Research Article

Comparison of chest CT findings in outpatient and hospitalized COVID-19 RT-PCR positive patients of Shiraz

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ABSTRACT

Introduction: Chest CT provides valuable information regarding coronavirus disease 2019 (COVID-19) during the treatment process. The present study aimed to assess the distribution of chest CT findings in outpatient (OPD) and hospitalized corona patients.

Material and method: This was a retrospective study. Archived corona patient's data on the picture archiving and communication system (PACS) was assessed in terms of demographic data and patients' lungs' radiologic features. The OPD and hospitalized patients referred to University hospitals from February 20 to the study's date were evaluated. Data were analyzed using independent chi-square and t-test.

Results: Five hundred and fifty nine patients, including 187 OPD and 372 hospitalized patients, were analyzed. The frequency of normal chest CT, typical, and possible corona features was 37.4%, 40.8%, and 14.3%. The normal chest CT rate was significantly higher in outpatient versus hospitalized patients (P<0.001). Consolidation and/or ground-glass opacity were seen in 61% of patients, considerably higher in hospitalized patients (P<0.001). 2% and 15% OPD and hospitalized patients had more than 25% lung involvement, respectively. The frequency of other signs such as Crazy Paving, atoll sign, subpleural band/distortion also was significantly higher in hospitalized patients (P<0.001).

Conclusion: Most OPD patients had less than 5% lung involvement or normal chest CT. The typical features of lung involvement in COVID-19 were significantly higher in hospitalized patients.

RÉSUMÉ

Introduction: La TDM thoracique fournit des renseignements précieux concernant la maladie à coronavirus 2019 (COVID-19) pendant le processus de traitement. La présente étude visait à évaluer la distribution des résultats de la tomographie thoracique chez les patients ambulatoires et les patients hospitalisés atteints de la maladie à coronavirus.

Matériel et méthodologie: Il s'agissait d'une étude rétrospective. Les données archivées des patients atteints de la maladie à coronavirus sur le système d'archivage et de communication des images (PACS) ont été évaluées en termes de données démographiques et de caractéristiques radiologiques des poumons des patients. Les patients ambulatoires et hospitalisés référés aux hôpitaux universitaires du 20 février à la date de l'étude ont été évalués. Les données ont été analysées à l'aide de tests indépendants de type chi carré et test de Student.

Résultats: Cinq cent cinquante-neuf patients, dont 187 en consultation et 372 hospitalisés, ont été analysés. La fréquence des caractéristiques normales du scanner thoracique, typiques et possibles de la couronne était de 37,4 %, 40,8 % et 14,3 %. Le taux de TDM thoracique normale était significativement plus élevé chez les patients ambulatoires que chez les patients hospitalisés (P<0,001). Une consolidation et/ou une opacité en verre dépoli ont été observées chez 61 % des patients, considérablement plus élevées chez les patients hospitalisés (P<0,001). 2 % et 15 % des patients en consultation et hospitalisés présentaient une atteinte pulmonaire supérieure à 25 %, respectivement. La fréquence d'autres signes tels que le « crazy paving », le signe

de l'atoll, la bande/distorsion sous-pleurale était également significativement plus élevée chez les patients hospitalisés (P<0,001).

Conclusion: La plupart des patients hospitalisés présentaient une atteinte pulmonaire inférieure à 5 % ou un scanner thoracique normal. Les caractéristiques typiques de l'atteinte pulmonaire dans la COVID-19 étaient significativement plus élevées chez les patients hospitalisés.

Introduction

Acute respiratory syndrome caused by Coronavirus (COVID-19) is a common human-animal disease that appeared in December 2019 [1,2]. This virus is classified as a ribonucleic acid (RNA) virus belonging to the coronavirus family [3,4], which is a severe warning to all world countries [5]. Iran is considered the 25th country that was infected with coronavirus [6,7]. The beginning of the Corona epidemy in Iran was from Qom's city on February 20, 2020 [8].

The disease is highly contagious, and each infected person can infect an average of 3 others [7]. Information on the characteristics and clinical outcomes of patients infected by COVID-19 is essential for reducing mortality [9]. The severe COVID-19 infection can lead to severe pneumonia and death due to multiple organ failure, while in mild disease, the usual symptoms of respiratory infection may not be present [10]. However, many ambiguities remain, and scientists conduct extensive research on this new virus [2].

