences in imaging interpretations were resolved in consensus to agree on the most probable results. The imaging manifestations included ground-glass densities, consolidation, mixed (ground-glass opacity and consolidation), air bronchograms, round opacities, crazy paving, halo sign, reversed halo sign, pleural effusion, mediastinal lymphadenopathy and vascular thickening. The distribution of the lesions was labeled as central (in inner half of lung) or peripheral (in outer half on lung); lobar distribution was classified as involving the upper or lower lobes or both lobes simultaneously. The lesions were also classified as focal (involves single segment), multifocal (involves multiple segments) or diffuse (the lesion looks confluent with no intervening normal parenchyma between affected segments).

Statistical analysis

Continuous data were expressed as means (+/- standard deviation SD). While categorical data were expressed as numbers and percentages. Two biostatisticians reviewed the data independently for each inspection indicator.

Figure 1: Positioning of the patient and staff wearing full PPE during preparation for CT examination.

Results:

The CT distribution of the lesions in our sample is shown in Table 1. The lesions were seen mostly in both upper and lower lobes (65.4%), while (31%) were located in the lower lobe only. Most lesions were distributed in the peripheral (subpleural) part of lung fields in (56.6%), while the lesions were located in both peripheral and central portions of the lungs in (41.4%). Bilateral lung disease occurred in (81.8%) patients, while unilateral lung disease was noted in (18.2%) patients. Multilobe (multifocal) disease was seen in (67.2%), while single-lobe (focal) and diffuse disease was noted in (16.4%) for each.

Table (1): CT distribution of the lesions.

Type of distribution		No. of patient	Percentage
Cranio-caudal distribution	Upper	2	3.6
	Lower	17	31.0
	Both	36	65.4
Transverse distribution	Central	1	1.8
	Peripheral	31	56.3
	Both	23	41.9
Lung distribution	Unilateral	10	18.2
	Bilateral	45	81.8
Scattered distribution	Focal	9	16.4
	Multi focal	37	67.2
	Diffuse	9	16.4

The CT signs that were noted in our study sample are shown in table (2). The lesions were mainly ground glass opacities (47.3%) and mixed ground glass and consolidation (43.6%), while in (9%) the lesion is pure consolidation without ground glass opacity. The ground glass shadow associated with thickening of the interlobular septum and manifested as "crazy-paving" change was seen in (20%), while vascular thickening was seen in (31%), and four patients (7.2%) had pleural effusion. Enlarged mediastinal lymph nodes seen in one patient (1.8%). Five patients showed a normal chest CT scan (9%).

Table (2): CT scan findings.

CT scan features	No. of patient	Percentage
Ground glass opacification	26	47.3
Consolidation	5	9.0
Ground glass and consolidation	24	43.6
Crazy paving	11	20.0
Vascular thickening	17	31.0
Architectural distortion	6	11.0
Bronchial change	4	7.2
Halo sign	9	16.5
Reverse halo sign	5	9.0
Rounded opacities	8	14.5
Pleural effusion	4	7.2
Mediastinal lymphadenopathy	1	1.8
Normal	5	9.0

The following figures (2 - 8) show a selection of CT findings from the cases series in our study.

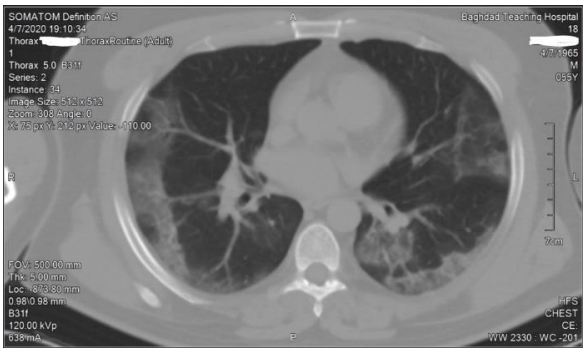

Figure 2: 55-year-old male patient with multifocal, bilateral, peripheral ground glass opacities.

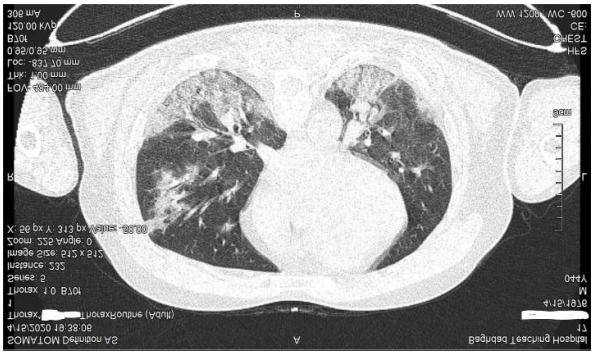

Figure 3: 44-year-old male patient with multifocal, bilateral, peripheral consolidation with air bronchograms.