Signs and symptoms of COVID-19 appear after a latency period of 1 to 14 days (average 2.5 days) [11–13]. The most common signs are fever, cough, and fatigue at the disease's onset [14,15]. If the patient does not respond to treatment, they die after about 6 to 41 days from the disease's onset [14]. According to available guidelines, detection of COVID-19 is performed by reverse transcript polymerase chain reaction (RT-PCR) or gene sequencing of respiratory or blood samples. However, the RT-PCR detection rate is at least 30 to 60% for the first time, and yet, this method has some limitations [16].

The diagnosis of COVID-19 can be based on radiological and laboratory findings. Radiological examinations are crucial in the early diagnosis and management of COVID-19 disease. Prominent radiographic images in patients with severe coronavirus pneumonia include ground-glass opacity (GGO) and lung consolidation, affecting both lungs [10]. Due to the limited number of nucleic acid test kits, such as rRT-PCR and the possibility of false-negative rRT-PCR results, CT scan of the chest as a non-invasive imaging technique can be helpful and a tool with high accuracy for early detection of suspected COVID-19 cases. For this purpose, it is essential to identify common imaging patterns of these cases [17].

Interestingly, Fang et al. found that COVID-19 rRT-PCR with a sensitivity of 71% may be comparable to CT with a sensitivity of 98% for COVID infection. Due to the ease of access and fast CT scan results compared to rRT-PCR kits, CT imaging is at the forefront of COVID-19 screening tools. Currently, most COVID-19 cases have shown pure and stabilizing GGO lesions in 60% of their initial chest CT imaging. CT imaging shows other findings as the infection progresses, such as the Crazy-Paving pattern [18].

Imaging is a valuable tool for diagnosing patients with suspected COVID-19, which shows the severity and progression of COVID-19 disease. Compared to RT-PCR, a chest CT scan is a more reliable, more comfortable, and faster tool to identify and evaluate cases of COVID-19, especially in areas where an epidemic has occurred. A recent report by China shows that chest CT scans have a 97% sensitivity to detect COVID-19, even better than RT-PCR [19]. Preliminary results show that low-dose CT scans, a widely available and relatively inexpensive imaging method in Iran, help diagnose COVID-19 in suspected symptomatic patients. Besides, the current pattern of chest scan reports developed by the Iranian Society of Radiology COVID-19 Consultant Group (ISRCC) can be used to classify and predict which patients should be treated and discharged in an outpatient setting and which patients need further evaluation and monitoring [20].

Considering the Intensity and spread of the COVID-19 epidemic in Iran and the world, the need to identify the disease's nature to control and treat this disease as one of the most critical priorities of the country's health care system; this study aimed to compare lung imaging findings (radiographic images and CT scan) in outpatients who were PCR positive for COVID-19 with patients hospitalized to University-affiliated hospitals.

Method

The present study is a cross-sectional study that was performed in a descriptive-analytical manner. The study population included outpatients and hospitalized patients in University-affiliated hospitals who tested positive for RT-PCR COVID-19. In this study, all patients were positive from February 20 until the test's time, and it should be mentioned that we consider the first imaging of these patients to diagnose COVID-19.

The patients who did not have High-Resolution Computed Tomography (HRCT) chest imaging information in the PACS system, patients with poor-quality chest HRCT, and hospitalized patients who were diseased were excluded from the study.

About the exclusion of severe cases, it should be explained that it was supposed that very severe patients (with evident symptoms) who might be deceased after first imaging had very

severe signs in their chest images, and it was apparent that they had Covid-19. This study intended to compare the chest image findings of patients not hospitalized who had a good condition and patients hospitalized with a severe condition but could survive to discover chest image findings to help detect Covid-19 in non-symptoms patients and patients who had mild to relatively severe symptoms. Therefore, considering the mentioned assumption and objective of the study, the severe patients were excluded.

Data were collected using a checklist prepared from patients' records. This checklist had two parts: patients' demographic information (i.e., age and sex) and clinical, radiological, and lung involvement. The interpretation of this information is based on the latest research on chest CT findings in COVID-19 infection.

Based on these characteristics, patients are classified into four groups: normal chest HRCT, HRCT with a definitive diagnosis for COVID19, probable HRCT for COVID-19, and other diagnoses instead of COVID-19. Data were analyzed using SPSS version-21 software and independent chi-square and t-test. The significance level in this study was considered 0.05.

Results

This study studied 559 patients (outpatient department (OPD) and admitted) diagnosed with COVID-19 by PCR test. Three hundred seventy-two patients (66.5%) were hospitalized, and 187 patients (33.5%) were treated in an outpatient department. The mean age of patients was 47.47 ± 18.13 years (3-96 years). The mean age of positive patients who were hospitalized was significantly higher than outpatients. Three hundred one patients were male (53.8%), and 258 patients were female (46.2%). The frequency distribution of gender did not show a significant difference between the two groups. One hundred twenty-six patients had consolidation (30% of admitted patients and 7.5% of OPD), and 312 patients had GGO (71% of admitted patients and 26% of OPD). The rates of GGO and consolidation were significantly higher in admitted patients. Multiple, bilateral, peripheral, posterior, and lower lobes involvement were the most frequent forms of distribution of GGO and consolidation among both OPD and admitted patients (Table 1).

According to results (Table 2), the frequency of crazy paving patterns and atoll signs was significantly higher in admitted patients. There is also evidence of a significant difference in subpleural sparing rate, subpleural band /distortion, lymphadenopathy (LAP), air bronchogram, tree-in-bud appearance, and pleural effusion between the two groups. (Rate of mentioned findings were significantly higher in admitted patients comparing to outpatient) The vascular dilatation, traction bronchiectasis, and air trapping showed no significant difference between the two groups. It was also found that the mean number of CT scans taken in hospitalized patients was significantly higher than in outpatients. The time interval between CT scans was higher in outpatients than in hospitalized patients, which was statistically significant.

According to the results of Table 3 about CT involvement score, 213 (38.4%) patients had no lung involvement, 100 patients (18.1%) had less than 5% lung involvement, 183 patients (33%) had 5-25%, 43 patients (7.8%) had 26-50%, 7 patients (1.3%) had 51-75% and 8 patients (1.4%) had more than 75% lung involvement. The rate of normal chest CT was significantly higher in outpatient versus hospitalized patients. (P<0.001) The highest frequency in the admitted group was related to 5-25% lung involvement, while in the OPD group, most of the patients either had normal chest CT or less than 5% lung involvement.

According to RSNA classification, 209 patients (37.4%) had normal chest CT, 228 patients (40.8%) had typical features of COVID-19, 80 patients (14.3%) had possible features and 42 patients (7.5%) had other diagnoses. The rate of typical features was significantly higher in the admitted group compared to the OPD group.

Discussion

The radiologists can identify COVID-19 cases promptly by evaluating CT images based on the appropriate epidemiologic and demographic features. Therefore, reasonable preventive action can be implemented to curtail the transmission of this novel coronavirus.

So far, most COVID-19 cases have shown pure GGO and consolidative lesions in 60% of their early chest CT imaging. CT imaging will reveal other findings as the infection progresses, such as the crazy-paving pattern [17].

The main results have shown that a low-dose CT scan, an accessible imaging test in Iran, is valuable for detecting COVID-19 in suspicious symptomatic patients. Furthermore, the current reporting template for thoracic CT scan suggested by IS-RCC could be beneficial for classifying patients and predicting which patients should be treated in the outpatient setting and discharged and which patients require further evaluation and monitoring, and even admission to intensive care unit (ICU) if necessary [20].

The present study showed that the mean age of hospitalized COVID-19 patients was significantly higher than outpatients, but the frequency distribution of gender between the two groups did not significantly differ. The result was consistent with the previous studies, such as the Davarpanah et al. study, in which the mean age of patients who needed ICU admission was significantly higher than those who were not admitted to ICU. Similarly, the mean age of patients who died during hospitalization was higher than that of survivors [21]. The Tenforde et al. study results also showed that hospitalized patients were typically older and had more underlying chronic diseases than outpatients [22]. Age was generally recognized as an independent risk factor for in-hospital death in previous studies. Older age has been confirmed in two other previous similar studies as an independent prognostic factor for mortality in patients with COVID-19 [23,24]. In a preliminary report of 121 ICU patients in the United States, 80% of whom died had been over 65 years old [25].

Table 1.
The distribution frequency of consolidation and ground-glass opacity (GGO) amongst Hospitalized and outpatient departments (OPDs).