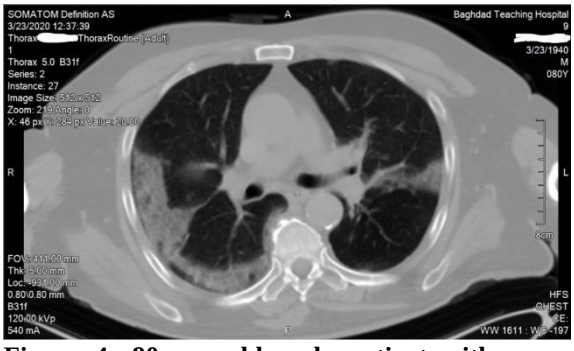

Figure 4: 80-year-old male patient with crazy paving lesion.

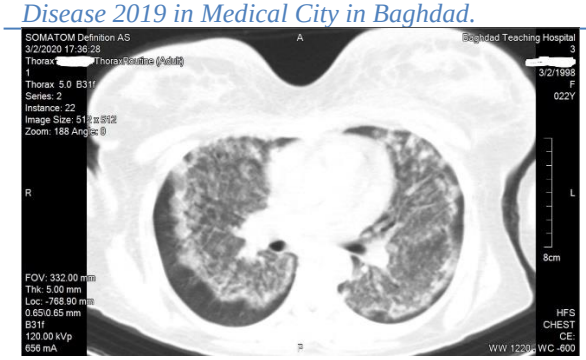

Figure 5: 22-year-old female patient with diffuse central ground glass opacity

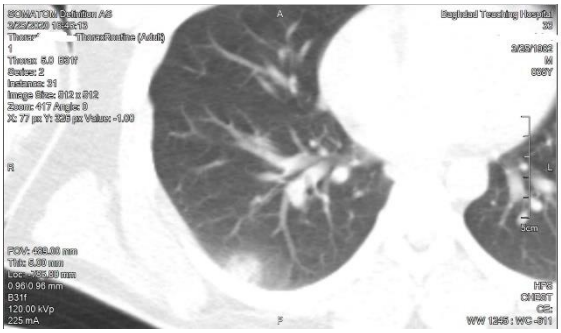

Figure 6: 38-year-old male patient with halo sign.

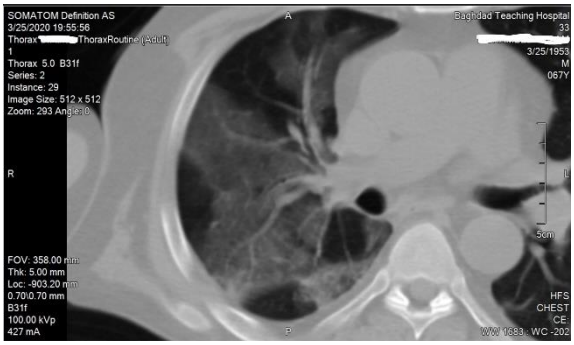

Figure 7: 67-year-old male patient with vascular thickening sign.

Figure 8: 47-year-old male patient with reversed halo sign.

Discussion:

Novel coronavirus pneumonia is a new viral infectious disease of the lower respiratory tract. The main patho-physiological mechanism of this pneumonia is not well understood. It is crucial to detect and early diagnose COVID-19 pneumonia for immediate isolation and treatment of the patients. CT has an important role in the early diagnosis of viral pneumonias (15), definitely including COVID-19 pneumonia (16, 17). In this series, we have reviewed the chest CT findings in confirmed COVID- 19 patients in patients from Baghdad, Iraq. In agreement with the study of Cheng et al (18), our study showed that most coronavirus pneumonia lesions were located in both the upper and lower lobes (65.4%) or in the lower lobe only (31%). More than half of the lesions in our study were located in the peripheral (subpleural) part of the lungs in (56.3%) in agreement with a study by Song et al (19). Our study showed that bilateral lung disease occurred in (81.8%) of patients, which is closely similar to the results of Chen et al (20) who that (75%) of his series had bilateral pneumonia. Our study showed that multilobe (multifocal) disease was seen in two thirds (67.2%) of patients, closely similar to the results of Han et al (21). In this study, the lesions were mainly pure GGO (47.3%), which is different from the findings of Zhao et al (22) and Han et al (21) who reported GGO in 71.2% and 86% of their cases respectively. This difference may be explained by the fact that our patients presented in later stages of the disease. Mixed ground glass and consolidation was reported in (43.6%) of our sample, closely similar to what was reported by Han et al (21). Our study showed a "crazy-paving" change in 20% of cases, similarly reported by Bernheim et al (32) who reported this finding in a late stage of disease (6-12 days) supporting the possibility that a significant number of our patients presented in the later stages of the disease. Our study showed the presence of vascular thickening in (31%) of the cases in disagreement with what was reported by Han et al (21) who reported vascular thickening in 80% of cases as well as with what was reported by Zhang et al (10) who found this sign in most cases. Zhou et al (24) reported this sign in (45.2% of cases), indicating that this sign had variable percentages in different studies. Architectural distortion was found in 11% of our series but was reported in variable percentages in different studies. Han et al (21) did not report this sign as his study concentrated on early CT manifestation of the disease, while Pan et al (13) reported architectural distortion in 17% of COVID-19 patients, which indicates that the presence of this sign depends on the stage and duration of disease. Bronchial changes were noted in 7.2% of our cases, closely similar to what was reported Wu et al (25). Halo sign was noted in 16.5% of our cases, closely similar to what was reported by Li et al (26). It is thought that angioinvasive fungal infections or hypervascular metastases to be associated with halo sign with perilesional hemorrhage, as well as viral infections and organizing pneumonia (27). The reverse halo sign (more or less complete ring-like consolidation surrounding a focal rounded GGO) was noted in 9% of our cases, which is higher than what was reported by Yoon et al (28) (3%) and Bernheim et al (23) (2%). This difference can be explained by the possible difference in the stage of the disease at presentation as this sign tend to appear in later stages of the disease. Rounded opacities were noted in 14.5% of