Variable	Characteristics	Admitted	OPD	Total	P value
Consolidation	Multiple	84(75.0%)	7(50.0%)	91(72.2%)	0.049
	Single	28(25.0%)	7(50.0%)	35(27.8%)	
	Peripheral	71(63.4%)	13(92.9%)	84(66.7%)	0.087
	Central	2(1.8%)	0	2(1.6%)	
	Diffuse	39(34.8%)	1(7.1%)	40(31.7%)	
	Round	31(27.7%)	7(50.0%)	38(30.2%)	0.086
	Irregular	81(72.3%)	7(50.0%)	88(69.8%)	
	Posterior	67(59.8%)	6(42.9%)	73(57.9%)	0.001
	Anterior	4(3.6%)	4(28.6%)	8(6.3%)	
	Both	41(36.6%)	4(28.6%)	45(35.7%)	
	Lower	59(52.7%)	10(71.4%)	69(54.8%)	0.25
	Upper	4(3.6%)	1(7.1%)	5(4.0%)	
	Both	49(43.8%)	3(21.4%)	52(41.3%)	
	Bilateral	91(81.3%)	8(57.1%)	99(78.6%)	0.038
	Unilateral	21(18.8%)	6(42.9%)	27(21.4%)	
GGO	Multiple	216(81.8%)	28(58.3%)	244(78.2%)	<0.001
	Single	48(18.2%)	20(41.7%)	68(21.8%)	
	Peripheral	191(72.3%)	38(79.2%)	229(73.4%)	0.017
	Central	3(1.1%)	3(6.3%)	6(1.9%)	
	Diffuse	70(26.5%)	7(14.6%)	77(24.7%)	
	Round	102(38.6%)	23(47.9%)	125(40.1%)	0.22
	Irregular	162(61.4%)	25(52.1%)	187(59.9%)	
	Posterior	101(38.3%)	22(45.8%)	123(39.4%)	0.064
	Anterior	14(5.3%)	6(12.5%)	20(6.4%)	
	Both	149(56.4%)	20(41.7%)	169(54.2%)	
	Lower	142(53.8%)	23(47.9%)	165(52.9%)	<0.001
	Upper	31(11.7%)	17(35.4%)	48(15.4%)	
	Both	91(34.5%)	8(16.7%)	99(31.7%)	
	Bilateral	176(66.7%)	31(64.6%)	207(66.3%)	0.57
	Unilateral	88(33.3%)	17(35.4%)	105(33.7%)	

Table 2.
Frequency of study parameters in hospitalized and OPDs.

Variable	Hospitalized	OPD	Total	P- value
age	50.52±18.32	41.44±16.16	47.47±18.13	<0.001
Sex(male)	209(56.2%)	92(49.2%)	301(53.8%)	0.18
Consolidation	112(30.1%)	14(7.5%)	126(22.5%)	<0.001
GGO	264(71.0%)	48(25.7%)	312(55.8%)	<0.001
GGO and Consolidation	86(23.1%)	11(5.9%)	97(17.4%)	<0.001
Crazy Paving	91(24.5%)	13(7.0%)	104(18.6%)	<0.001
atol sign	52(14.0%)	9(4.8%)	61(10.9%)	<0.001
subpleural sparing	83(22.3%)	11(5.9%)	94(16.8%)	<0.001
subpleuralband/distortion	37(9.9%)	6(3.2%)	43(7.7%)	0.004
vascular dilatation	18(4.8%)	3(1.6%)	21(3.8%)	0.062
traction bronchectasis	18(4.8%)	4(2.1%)	22(3.9%)	0.16
LAP	39(10.5%)	4(2.1%)	43(7.7%)	<0.001
air trapping	5(1.3%)	1(0.5%)	6(1.1%)	0.66
cavitation	5(1.3%)	3(1.6%)	8(1.4%)	0.80
air bronchogram	41(11.0%)	6(3.2%)	47(8.4%)	0.001
Tree-in-bud/ nodule	44(11.8%)	9(4.8%)	53(9.5%)	0.009
pleural effusion	23(6.2%)	4(2.1%)	27(4.8%)	0.037
number of CT	1.87±1.05	1.19±0.44	1.72±0.99	<0.001
time interval	9.09±6.30	13.38±8.98	9.82±7	<0.001

CT: Computed tomography
GGO: Ground-glass opacity
LAP: Lymphadenopathy
OPD: Outpatient department

Table 3.
CT involvement scores of hospitalized and outpatient department (OPD)'s high-resolustion computed tomography (HRCTs).

CT involvement score	Variable			
	Hospitalized	OPD	Total	*P*-value
non	77(21.0%)	136(72.7%)	213(38.4%)	<0.001
< 5% involvement	68(18.5%)	32(17.1%)	100(18.1%)	
5%-25% involvement	168(45.8%)	15(8.0%)	183(33.0%)	
26%-49% involvement	39(10.6%)	4(2.1%)	43(7.8%)	
50%-75% involvement	7(1.9%)	0	7(1.3%)	
> 75% involvement	8(2.2%)	0	8(1.4%)	

Table 4.
The frequency of definite and suspected cases of corona patient's computed tomography (CT) findings. There was a significant difference between hospitalized patients and outpatient departments (OPD).

CT Finding	Variable			
	Hospitalized	OPD Table 4:	Total	*P*-value
Normal	75(20.2%)	134(71.7%)	209(37.4%)	<0.001
Typical	211(56.7%)	17(9.1%)	228(40.8%)	
Possible	59(15.9%)	21(11.2%)	80(14.3%)	
Other	27(7.3%)	15(8.0%)	42(7.5%)	

According to Table 1, GGO and consolidation rates were significantly higher in admitted patients, which indicated the severity of the disease in hospitalized patients. Multiple, bilateral, peripheral, posterior, and lower lobes involvement were the most frequent forms of distribution of GGO and consolidation among both OPD and admitted patients.

Consistent with another study conducted in Wuhan on 81 COVID patients, most patients in their study showed bilateral lung involvement with the dominant peripheral location. The predominant pattern was ground-glass opacity, with ill-defined margins, air bronchogram, smooth or irregular interlobular septal thickening, and thickening of the adjacent pleura [26].

Based on another study conducted in Wuhan on 58 asymptomatic cases with COVID-19 pneumonia admitted to their hospital, ground-glass opacity with peripheral distribution, unilateral location, and mostly involving one or two lobes was the predominant chest CT findings [27].

In another study conducted in China about chest CT findings in coronavirus infection, the results showed that more than half of patients had normal CT in the early phase of the disease (in the first two days from the initial onset of symptoms and first chest CT taken). After a long time from the onset of symptoms, CT findings were more frequent, including bilateral and peripheral ground glass and consolidative opacification, crazy-paving patterns, and reverse halo signs with greater total lung involvement [28].

In the study of Jiong Wu et al., the most common chest CT findings of COVID-19 were multiple GGO, consolidation, and interlobular septal thickening in both lungs and with the subpleural distribution. The most common involved lung segments were the dorsal segment of the right lower lobe (86%) and the posterior basal segment of the right lower lobe (85%) [29].

According to another study conducted in Rome, Italy, on 158 patients, the typical pattern of COVID-19 pneumonia in chest CT was peripheral ground-glass opacities with multilobar and posterior involvement, bilateral distribution, and subsegmental vessel enlargement (>3 mm). Chest CT had high sensitivity (97%) but lower specificity (56%) in comparison with RT-PCR [30].

The present study also showed that the frequency of crazy paving patterns and atoll signs was significantly higher in admitted patients. The rate of subpleural sparing, subpleural band /distortion, LAP, air bronchogram, tree-in-bud appearance, and pleural effusion were significantly higher in admitted patients than in outpatient. Higher LAP rates, tree in the bud, and pleural effusion in admitted patients may contribute to superimposed infection or more comorbidities in these groups than outpatients.

Our results showed that about 20% of admitted patients and 70% of OPD patients had a normal initial chest CT scan. The sensitivity of chest CT in the diagnosis of COVID-19 was lower in our study than in previous studies. According to a study conducted by Fang et al., on 51 patients with positive RT-PCR, only one patient had normal chest CT [18]. Another study by Chung et al. showed that chest CT might be negative for viral pneumonia of COVID-19 at initial presentation. Three of 21 patients had normal chest CT in their study [31]. Our study's high rate of normal chest CT may contribute to the time of initial chest CT taken. As seen in previous studies, some patients may have normal chest CT in the early stage of disease (0-4 days after onset of symptoms), so normal chest CT cannot exclude COVID-19, especially in symptomatic patients in the early stage of disease follow-up CT is recommended in these groups [32,33]. Moreover, patients who expired at hospital courses were not included in our study, so severe cases with more lung involvement were not studied. The present study

also showed that outpatients did not have lung involvement above 50%, and the rate of lung involvement in hospitalized patients was higher than outpatients.

Limitations of this study include the retrospective nature of our analysis and exclusion of severe COVID-19 who expired at hospital course for comparison. Moreover, the initial chest CT taken was used to describe lung involvement of COVID-19 in our study, and most of the patients who had normal chest CT or nonspecific findings in the chest developed with typical chest CT findings in follow-up imaging.

Conclusion

Most OPD patients had normal chest CT or less than 5% lung involvement, so normal chest CT cannot exclude COVID-19, especially in a mild form of the disease and correlation with clinical findings and lab data (especially RT-PCR) and also follow-up CT is mandatory in most patients. The typical features of lung involvement in COVID-19 were significantly higher in hospitalized patients, and consistent with previous studies, multiple, bilateral, peripheral, posterior, and lower lobes ground-glass opacities and consolidation were the most common findings of lung involvement among both OPD and admitted patients.

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