our cases, closely similar to what was reported by Bernheim et al (23).Pleural effusion was noted in 7.2% of our cases which is approximately similar to what was reported by Zhou et al (24). Mediastinal lymphadenopathy was only seen in one of our cases which was slightly enlarged and is closely similar to what was reported by Zhao et al (22). Normal chest CT was reported in 9% of our cases, closely similar to what was reported by Bernheim et al (23).

Conclusion:

The most common chest CT findings in COVID-19 in this study include multiple GGO, consolidation, both lungs involvement, with mostly peripheral distribution. The atypical chest CT findings in this study include mediastinal lymphadenopathy, pleural effusion and bronchial changes.

Two limitations were faced:

- First, a retrospective review of a small number of patients with positive RT-PCR test infection.
- Second, the dynamic CT changes in different stages cannot be analysed in this study since it was a cross-sectional study.

Author contribution:

- Atheer A. Fadhil: Study design, acquisition of data analysis, interpretation of data and drafting of manuscript
- Salam M. Joori: Study conception and study design
- Zaid H. Hammoodi: Study conception, study design, drafting of manuscript and critical revision.
- Haider A. Ghayad: Study design, acquisition of data analysis, interpretation of data, and drafting of manuscript.
- Ali Ibrahim: Study design and interpretation of data.

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طيف نتائج التصوير المقطعي المحوسب لمنطقة الصدر في مرض فايروس كورونا المستجد 2019 في مدينة الطب ببغداد

د. أثير عدنان فاضل
د. سلام محمد جوري
د. زيد هادي حمودي
د. حيدر عبد الامير
د. علي إبراهيم

الخلاصة:
الخلفية: يعتبر فحص التصوير المقطعي المحوسب (المفراس) لمنطقة الصدر من الفحوصات التشخيصية السريعة والعملية ويلعب دوراً مهماً في تقييم مرض كوفيد 19.
الهدف من الدراسة: وصف علامات ومشاهدات التصوير المقطعي المحوسب للصدر في عينة من المرضى المؤكد إصابتهم بمرض كوفيد 19 من مدينة بغداد.
المرضى وطرق البحث: تكونت عينة الدراسة من 55 مريض تم تأكيد إصابتهم بمرض كوفيد 19 مختبرياً وتم إجراء فحص مفراس الصدر للفترة من الأول من اذار لغاية الخامس عشر من نيسان 2020 في أقسام الأشعة في مجمع مدينة الطب التعليمية وتم مراجعة وتحليل النتائج.
النتائج: كانت العلامات الأكثر شيوعاً في التصوير المقطعي للصدر هي عتمة الزجاج المصنفر بنسبة 47.3% ومزيج من عتمة الزجاج المصنفر والتصلد بنسبة 43.6%. معظم الافات كانت متعددة بنسبة 67.2% وفي الجزء الخارجي من الرئتين بنسبة 56.3% وثنائية الجنب بنسبة 81.8%. أما المشاهدات الأقل شيوعاً كانت الإنصباب الجنبي بنسبة 7.2% وتضخم الغدد اللمفاوية المصنفية بنسبة 1.8%.
الإستنتاج: العلامات الأكثر شيوعاً في التصوير المقطعي المحوسب للصدر في مرض كوفيد 19 في بغداد كانت عتمة الزجاج المصنفر والتصلد المتعدد، الثنائي الجنب والخارجي (الذي يصيب الجزء الخارجي من الرئتين).
مفتاح الكلمات: كوفيد 19، التصوير المقطعي المحوسب.